

Appendix P  
**Responses to Comments on DEIR**

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Appendix P.1  
**Responses to Comments on the Draft EIR**

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## **APPENDIX P1 RESPONSE TO COMMENTS ON THE DRAFT EIR**

The Draft Environmental Impact Report (Draft EIR) for San Diego Forward: The 2021 Regional Plan (the Regional Plan) was distributed for public review on August 27, 2021, for a 45-day public review period that ended October 11, 2021. The Draft EIR and all appendices were available for review online at [www.sdforward.com](http://www.sdforward.com); at San Diego Association of Governments (SANDAG) offices located at 401 B Street, Suite 800, San Diego, California 92101; and at the San Diego Central Library located at 330 Park Boulevard, San Diego, California 92101. The Central Library facilitates inter-library transfers upon request by a member of the public in order to provide access at local libraries. On a case-by-case basis, the San Diego Central Library can also digitize documents and transfer them to other libraries. No such requests were made of the Central Library with respect to the Draft EIR, nor were any requests made of SANDAG with respect to providing access to the Draft EIR during the public comment period.

A total of 51 comment letters, web comments, or other written documents such as emails (hereinafter collectively referred to as “comment letters”) were received before the close of the public review period. Table P-1 provides a list of all comments received, including the name of the public agency, organization, or individual that submitted the letter and the date of the letter. Each comment letter also has been assigned an identification number in Table P-1.

In this appendix, each comment letter is reproduced in its entirety and is aligned side-by-side with the response(s) to the letter. Where commenters provided multiple comments, each comment is identified with a bracket and an identifying number in the margin of the comment letter. All comment letters received on the Draft EIR were evaluated for significant environmental issues, and written responses to comments on environmental issues were prepared. In addition to comments related to environmental issues, several of the comment letters submitted on the Draft EIR also include individual comments on the content of the Plan itself that are not related to the adequacy of the Draft EIR. In those cases, this document identifies the specific reference number assigned to that comment in the matrix of Regional Plan comments and responses where the response can be found (e.g., “Please see the response to Plan comment 901”). For ease of reference the matrix of responses to comments on the Regional Plan is included as Appendix P.2 to the Final EIR.

### **MASTER RESPONSES**

SANDAG has prepared the following two Master Responses dealing with common themes raised in the comment letters:

- Master Response 1: Draft EIR Evaluates a Reasonable Range of Alternatives
- Master Response 2: Mitigation Measures that Other Agencies “Can and Should” Implement

The text of each Master Response is provided below. Individual responses reference the Master Response number when all or part of a response is included within a Master Response (e.g., “Please see Master Response 1”).

**Table P1-1**  
**List of Comment Letters on the Draft EIR for the Draft 2021 Regional Plan**

Identification Number	Public Agency, Organization, or Individual	Date of Letter
1	Office of Joel Anderson	10/11/2021
2	Dr. Tim Bilash	10/11/2021
3	Patricia Borchmann	9/24/2021
4	Mike Brower	10/11/2021
5	Mike Bullock	10/11/2021
6	Climate Action Campaign	10/11/2021
7	City of Carlsbad	10/11/2021
8	Center for Biological Diversity	10/11/2021
9	California Department of Fish and Wildlife	10/11/2021
10	California Coastal Commission	10/11/2021
11	City of Coronado	10/6/2021
12	County of San Diego	10/11/2021
13	City of Del Mar	10/4/2021
14	Descanso Community Planning Group	10/4/2021
15	Endangered Habitats League	10/11/2021
16	Friends of Rose Creek	10/11/2021
17	Friends of Rose Canyon	10/11/2021
18	David Grubb (Quality of Life Coalition)	10/11/2021
19	Toshi Ishihara	9/17/2021
20	Jacumba Community Sponsor Group	10/11/2021
21	Craig Jones	9/17/2021
22	San Diego County Local Agency Formation Commission	9/30/2021
23	Libby Lucas	10/11/2021
24	James Marple	9/3/2021*
25	City of Oceanside	10/11/2021
26	City of Poway	10/11/2021
27	City of San Diego	10/11/2021
28	City of San Marcos	10/7/2021
29	Southern California Tribal Chairmen's Association	9/8/2021
30	San Diego County Air Pollution Control District	10/11/2021
31	San Diego County Regional Airport Authority	10/11/2021
32	San Diego Transportation Equity Working Group	10/8/2021
33	Sierra Club San Diego	10/11/2021
34	Chatten Brown, Carstens & Minter LLP (on behalf of Sierra Club San Diego)	10/11/2021
35	Save our Forest and Ranchlands/Cleveland National Forest Foundation	10/7/2021
36	City of Solana Beach	10/11/2021
37	Southwest Wetlands Interpretive Association	10/11/2021

Identification Number	Public Agency, Organization, or Individual	Date of Letter
38	United States Fish and Wildlife Service	10/8/2021
39	Karin Zirk	10/10/2021
<b>Comments Received via Website</b>		
40	Unidentified Web Comment	9/17/2021
41	Unidentified Web Comment	9/20/2021
42	Bruce Higgins	8/28/2021
43	Brent Tanner	9/30/2021
44	Craig Forman	8/28/2021
45	John Wotzka	8/31/2021
46	James Ferguson	8/28/2021
47	Craig Nelson	8/31/2021
48	Philip Muniz	8/28/2021
49	Justin Wong	9/3/2021
50	Justin Wong	9/3/2021
51	Elizabeth Fattah	10/11/2021

\*Original comment submitted by Mr. Marple was inadvertently left blank. SANDAG subsequently contacted Mr. Marple and received the full comment letter on November 11, 2021.

## **MASTER RESPONSE 1: DRAFT EIR EVALUATES A REASONABLE RANGE OF ALTERNATIVES**

### **INTRODUCTION**

Comments assert that the range of alternatives evaluated in the EIR does not meet the California Environmental Quality Act's (CEQA's) requirement to evaluate a reasonable range of potentially feasible alternatives that would avoid or substantially reduce the project's significant environmental impacts. Comments also assert that all alternatives evaluated in the Draft EIR are infeasible for financial and other reasons because they accelerate all transit and alternative transportation projects to the first 10 years of the Plan with insufficient funding. Comments also state that the Draft EIR should have considered a number of additional alternatives, including:

- A feasible alternative that would substantially reduce vehicle trips and vehicle miles traveled (VMT).
- Save Our Forests and Ranchlands' (SOFAR's) and Cleveland National Forest Foundation's (CNFF's) Climate, Housing, Transit Alternative.
- An alternative that substantially lessens significant impacts on biological resources.
- An alternative with VMT reduction features such as subsidized transit fares and microtransit.
- Southwest Wetlands Interpretive Association's (SWIA's) alternative that prioritizes transit over managed lanes, institutes a much more rigorous monitoring system, adds a regional habitat conservation fund, and ensures enforcement of Plan compliance.
- An alternative that reduces greenhouse gas (GHG) emissions consistent with State goals or achieves net zero emissions.

As explained below, the Draft EIR does evaluate a reasonable range of alternatives that achieve most of the basic project objectives and that are potentially feasible. The discussion also explains why the Draft EIR was not required to consider the alternatives listed above.

## **RANGE OF ALTERNATIVES**

As discussed in Chapter 6, *Alternatives Analysis*, of the Draft EIR, nine potential alternatives were initially considered for further detailed analysis. Of these, three alternatives to the proposed Plan were evaluated in detail. In addition to the no project alternative, the alternatives evaluated in detail included an alternative that consists of the 2019 Federal Regional Transportation Plan (RTP) transportation network and land use pattern with new value pricing and user fees policies; and an alternative that consists of the proposed Plan transportation network, a land use pattern that restricts regional growth to mobility hubs, and includes more progressive value pricing and user fees policies than what is included in the proposed Plan. The three alternatives evaluated in detail are described in Draft EIR Section 6.2 (pages 6-2 through 6-8).

They are as follows:

- Alternative 1: No Project
- Alternative 2: 2019 Transportation Network with New Value Pricing and User Fee Policies
- Alternative 3: All Growth in Mobility Hubs and More Progressive Value Pricing and User Fee Policies

Draft EIR Section 6.5 (pages 6-9 to 6-16) explains why other alternatives suggested by the public during EIR scoping were not evaluated in detail, either because they did not meet the project objectives, they were potentially infeasible, or they were similar to the alternatives already evaluated in detail.

## **ALTERNATIVES RESPOND TO PUBLIC CONCERNS EXPRESSED DURING SCOPING**

As the Draft EIR explains (p. 6-1), SANDAG listened to public input expressed during the EIR scoping process, and used this input to develop the reasonable range of alternatives. Public input requested alternatives that reduce GHG emissions, air quality impacts, and VMT. The alternatives selected for detailed consideration incorporate many of the major transportation investments and policy options that commenters suggested, such as providing more compact land use patterns, substantially lowering transit fares, and substantially increasing the cost of driving.

Notably, alternatives do not need to be environmentally superior in all respects to the proposed Plan. Courts have noted that for complex projects with a wide scope, “it is practically impossible to imagine an alternative that would provide substantial environmental advantages in all respects” (*Sierra Club v. City of Orange* (2008) 163 Cal. App. 4th 523).

## **FEASIBILITY OF ALTERNATIVES EVALUATED IN DETAIL**

The feasibility of alternatives is considered twice in the CEQA process. At the outset, the Draft EIR considered a reasonable range of alternatives that are “potentially feasible” (CEQA Guidelines Section 15126.6(a)). At the conclusion of the EIR process, the decision-makers (in this case the SANDAG Board of Directors) makes final determinations as to the feasibility of alternatives, considering information in the Draft EIR, additional information in the Final EIR and elsewhere in the administrative record, and policy factors. (See Guidelines Section 15091(a)(3).)

This final determination of feasibility may include policy considerations. Where the feasibility of alternatives evaluated in the EIR is dependent upon changes in existing laws, regulations, or funding patterns for transportation improvements, the SANDAG Board must consider the likelihood that such changes will occur within the time frame for implementation of relevant elements of the proposed Plan.

## ALTERNATIVES SUGGESTED BY COMMENTERS

**General Principles.** Alternatives suggested by commenters include, but are not limited to:

- A feasible alternative that would substantially reduce vehicle trips and VMT.
- SOFAR’s and CNFF’s Climate, Housing, Transit Alternative.
- An alternative that substantially lessens significant impacts on biological resources.
- An alternative with VMT reduction features such as subsidized transit fares and microtransit.
- SWIA’s alternative that prioritizes transit over managed lanes, institutes a much more rigorous monitoring system, adds a regional habitat conservation fund, and ensures enforcement of Plan compliance.
- An alternative that reduces GHG emissions consistent with State goals or achieves net zero emissions.

Some of the alternatives suggested by commenters are variations of alternatives that the Draft EIR evaluated in detail. CEQA does not require an EIR to consider multiple variations on the alternatives analyzed in a Draft EIR, or to consider additional potential alternatives that are not “considerably different” than those already evaluated in the EIR. Other alternatives suggested by commenters are alternatives to one component of the proposed Plan, e.g., transit-emphasis alternatives, rather than comprehensive alternatives addressing the Sustainable Communities Strategy (SCS) and highway network improvements as well as transit. To be legally adequate under federal transportation law and Senate Bill (SB) 375, the proposed Plan is required to address transit projects, highway projects, and sustainable land use patterns; all three components are integrated into the basic project objectives described in EIR Section 2.4 (page 2-6). An EIR must discuss alternatives to a project in its entirety but is not required to discuss alternatives to each particular component of a project. Also, an EIR need not evaluate in detail alternatives that would not substantially lessen the proposed project’s significant environmental impacts.

The potential alternatives proposed for evaluation in comments on the Draft EIR either are not considerably different than those evaluated in the Draft EIR, do not address all project components, do not meet most basic project objectives, do not substantially reduce the proposed Plan’s significant impacts, and/or are infeasible. Selected individual potential alternatives are discussed below

### Alternative that Substantially Reduces VMT Below Existing Levels

Commenters suggest the Draft EIR should have evaluated a project alternative that substantially reduces VMT below existing levels. Alternative 3 consists of the proposed Plan transportation network, a land use pattern that restricts all regional growth to the mobility hubs, and more progressive value pricing and user fees policies than what is included in the proposed Plan; it achieves lower total VMT than the proposed Plan, though still above existing levels. An alternative including *further* VMT-reduction measures to reduce total VMT below existing levels is not currently feasible for several reasons, including:

- *Further* substantial changes needed in State and federal policy and legislation. These would include still *further* changes in State road pricing policy, land use policies, and parking policies—beyond those included in the proposed Plan and Alternatives 2 and 3—that are not reasonably foreseeable.
- Lack of funding for *further and accelerated* major transit service improvements (recognizing that, as discussed in additional detail in subsequent discussion, increased transit investments alone cannot achieve substantial VMT reductions). The request to switch funding from roadways to transit fails to recognize that there are regulatory constraints on directing roadway funds to transit, and on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or



collected on an annual basis and much funding cannot be advanced. There are also constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network.

- Severe economic and social impacts caused by substantial increases in driving costs. Alternative 3 already raises the fees compared to the proposed Plan. From a consumer standpoint, increases in fuel or vehicle user costs can be a trade-off with discretionary expendable income for purchasing food, clothing, and other personal items, especially for lower income households. A significant increase in fuel cost or vehicle user fees would also result in lower spending in other areas of the economy, and economic disruption would occur in adjusting to higher fuel or vehicle registration prices.
- Lack of authority for SANDAG and local governments to implement such *further* measures. For example, SANDAG has no authority to increase State road pricing, or require local governments to implement land use or parking policies.
- SANDAG's inability to control the total regional population growth that is the main cause of total VMT increases. As SANDAG modeling indicates, population growth is the main driver of future VMT growth. Alternative 3 would result in VMT per capita of 15.6 (home-based) compared to the proposed Plan VMT per capita of 16.03 in 2050. Alternative 3 would result in a total VMT increase of 2,756,715 miles per day in year 2050, which is approximately 39 percent lower than the proposed Plan (total VMT increase of 4,519,230 miles per day in year 2050). Population growth under the proposed Plan, however, increases by 13 percent. Even with decreases in driving per capita, under Alternative 3 total VMT still increases by 3.2 percent compared to 2016 because population growth outpaces driving reductions. As courts have noted, "CEQA is not intended as a population control measure" (*Center for Biological Diversity v. Department of Fish & Wildlife* (2015) 62 Cal.4th 204, 220).

#### **SOFAR's and CNFF's Climate, Housing, Transit Alternative**

This alternative was proposed in scoping, but considered and rejected from detailed consideration in the Draft EIR; in response to a later Draft EIR comment letter reiterating it should have been included, further explanations for rejection are included in the Final EIR's responses to SOFAR's and CNFF's Draft EIR comment letter.

As explained in the Draft EIR (pp. 6-14 and 6-15), some specific feasible components of this alternative are already included in the proposed Plan and/or Alternative 3. These include comprehensive transit investments in: high-speed commuter rail; tunneling and double-tracking where feasible; rail line straightening, higher-speed and higher-frequency transit with separate rights-of-way, fewer stops, grade separation, and new high-speed lines; a Central Mobility Hub that connects to the airport as well as to transit elements offering further interconnectivity throughout the San Diego region; and expanded local transit and shared mobility. The proposed Plan and Alternative 3 also include an intensified, compact land use, as well as expanded active transportation infrastructure improvements.

This alternative includes the following major components that were not included in the proposed Plan or EIR alternatives, for the reasons discussed below:

- A "transit first" plan that substantially reduces VMT and provides substantive benefits in transit/bike/walk mode share and advancing all transit projects to the first 10 years of the Plan.
- Prioritize transit/active transit over managed lanes.
- Accelerate implementation of the Los Angeles–San Diego–San Luis Obispo Rail Corridor (LOSSAN) double-track rail project and Miramar tunnel and rail line straightening project.

With regards to accelerating transit to the first 10 years of the Plan, there are regulatory constraints on redirecting roadway funds to transit, and on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or collected on an annual basis and much funding cannot be advanced. There are also constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network. For instance, federal formula funds such as Federal Transit Administration (FTA) Section 5307 or Regional Surface Transportation Program (RSTP), are apportioned annually; SANDAG can make assumptions about how much can be anticipated in the future based on historical data but cannot advance any project(s) that need the funding in years prior to apportionment. Other funds that SANDAG cannot advance and re-direct to transit include funds going to other agencies, such as the State Highway and Protection Program (SHOPP) funds, which are managed by the California Transportation Commission and are used for safety, operations, and rehabilitation projects on the state highway system by the California Department of Transportation (Caltrans).

With regards to prioritizing transit over managed lanes and accelerated implementation of rail projects, SANDAG conducted a modeling analysis to compare the proposed Plan network with managed lanes investments to the Climate, Housing, Transit Alternative. The model run assumed no new managed lanes (only transit lanes), and accelerated the Miramar Tunnel rail line and straightening project to 2035. As discussed in detail in responses to SOFAR's and CNFF's Draft EIR comment letter, converting managed lanes to transit lanes and accelerating the Miramar Tunnel rail line results in similar VMT and GHG impacts as the proposed Plan, and does not substantially reduce them.

In summary, the Climate, Housing, Transit alternative was not selected for detailed consideration in the EIR because:

- Some specific feasible components of this alternative are already included in the proposed Plan and/or Alternative 3.
- It is infeasible to accelerate transit to the first 10 years of the Plan and redirect all roadway funding to transit.
- The Climate, Housing, Transit alternative results in similar VMT and GHG impacts as the proposed Plan, and does not substantially reduce them.
- It is infeasible to achieve the GHG and VMT reduction goals proposed in the Climate, Housing Transit alternative; see Draft EIR p. 6-15 through 6-16 and the discussion below regarding the infeasibility of an alternative that reduces GHG emissions consistent with State goals.

#### **Alternative that Substantially Lessens Significant Impacts on Biological Resources**

A commenter suggested an alternative that would avoid or substantially lessen impacts on biological resources. As discussed in Section 4.4, *Biological Resources*, of the EIR the impacts on biological resources were analyzed at a programmatic level based on best available information. Impacts were analyzed based on the programmatic footprint developed for the 2021 Regional Plan, and mitigation measures were identified accordingly that achieve substantial reductions to impacts. Additional analysis will be conducted on a project-specific level under CEQA, including project-specific impact analysis of biological resources and identification of mitigation measures. Mitigation measures would be refined and implementation methods identified, as required by CEQA, the local jurisdictions, and Wildlife Agencies on a project-specific level.

The Plan places emphasis on maximizing the use of existing facilities and focusing growth within urban areas to preserve habitat and open space. In addition, Alternative 3 has a smaller footprint and would further reduce impacts on biological resources. In summary, the proposed Plan and Alternative 3 both substantially reduce

biological resources with the implementation of mitigation measures and the proposed footprints, and a new alternative that also reduces such impacts is not required for an adequate range of alternatives.

### **Alternative with Subsidized Transit Fares and Microtransit**

Another commenter requested that alternatives that include features such as subsidized transit fares and microtransit be considered. SANDAG considered public input provided during the EIR scoping process, and used this input to develop the reasonable range of alternatives. Public input requested alternatives that reduce GHG emissions, air quality impacts, and VMT. The alternatives selected for detailed consideration incorporate many of the major transportation investments and policy options that commenters suggested, including subsidized transit fares and microtransit. As discussed in Chapter 6, Alternative 3 (All Growth in Mobility Hubs and More Progressive Value Pricing and User Fee Policies) includes free transit and microtransit by 2035. Because Alternative 3 would not reduce any of the Plan's significant impacts to less-than-significant levels, just modifying the transportation network to include subsidized transit fares and microtransit would not be enough to substantially reduce VMT and GHG emissions as compared to the proposed Plan.

In addition, one of the Implementation Actions listed in Appendix B of the proposed Plan is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by fiscal year (FY) 2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, Metropolitan Transit System (MTS), and North County Transit District (NCTD) are working with stakeholders on a 1-year pilot that may provide free fares for youth under age 19.

### **SWIA's Alternative that Prioritizes Transit Over Managed Lanes, Institutes a Much More Rigorous Monitoring System, Adds a Regional Habitat Conservation Fund, and Ensures Enforcement of Plan Compliance**

Reasons for not including each of the four components in an EIR alternative are discussed below. In addition, there is no evidence that collectively, they would substantially reduce any of the proposed Plan's significant impacts.

#### ***Prioritizing Transit over Managed Lanes***

Comments suggest that the proposed Plan should prioritize transit over managed lanes. The Managed Lanes network of the proposed Plan uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools, and low-emission vehicles with appropriate decals. The system of Managed Lanes and supporting connectors support Transit Leap and High-Occupancy Vehicles (HOVs) to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes. The Managed Lane system is important for supporting the transit network and Flexible Fleets envisioned in the Regional Plan.

As discussed above under SOFAR's and CNFF's Climate, Housing, Transit Alternative, SANDAG conducted a modeling analysis to compare the proposed Plan network with managed lanes investments to the Climate, Housing, Transit Alternative, which focuses on prioritizing transit. The model run assumed no new managed lanes (only transit lanes), and accelerated the LOSSAN double-track rail project and the Miramar Tunnel rail line and straightening project to 2035. As discussed in detail in responses to SOFAR's and CNFF's Draft EIR comment letter, converting managed lanes to transit lanes and accelerating the two suggested rail projects results in similar VMT and GHG impacts as the proposed Plan, and does not substantially reduce them.

Furthermore, there are regulatory constraints on redirecting roadway funds to transit, and on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved

or collected on an annual basis and much funding cannot be advanced. There are also constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network, as described further under the SOFAR and CNFF Climate, Housing, Transit Alternative above.

### ***Monitoring System for Transportation System's Buildout and Performance***

Comments suggest that SANDAG implement clear and definitive mechanisms to monitor future population growth, jobs, and housing development in accordance with the proposed Plan to ensure that transportation system investments are in line with development and growth trends.

As identified in Appendix B of the Regional Plan, SANDAG will continue to monitor the implementation of the Regional Plan on a 4-year cycle and make the data accessible to the public. Monitoring would occur 2 years after adoption of the Regional Plan. Furthermore, SANDAG has committed to monitor the implementation for the SCS on a 2-year cycle pursuant to California Assembly Bill 1730 (Gonzalez 2019). A performance monitoring report using the indicators from Appendix E of the Regional Plan is developed halfway between each 4-year regional plan cycle. The report is shared with the SANDAG Board of Directors to provide a high-level status update on critical areas across the region. This information helps inform the Board of Directors in their development of regional goals for the subsequent regional plan. The indicators use available observed data that also informs how each indicator is calculated. In summary, some specific feasible components of this alternative are already included in the proposed Plan.

### ***Regional Habitat Conservation Fund***

Comments suggest that an alternative that includes a regional habitat conservation fund be included in the EIR. Appendix AA of the Regional Plan describes the status of the Habitat Conservation Plans (HCPs) within the region. Each local jurisdiction that signed an Implementing Agreement for their HCP has been granted “take” authorization for impacts on endangered and threatened species. By way of the take authorizations, the local jurisdictions have made commitments to fund the local costs for acquisitions, management, and monitoring. Funds to cover these local costs will be raised on a regional or plan area basis as outlined in the Implementing Agreements.

SANDAG will continue its existing grant programs, partner with member agencies on State funding opportunities, and provide data and technical support to assist local jurisdictions with land use planning efforts in line with the 2021 Regional Plan. To meet the region’s habitat conservation goals, the 2021 Regional Plan identifies approximately \$3 billion for habitat-related efforts. This includes \$2,087 million for an enhanced habitat conservation, management, and monitoring program (see Land Use and Habitat programs in Appendix B of the proposed Plan), a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (see Climate Adaptation and Resilience programs in Appendix B of the proposed Plan and mitigation measure GHG-5c in Section 4.8, *Greenhouse Gas Emissions*, of the EIR), and \$300–\$500 million of land acquisition and restoration for habitat mitigation of transportation projects (incorporated in project costs presented in Appendix A of the proposed Plan).

As such, because HCP funding is already included in the proposed Final Plan, no additional alternative with this component is necessary.

### ***Ensuring enforcement***

Comments suggest that an alternative should ensure enforcement of the jurisdictions’ compliance with the Plan. Land use authority is reserved to local jurisdictions: the cities and the County. The cities and the County are best positioned to effectively implement and monitor the objectives outlined in the 2021 Regional Plan as

those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program, and it will meet the goals of the proposed Final 2021 Regional Plan.

The 2021 Regional Plan envisions forecasted growth to be concentrated in Mobility Hubs throughout the region, which will be implemented in close coordination with local jurisdictions to align with the unique needs of each community. Many Mobility Hubs are employment centers or other popular destinations, and SANDAG would work with local jurisdictions to update plans and policies to allow for more housing in these locations where feasible. Local jurisdictions maintain land use authority and are responsible for decisions regarding density, zoning, and housing policies.

In addition, for second-tier transportation projects, SANDAG will implement mitigation measures for those projects that SANDAG directly approves or carries out as the CEQA lead agency or where discretionary TransNet funds are used. Where SANDAG acts as a pass-through agency for funding, it is the funding agency's responsibility to place conditions on grant funding. When using discretionary TransNet funds, which support TransNet grant programs funding local agency capital projects, SANDAG will require as a grant condition the implementation of all feasible EIR mitigation measures that are applicable to the project type being funded.

In summary, a number of enforcement provisions are already included in the proposed Plan, and an additional alternative with this component is not required.

#### ***Alternative that Reduces GHG Emissions to Net Zero or Consistent with State Goals***

Multiple commenters assert that the range of alternatives is not reasonable because the alternatives would still be inconsistent with statewide GHG reduction and climate goals. The Draft EIR Impact GHG-5 analysis explains why it is infeasible for the proposed Plan to be consistent with the State's ability to meet the 2030 reduction target of SB 32 and the long-term reduction goals of Executive Orders B-55-18 (2045) and S-3-05 (2050). Similar feasibility constraints apply to other potential proposed Plan alternatives. In addition, as identified in Section 4.8 of the EIR, the proposed Plan would reduce GHG emissions for all three horizon years. As discussed in the Draft EIR, p. 4.8-40, the State has yet to develop or adopt an overarching plan that provides the framework for how California will achieve carbon neutrality by 2045. California's 2017 Climate Change Scoping establishes the statewide framework for achieving the goal of a 40 percent reduction from 1990 GHG levels in 2030 and put post-2030 statewide emissions on a downward trajectory toward the long-term statewide GHG reduction goals for 2045 and 2050. The 2017 Scoping Plan indicates that to achieve these targets and goals, long-term investments in renewable energy generation, electrified transportation, energy efficient and decarbonized buildings, enhanced industry efficiency, restoration of California's natural and working lands, and sustainable solid waste management are among many actions the State must take. The State has not adopted a plan analogous to the 2017 Scoping Plan since that addresses achieving the EO S-3-05 goal of reducing statewide GHG emissions by 80 percent below 1990 levels by 2050 or the B-55-18 goal of achieving statewide carbon neutrality no later than 2045.

The proposed Plan would assist in meeting the statewide 2030 GHG target in putting statewide emissions on a downward trajectory toward statewide post-2030 goals by reducing GHG emissions in the passenger vehicle sector through the implementation of transportation network improvements and programs and efficient land use patterns to ultimately reduce VMT and the combustion of gasoline and diesel fuels pursuant to SB 375. However, it is unknown at this time what combination of reduction and removal strategies will be pursued in California to achieve this goal. Available research and reports, discussed in detail in Section 4.8 of the EIR, indicate that achieving statewide GHG reduction goals will require major shifts or even fundamental transformations in the economic, social, technological, and political fabric of life in California and beyond, including the development of new technologies; large-scale deployment of new and existing technologies; and

the roles of local, State, and the federal government in regulating economic activities and personal behaviors that affect GHG emissions.

Furthermore, as discussed in Chapter 2, *Project Description*, of the EIR SANDAG updates the Regional Plan every 4 years, and future iterations of the Plan and, as the State continues to identify new plans and technologies to meet the mid-century GHG emission targets, SANDAG will be able to implement these features into future plans to further the region's progress toward the State's goal of carbon neutrality by 2045. The required GHG reductions from the aforementioned sectors will be achieved through a coordinated effort by, at minimum, State, regional, and local agencies, organizations, and stakeholders, and is well beyond the scope and jurisdiction of SANDAG alone. As such, a proposed Plan alternative that further reduces GHG emissions consistent with State GHG reduction goals was not included for detailed consideration in the EIR because it is beyond SANDAG's or local agencies' current ability to implement.

## **MASTER RESPONSE 2: MITIGATION MEASURES THAT OTHER AGENCIES "CAN AND SHOULD" IMPLEMENT**

### **INTRODUCTION**

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects. Many Draft EIR mitigation measures for second-tier projects, recognizing that agencies other than SANDAG (e.g., local governments, transit districts, and Caltrans) are responsible for implementation, state that such agencies "can and should" implement them. Comments assert that there is no guarantee these agencies will actually implement these mitigation measures, question whether they will be imposed on second-tier projects, and allege that, to the extent SANDAG has any discretion over awarding funds for such projects, SANDAG must require the mitigation measures as conditions of approval.

One comment asserted that "can and should" is discretionary language and makes the mitigation measure non-enforceable, and that SANDAG should mandate implementation of mitigation measures for its own projects and for other agencies implementing projects under the Regional Plan.

As discussed in the Draft EIR (page 4-4), SANDAG is responsible for implementing those mitigation measures within its responsibility, jurisdiction, and statutory authority. Mitigation can also include measures that are within the responsibility and jurisdiction of another public agency (CEQA Guidelines Section 15091 (a)(2)). In many instances, mitigation measures included in the EIR that would avoid or substantially lessen significant impacts of the proposed Plan fall under the responsibility and jurisdiction of other implementation agencies, such as cities, the County, Caltrans, public transit agencies, or other special districts. In other words, SANDAG will not be the lead agency for the majority of the second-tier projects that implement the proposed Plan.

Because other project agencies would be responsible for certain mitigation measures identified in this EIR, SANDAG in its CEQA findings may find that those measures, if feasible, can and should be adopted by those other agencies (CEQA Guidelines Section 15091(a)(2)). Further details regarding responsibilities for mitigation measure implementation will be provided in a separate mitigation monitoring and reporting program (MMRP) that the SANDAG Board of Directors will consider for approval in conjunction with approval of the proposed Plan.

## EIR MITIGATION APPROACH

When CEQA findings are adopted, SANDAG will commit to those feasible mitigation measures that are within its responsibility and jurisdiction by making the finding that its mitigation measures “have been required in, or incorporated into, the project” (Public Resources Code Section 21081(a)(1); CEQA Guidelines Section 15092(a)(1)). For second-tier transportation projects, SANDAG will implement mitigation measures for those projects that SANDAG directly approves or carries out as the CEQA lead agency or where discretionary TransNet funds are used.<sup>1</sup> Where SANDAG acts as a pass-through agency for funding, it is the funding agency’s responsibility to place conditions on grant funding. When using discretionary TransNet funds, which support TransNet grant programs funding local agency capital projects, SANDAG will require as a grant condition the implementation of all feasible EIR mitigation measures that are applicable to the project type being funded.

Therefore, the assertion that “can and should” language is unenforceable is incorrect, in that SANDAG would enforce these measures by requiring them as grant conditions for transportation projects whenever it has discretionary authority to do so.

When SANDAG makes “can and should” findings at the end of the CEQA process, there is no further requirement that SANDAG find that mitigation measures that are solely within the responsibility and jurisdiction of another agency have been incorporated into the project (Public Resources Code Section 21081; CEQA Guidelines Section 15091(a)(2)). Nevertheless, as discussed below, it is reasonable to expect that the other agencies will actually implement the mitigation measures assigned to them.

The Draft EIR (pages 4-3 through 4-4) describes the intended use of a mitigation measure and the general approach to the mitigation measures in the EIR.

“The EIR includes three broad types of mitigation measures: (1) plan- and policy-level mitigation measures assigned to SANDAG; (2) mitigation measures for transportation network improvements and programs, assigned to SANDAG and other transportation project sponsors; and (3) mitigation measures for development projects implementing regional growth and land use changes, which local jurisdictions implement.”

“While the EIR provides as much detail as needed in the mitigation measures to evaluate their ability to avoid or substantially lessen impacts, some flexibility must be maintained to present mitigation approaches for impacts occurring under different circumstances. Many of the mitigation measures include lists of mitigation actions that can be implemented in connection with individual future transportation and development projects that would implement the proposed Plan; development projects would be undertaken under the land use authority of local governments. These individual future projects will occur over a wide and diverse geographic scope over the 30-year time span addressed in the proposed Plan. Some will require approvals from multiple public agencies, each with different legal, regulatory, or other authority relevant to the proposed Plan. Because the nature of individual future projects, resources, and legal authority of the approving agency or agencies, physical circumstances of the project, and local policy considerations for all future projects implementing the proposed Plan will vary widely, the mitigation actions included, while generally feasible for many projects, may not be feasible for specific projects. In each case, the lead agency (and any responsible agencies) for an individual project will have to determine

---

<sup>1</sup> SB 1703 consolidated the region’s transit capital construction with SANDAG from the two transit operators. SANDAG also coordinates with Caltrans as the lead agency for highway projects. Local jurisdictions construct arterial and local roadway projects.

which mitigation actions are specifically applicable to the project, and the degree to which the recommended mitigation actions can feasibly be implemented based on project-specific circumstances.

### **GREENHOUSE GAS EMISSIONS MITIGATION**

In addition, the Draft EIR (pages 4.8-35 and 4.8-36) explains the EIR's general approach to GHG mitigation. This approach is applicable to other significant impacts described in the EIR.

"Many features currently included in the proposed Plan (e.g., the SCS, increased transit, and active transportation investments) have the effect of reducing GHG emissions that might otherwise occur. Mitigation measures presented in this section are additional feasible GHG reduction measures not included in the proposed Plan that SANDAG would or other agencies could implement."

"While SANDAG has the authority to implement the mitigation measures it has committed to, it has no legal or jurisdictional authority to require other transportation project sponsors or local jurisdictions to implement mitigation measures for specific projects for which they have responsibility and jurisdiction. As explained in the introduction to Chapter 4, mitigation can include measures that are within the responsibility and jurisdiction of another public agency. SANDAG in its CEQA findings may find that those measures assigned to other agencies can and should be adopted by those other agencies (CEQA Guidelines Section 15091(a)(2))."

### **TRANSPORTATION PROJECT MITIGATION**

SANDAG has limited authority to approve individual second-tier transportation network improvement projects in the RTP. Many individual transportation projects in the RTP would be implemented by Caltrans and local governments. For example, Caltrans would implement most of the managed lane projects, and local governments would implement the arterial project shown on Figures 2-23 through 2-25 of the EIR. As required by CEQA and agency-specific CEQA procedures (e.g., the Caltrans Standard Environmental Reference), these agencies routinely implement the types of mitigation measures assigned to them during project design, CEQA review, and/or project construction, and the Draft EIR has made a preliminary determination that these mitigation measures are feasible and effective. Therefore, it is reasonable to expect that these agencies will actually implement them. Additionally, SANDAG is the direct source of funding (versus a pass-through agency) for TransNet grant programs funding local agency capital projects and will require as a grant condition the implementation of all feasible EIR mitigation measures that are applicable to the project type being funded.

### **LAND USE PLAN AND PROJECT MITIGATION**

SANDAG has no authority to adopt local land use plans or approve local land use projects that will implement the SCS. SB 375 specifically provides that nothing in SB 375 supersedes the land use authority of cities and counties, and that cities and counties are not required to change their land use plans and policies, including general plans, to be consistent with an RTP/SCS (Government Code Section 65080(b)(2)(K)). Local governments are the main agencies responsible for mitigation of the impacts of land use plans and projects that implement the SCS, and SANDAG has no concurrent authority to mitigate the impacts of land use plans and policies. Local governments routinely implement the types of mitigation measures assigned to them during project design, CEQA review, and/or project construction, and the Draft EIR has made a preliminary determination that these mitigation measures are feasible and effective. Therefore, it is reasonable to expect that local governments will actually implement them.



A recent, relevant example of local government implementation of mitigation measures addressing the land use change and regional growth projected to occur as a result of implementation of local general plans is provided below.<sup>2</sup>

- An Air Quality Impact Analysis shall be prepared for projects within the General Plan Update boundary that exceed one of the air quality study trigger criteria in Table 4.3-12, Air Quality Impact Analysis Trigger Criteria.

Land Use	Project Site that would Trigger Air Quality Impact Assessment	Single Family Dwelling Unit Equivalent
Single Family Residential 300 du 1 du/1 du	300 du	1 du/1 du
Apartments: 6-20 du/acre	370 du	1 du/1.23 du
Apartments: - > 20 du/acre	420 du	1 du/1.4 du
Condominiums	370 du	1 du/1.23 du
Mobile Home Park	400 du	1 du/1.33 du
Supermarket	25,000 sf	1 du/83.33 sf
Restaurant, Fast Food w/drive through	6,500 sf	1 du/21.67 sf
Restaurant, Quality Sit Down	43,000 sf	1 du/143.33 sf
Neighborhood/County Park (undeveloped)	880 acres	1 du/2.93 acre
Motel	480 rooms	1 du/1.6 room
Standard Commercial Office (<100,000 sf per office site)	190,000 sf	1 du/633.33 sf
Neighborhood shopping center	35,000 sf	1 du/116.67 sf

- Siting Sensitive Receptors near sources of Toxic Air Contaminants. A Health Risk Assessment (HRA) shall be prepared by a qualified air quality professional for development of new sensitive receptors proposed in the General Plan Update planning area within 500 feet of a waste transfer facility. A Health Risk Assessment (HRA) shall be prepared for development of new sensitive receptors in the General Plan Update planning area proposed within one mile of industrial land uses, medical facilities, or research and development facilities that generate a potential source of Toxic Air Contaminants (TACs). The project shall not be considered for approval until an HRA has been completed and approved by the City. The methodology for the HRA shall follow the Office of Environmental Health Hazard Assessment and SDAPCD guidelines for the preparation of HRAs. If a potentially significant health risk is identified, the HRA shall identify appropriate measures to reduce the potential health risk to below a significant level, or the sensitive receptor shall be sited in another location.

#### PROJECT-SPECIFIC MITIGATION MEASURES MAY NOT APPLY TO EVERY PROJECT

Comments suggest that the text in the EIR should remove the “can and should” language and require all agencies to implement the mitigation measures. Although second-tier lead agencies routinely implement the types of mitigation measures assigned to them during project design, CEQA review, and/or project construction, the Draft EIR recognizes that due to project- or site-specific circumstances, it may not be feasible for individual lead agencies to implement all of the “can and should” mitigation measures listed for a particular significant impact; in this case, the Regional Plan EIR programmatic mitigation measures still meet CEQA

<sup>2</sup> City of Escondido. 2015. *Escondido General Plan, Downtown Specific Plan and Climate Action Plan EIR, 4.3 Air Quality*. Available: <https://www.escondido.org/Data/Sites/1/media/PDFs/Planning/GPUpdate/Vol1AirQuality.pdf>.

requirements, but in the later project-specific CEQA review, the Regional Plan EIR could not be used as a first-tier Program EIR for the significant impact proposed for mitigation. As stated on p. 4-4 of the Draft EIR:

“Because the nature of individual future projects, resources and legal authority of the approving agency or agencies, physical circumstances of the project, and local policy considerations for all future projects implementing the proposed Plan will vary widely, the mitigation actions included, while generally feasible for many projects, may not be feasible for specific projects. In each case, the lead agency (and any responsible agencies) for an individual project will have to determine which mitigation actions are specifically applicable to the project, and the degree to which the recommended mitigation actions can feasibly be implemented based on project-specific circumstances.”

Similarly, lead and responsible agencies for an individual project will have to determine whether the lead agency, the project proponent, or another entity is responsible for implementation of particular mitigation measures.



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 October 11, 2021  
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1-3 **Investing in Emerging Technologies**  
 Although micromobility options such as scooters and bicycles are not realistic options for most East County communities, I appreciate SANDAG's willingness to explore innovative solutions. I encourage you to continue to investigate the benefits and potential to invest in emerging technologies that lower emissions while maximizing the use of existing transportation infrastructure. One example is the emergence of autonomous electric vehicles that can be charged via renewable energy while providing convenient and equitable door-to-door transportation service to all San Diego County residents.

1-4 **Uphold Projects Promised in TransNet Program**  
 It is my understanding that SANDAG plans to eliminate over twenty projects included in the TransNet Extension Ordinance and Expenditure Plan approved by voters in 2004. Included in the list of canceled projects are several that, if eliminated, would adversely impact my district, which again, has almost no alternatives to motor vehicle use. I urge you to continue to move forward with the following projects, which were promised to the region's residents to secure their votes for TransNet:

- Interstate 8 Widening (2nd Street to Los Coches Road)
- State Route 52 Express Lanes (Interstate 15 to Interstate 805)
- Interstate 805/State Route 52 HOV Connectors
- State Route 94 Widening (State Route 125 to Steele Canyon)

1-5 **Investment in East County Transportation Options**  
 Although the draft Regional Plan proposes to focus significant funding on new rail and trolley line infrastructure along the region's coast, it does not include similar investments for alternative transportation options in East County. As a result, most of my constituents must continue to rely on motor vehicles for their commutes to work and school and for other daily mobility needs, as investments in freeways decrease and road user costs increase. This approach will increase traffic congestion in East County while impeding the region's efforts to meet vehicle miles traveled and emissions reductions goals or attempts to achieve carbon neutrality. Therefore, I urge you to consider adding alternative transportation infrastructure options in East County where feasible.

1-6 **Housing**  
 The Draft Regional Plan and DEIR make land use assumptions for jurisdictions based on Regional Housing Needs Allocations (RHNA). It is stated that the Mobility Hubs encourage a diversity of housing options, mixed-use development, and travel options within a centralized area. But the planning of transportation and housing does not match in the years 2025, 2035, or even 2050.

**RESPONSE TO COMMENT 1-3**

Transit Leap will offer people a network of high-capacity, high-speed, and high-frequency transit services that will incorporate new modes of transit while also providing improved existing services. Transit Leap includes Next Gen Rapid Bus Service, local bus, and Flexible Fleet services to complete the Transit Leap network. This bus network would offer faster and more reliable service with increased frequencies and longer service hours.

Flexible Fleets can range from bikes and scooters to autonomous shuttles that provide on-demand service that are ADA compliant and provide options for users that may not have access to a smartphone or internet device to hail a ride.

**RESPONSE TO COMMENT 1-4**

The TransNet measure approved by San Diego County voters in 2004 focused on congestion relief and included a set of transportation improvements, many of which have been completed. The remaining projects in the TransNet measure may not be constructed due to changes in regional needs, changes in State law, and technology advancements that would suggest a different transportation solution.

CAL536, shown in the 2021 Regional Transportation Improvement Program (RTIP), is a project for Operational Improvements to SR 52, which include a truck climbing lane, a bike lane, and an auxiliary lane. This project is currently expected to open to traffic in September of 2024. The project shown in the Regional Plan in 2035 includes the addition of three Managed Lanes to SR 52. When TransNet was adopted the anticipated future land use pattern included significant development in East County. Those developments are no longer expected due to expanded land preservation, slower regional growth rates, and state regulations focusing development near existing infrastructure. Many of the TransNet projects that have not yet been built were designed to support the East County growth that has not happened and is no longer anticipated.

The SANDAG Board of Directors may review the TransNet ordinance and discuss possible updates. This process is outside of the development the proposed Plan.

**RESPONSE TO COMMENT 1-5**

The proposed Plan includes Mobility Hubs for East County which can facilitate creating additional economic opportunities within that hub.

Mobility Hubs are communities with a high concentration of people, destinations, and travel choices. They offer on-demand travel options and supporting infrastructure to enhance connections to high-quality Transit Leap services while helping people make short trips around the community on Flexible Fleets. Mobility Hubs will be implemented in close coordination with local jurisdictions to align with the unique needs of each community.

Several corridors were evaluated for their travel times between the 2016 baseline and future build scenarios (2025, 2035, and 2050). Two of these corridors were rural corridors between Ramona and Downtown San Diego via SR 67 and El Cajon to Kearny Mesa. In both of those corridors travel times were improved for auto travel (both solo vehicle and carpool) for all three build scenarios compared to the base year. These travel times will be included in Appendix T of the Final Plan.

SANDAG is also developing a Flexible Fleet Implementation Strategic Plan to identify near-term opportunities for Flexible Fleet pilots that support mobility, equity, and sustainability goals.

Also, the proposed Plan has been shown to meet the State GHG goals (19% reduction from 2005 levels by 2035). While related, no VMT goals are included in the Plan

#### **RESPONSE TO COMMENT 1-6**

The 6th Cycle Regional Housing Needs Assessment (RHNA) Plan sets a strategy for sustainability that focuses housing and job growth in urban areas where there is existing and planned transportation infrastructure, protects the environment and helps ensure the success of smart growth land use policies by preserving sensitive habitat and open space, and addresses the housing needs of all economic segments of the population. In the long term, housing located near transit and jobs should provide opportunities for residents to take more trips by bus or train and live closer to where they work, reducing VMT and GHG emissions. A specific effort was made in the proposed Plan to match transportation with land use (including housing).

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October 11, 2021  
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1-6 cont. For example, the DEIR states that most of the transportation network improvements in the next decade are addition of managed lanes along Interstate 5 through the coastal cities of Encinitas, Carlsbad, and Oceanside. Yet, the DEIR also states that the rates of housing unit increases are forecasted to be lower than the regional average in the coastal cities of Oceanside (8.4 percent), Carlsbad (14.2 percent), Encinitas (6.3 percent), Solana Beach (13.3 percent), Del Mar (6.4 percent), Coronado (9.5 percent), and Imperial Beach (18.7 percent).

1-7 Further, there is no mechanism to ensure the RHNA numbers are actually met by all jurisdictions. Until each city commits to meeting these RHNA numbers, the substantial housing shortage will continue. If, as the DEIR states in Chapter 4.14, that there will be no housing constructed in the unincorporated area from 2036 to 2050, each city should have a more comprehensive Housing Element that includes penalties for not meeting the planned growth.

1-8 The DEIR states that impacts related to induced substantial increases in population under the proposed Plan would be significant and unavoidable. As Lead Agency, SANDAG is required to consider all feasible mitigation measures. SANDAG should consider, develop, and adopt a mitigation measure that enacts a financial penalty for the cities that cannot meet their RHNA numbers.

Thank you for the opportunity to submit my comments on the Draft Environmental Impact Report for the 2021 Regional Plan. If you have any questions concerning my comments, please feel free to contact me at (619) 531-5522.

Sincerely,



Joel Anderson  
Supervisor, Second District

Cc: Kirsten Uchitel, Associate Planner, SANDAG

**RESPONSE TO COMMENT 1-7**

Land use authority is under the purview of local jurisdictions: the cities and the County. The cities and the County are best positioned to effectively implement the housing objectives outlined in the proposed Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program, and it will meet the goals of the proposed Plan. SANDAG's Housing Incentive Program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs.

**RESPONSE TO COMMENT 1-8**

The commentor is requesting that SANDAG consider, develop, and adopt a mitigation measure that enacts a financial penalty for the cities that cannot meet their RHNA numbers. This mitigation measure is not within the authority of SANDAG to enact. SANDAG will continue to collaborate and coordinate with cities as applicable to meet RHNA numbers. Thank you for your comment, SANDAG appreciates your input.

**COMMENT LETTER 2: DR. TIM BILASH**

Comment Letter 2

**From:** DrTim <[drtimbilash@gmail.com](mailto:drtimbilash@gmail.com)>  
**Sent:** Monday, October 11, 2021 7:04:18 AM (UTC+00:00) Monrovia, Reykjavik  
**To:** RegionalPlanEIR <[RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)>  
**Subject:** Regional Plan EIR

**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

Subject:  
 Wildfires and Tire Road Wear  
 From:  
 DrTim <[DrTimBilash@gmail.com](mailto:DrTimBilash@gmail.com)>  
 Date:  
 10/10/21, 11:56 PM  
 To:  
[ClerkoftheBoard@sandag.org](mailto:ClerkoftheBoard@sandag.org)  
 CC:  
 tim <[vote@obssoft.net](mailto:vote@obssoft.net)>

SANDAG

2-1 I fear the following is beyond the time period for inclusion in the EIR. The issues are so severe I would ask for it to be forwarded to the appropriate agencies and committees.  
 The Emergent Nature of Wildfires which are increasing and Ultrafine Particles appears to relate to increasing Health Risks and outcomes we are experiencing. Forgive the hastiness of this organization - I am only recently alerted to it's importance in health issues. I thank to SANDAG Members and Participants for their contributions.

2-2 1) From a discussion on the recent Medpage Today, Johns Hopkins Medicine Podcast, "TTHHealthWatch" (August 21, 2021) citing an article in Science Advances  
 They noted:  
 -short-term exposure to wildfire smoke PM 2.5, particulate matter 2.5 is associated with health conditions such as heart attack  
 -wildfire smoke was associated with the increased risk of COVID-19 cases and deaths.  
 -wildfires contribute up to 25% of the PM 2.5 concentrations in the atmosphere in the United States. Most of those wildfires in 2020 occurred in California, Washington, and Oregon

**RESPONSE TO COMMENT 2-1**

Thank you for your participation in the environmental review process. It is acknowledged that the body of knowledge regarding health risks associated with ultrafine particles originating from wildfires is rapidly evolving. Further elaboration regarding your concerns related to wildfires and ultrafine particles will be addressed in additional details in subsequent responses below.

**RESPONSE TO COMMENT 2-2**

As shown in Table 4.3-7 of the EIR, PM2.5 emissions would decrease by 9 percent between 2016 and 2050. In addition, as discussed in additional detail in Section 4.19, *Wildfire*, regional growth, land use change, and transportation network improvements associated with the proposed Plan would expose additional people and structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildland. Wildfires would also potentially expose the region's population to harmful pollutant concentrations in the form of wildfire smoke. Mitigation measure WF-1 will reduce this impact by requiring measures to preclude or substantially reduce risks from wildland fires by requiring specific design features for new development and by requiring that adequate emergency response is in place to serve new development when wildfires occur. To the extent that these measures reduce risk of wildfire, they would also reduce the exposure of county residents to uncontrolled wildfire spread and to harmful pollutant concentrations in the form of wildfire smoke. However, given the uncertain nature of wildfires, it cannot be concluded that wildland fire risks and the risks associated with wildfire smoke pollution would be reduced to less than significant in all locations for all future development projects. Therefore, impacts remain significant and unavoidable.

The following text regarding newly published data concerning the association of elevated levels of PM2.5 from wildfires with increased incidence of COVID-19 was added to page 4.19-21 of Section 4.19, *Wildfire*:

A recent study suggests that the airborne PM2.5 can carry harmful microbes as evidenced by an increase in fungal infections in areas

characterized by recent wildfires (Kobziar and Thompson III, 2020). Another recent study showed an association between elevated levels of COVID-19 cases and high PM2.5 concentrations originating from wildfires in the four weeks after exposure in counties with large wildfires in 2020 (Zhou et al 2021).



2-2 cont. They also looked at what they called the lag effect: how much did this wildfire exposure affect COVID-19 cases 14 and 21 days post exposure?

- found daily increases in PM 2.5 of 10 µg per cubic meter
- found an almost 12% increase in COVID-19 cases at 28 subsequent days
- found that 17 of 92 counties had strong evidence of a positive association between exposure to these particles and increased risk of death 4 weeks later.
- the average increase of death is about 8% and the increase in cases is about 12% for every 10 µg/m3 increase. In some counties it was as high as 60% or 70% in terms of deaths and rates.

The plausibility is that wildfires increase inflammation in the lung, and may suppress the immune system, and therefore make it more likely for people to get COVID several weeks after the wildfire was reported.

The other possibility is perhaps that particulate matter helps the virus to transport further distances. It looks like this association does have some biologic plausibility.

[https://www.medpagetoday.com/podcasts/healthwatch/94147?xid=nl\\_mpt\\_DHE\\_2021-08-23&utm-e=1493923d0r&utm\\_source=Salithru&utm\\_medium=email&utm\\_campaign=Daily%20Headlines%20Top%20Cat%20HeC%20%202021-08-23&utm\\_term=NL\\_Daily\\_DHE\\_dual-email-definition](https://www.medpagetoday.com/podcasts/healthwatch/94147?xid=nl_mpt_DHE_2021-08-23&utm-e=1493923d0r&utm_source=Salithru&utm_medium=email&utm_campaign=Daily%20Headlines%20Top%20Cat%20HeC%20%202021-08-23&utm_term=NL_Daily_DHE_dual-email-definition)

2-3 2) The COVID-19 pandemic also highlights the persistent inequities among several communities in terms of their infection rate, their morbidity, or mortality associated with wildfires -- particularly for the American Indians, Blacks, Latinos, and even Native Hawaiians and Pacific Islanders. The largest risk factor for COVID-19 is Smoking, and young persons have high rates of Vaping associated with the disease.

<https://scitechdaily.com/a-little-known-threat-infectious-microbes-harmful-living-bacteria-and-fungi-in-wildfire-smoke/>

2-4 3) A recent article from the American Association for the Advancement of Science highlights an additional risk from wildfire smoke microbes.

"According to Kobziar and Thompson, wildfire smoke contains living microbes bacteria and fungi known to affect human health — aerosolized from burning materials such as soils, detritus and wild woods and transported in smoke plumes.

2-4 However, while the pulmonary and cardiovascular consequences of smoke exposure are well known and recognized, the potential for wildfire smoke to be a source of infection has been overlooked and remains unaddressed in public health and wildfire science. To date, very little research has been done to determine whether the transport of smoke-borne microbes poses a health risk, in addition to the risk known from particulate inhalation, despite compelling evidence that shows increasing rates of certain fungal infections in areas with increased levels of wildfire smoke."

2-5 4) Wildfires in the US were noted low in 2016, 2018; but high in 2017 & 2020 when Total US Deaths were also high.

**RESPONSE TO COMMENT 2-3**

The referenced podcast, available at <https://www.medpagetoday.com/podcasts/healthwatch/94147>, discusses several different issues. The first issue discussed is the health effects of PM2.5 from wildfires. The large contribution of wildfires to PM2.5 levels in the western U.S. is outlined, and the adverse health effects are discussed. The second issue addressed in the podcast is inequalities in access to health care between different ethnic groups, and how these inequities have been exacerbated by COVID-19. These issue discussions are distinct however, and neither wildfires nor PM2.5 are mentioned in the healthcare inequality discussion. Also, note that under CEQA, social equity is not an environmental issue required to be analyzed in an EIR.

**RESPONSE TO COMMENT 2-4**

Recent data suggesting that airborne PM2.5 originating from wildfires can carry harmful microbes, as evidenced by an increase in fungal infections in areas characterized by recent wildfires, was added to the impact discussion of Section 4.19, *Wildfire*, of the Final EIR.

**RESPONSE TO COMMENT 2-5**

The association between more prevalent wildfires and increased deaths is acknowledged. The existing conclusions state that the healthcare effects of wildfire include increased risk of death.

As discussed above under response to comment Bilash 2-2, mitigation measure WF-1 will reduce wildfires by requiring measures to preclude or substantially reduce risks from wildland fires in VHFSZs by requiring specific design features for new development and by requiring that adequate emergency response is in place to serve new development when wildfires occur.

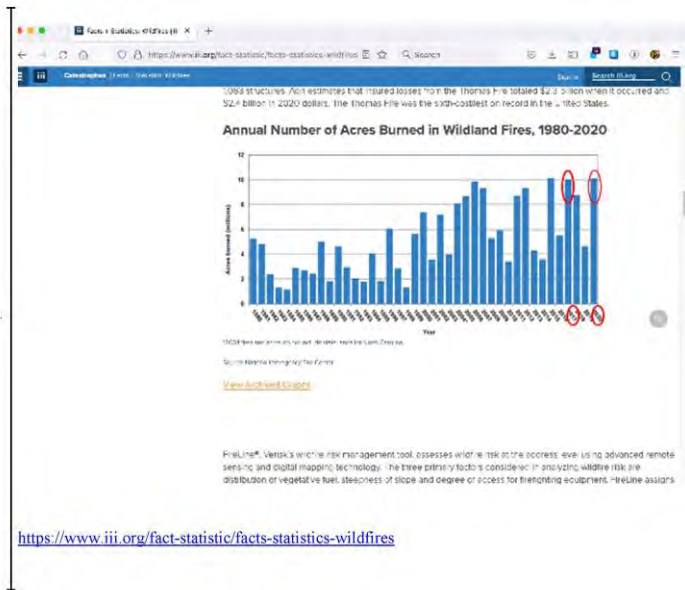
In addition, mitigation measure WF-2, as discussed in greater detail in Section 4.19, *Wildfire*, of the EIR, combined with other mitigation measures resulting from project-level CEQA conducted by the implementing agency, including adherence to existing fire prevention regulations and BMPs, will reduce the impact of transportation-related infrastructure on wildfire risk.

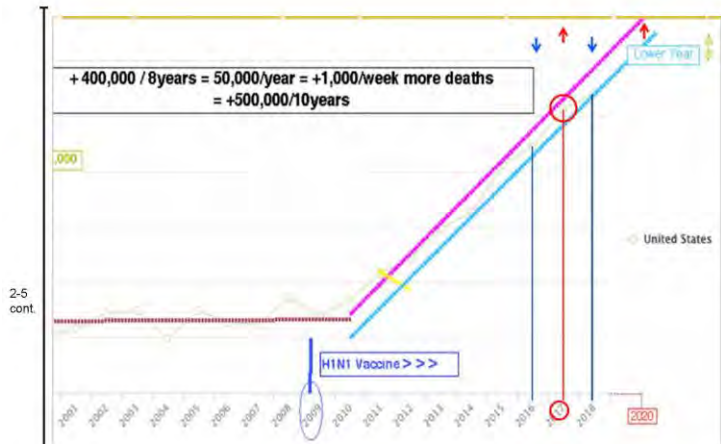
However, as noted in the EIR, because there are no other feasible mitigation measures to reduce the proposed Plan's contribution to

wildland fires to less than significant, impacts remain significant and unavoidable.

Thank you for providing a wide range of references for studies related to the effects of PM1, PM2.5, and PM10 on health and the environment. SANDAG will take these into consideration, as appropriate, during future air quality analyses.

2-5  
cont.





<https://www.prb.org/usdata/indicator/deaths/chart/>

I have attached a wide range of references for these small particles. I believe this demands new resources to monitor and find ways to mitigate the severe environmental impacts of population expansion, transportation and encroachment into high fire areas and transportation roadwear pollution.

Please do not fail to include appropriate studies for these hazards.

Sincerely,  
 Timothy Bilash MD MS FACOG  
[dtimbilash@gmail.com](mailto:dtimbilash@gmail.com)

Attachments:  
 PMs.pdf 25.7 KB

References for PM1,2.5,10

PM10/25

Tires- An Emerging Threat to Our Waterways, Our Seafood, and Ourselves? | NRDC  
<https://www.nrdc.org/onearth/tires-emerging-threat-our-waterways-our-seafood-and-ourselves>

Scientists point to chemical in car tires that's been killing coho salmon  
<https://www.opb.org/article/2020/12/04/scientists-point-to-chemical-in-car-tires-thats-been-killing-coho-salmon/>

Tires tread on the environment - POLITICO  
<https://www.politico.eu/article/tires-plastic-circular-economy-waste-ocean-pollution/>

Rubber in the environment Where the tread from our tires 'disappears' to  
<https://phys.org/news/2019-11-rubber-environment.html>

Tires The plastic polluter you never thought about  
<https://www.nationalgeographic.com/environment/article/tires-unseen-plastic-polluter>

Pollution from tire wear 1,000 times worse than exhaust emissions | Tire Technology International  
<https://www.tiretechnologyinternational.com/news/regulations/pollution-from-tire-wear-1000-times-worse-than-exhaust-emissions.html>

Tyre and road wear particles (TRWP)  
<https://www.sciencedirect.com/science/article/pii/S0048969720313358>

Brake and tire particles measured from on-road vehicles: Effects of vehicle mass and braking intensity  
<https://www.sciencedirect.com/science/article/pii/S2590162121000216>

Air particulate matter and cardiovascular disease: the epidemiological, biomedical and clinical evidence  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4740122/>

Particulates (PM10, PM 2.5)  
[https://www.michigan.gov/egle/0,9429,7-135-3310\\_70940-193454--,00.html](https://www.michigan.gov/egle/0,9429,7-135-3310_70940-193454--,00.html)

Particle Pollution  
<https://www.lung.org/clean-air/outdoors/what-makes-air-unhealthy/particle-pollution>

Brake and tire particles measured from on-road vehicles: Effects of vehicle mass and braking intensity  
<https://www.sciencedirect.com/science/article/pii/S2590162121000216>

Research Synthesis #16-01 "Exposure to Fine Particulate Matter (PM2.5) Increases Health Risks for Californians"  
<https://w2.arb.ca.gov/resources/documents/research-synthesis-16-01-exposure-fine-particulate-matter-pm25-increases-health>

Health effects of PM2.5 emissions from on-road vehicles during weekdays and weekends in Beijing, China  
<https://www.sciencedirect.com/science/article/abs/pii/S1352231019308969>

The health effects of ambient PM2.5 and potential mechanisms  
<https://pubmed.ncbi.nlm.nih.gov/26896893/>

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PM1

A work group report on ultrafine particles (American Academy of Allergy, Asthma & Immunology)  
[https://www.researchgate.net/profile/Bin-Zhao-63/post/How\\_dangerous\\_is\\_PM10\\_for\\_human/attachment/59d64a5879197b80779a4a10/AS%3A474912105209857%401490239277788/download/A+work+group+report+on+ultrafine+particles+%28American+Academy+of+Allergy%2C+Asthma+%26+Immunology%29+Why+ambient+ultrafine+and+engineered+nano+particles+should+receive+special+attention+for+possible+adverse+health+outcomes+in+human+subjects%E5%89%AF%E6%9C%AC.pdf](https://www.researchgate.net/profile/Bin-Zhao-63/post/How_dangerous_is_PM10_for_human/attachment/59d64a5879197b80779a4a10/AS%3A474912105209857%401490239277788/download/A+work+group+report+on+ultrafine+particles+%28American+Academy+of+Allergy%2C+Asthma+%26+Immunology%29+Why+ambient+ultrafine+and+engineered+nano+particles+should+receive+special+attention+for+possible+adverse+health+outcomes+in+human+subjects%E5%89%AF%E6%9C%AC.pdf)

Air Quality\_ Community Engagement Helps Make the Invisible Visible \_ Earthwatch  
[https://earthwatch.org/stories/air-quality-community-engagement-helps-make-invisible-visible?gclid=FAIaIQobChMI\\_oiBztir8wIV1CCtBh2SXAg8EAAYAAAEgKECvD\\_BwE](https://earthwatch.org/stories/air-quality-community-engagement-helps-make-invisible-visible?gclid=FAIaIQobChMI_oiBztir8wIV1CCtBh2SXAg8EAAYAAAEgKECvD_BwE)

Effects of ambient PM1 air pollution on daily emergency hospital visits in China: an epidemiological study  
<https://www.sciencedirect.com/science/article/pii/S2542519617301006>

Exposure to submicron particles (PM1.0) from diesel exhaust and pollen allergens of human lung epithelial cells induces morphological changes of mitochondria tonofilaments and rough endoplasmic reticulum

<https://pubmed.ncbi.nlm.nih.gov/24982222/>

Finer particulate matter (PM1) could increase cardiovascular disease risk  
<https://www.sciencedaily.com/releases/2020/01/200129091444.htm>

Is PM1 similar to PM2.5? A new insight into the association of PM1 and PM2.5 with children's lung function  
<https://www.sciencedirect.com/science/article/pii/S016041202032047X>

PM1 – The new focus to protect human health  
<https://www.camfil.com/en/insights/standard-and-regulations/pm1-is-most-harmful>

PM1 particles at coal- and gas-fired power plant work areas  
<https://pubmed.ncbi.nlm.nih.gov/22127876/>

Seasonal concentration distribution of PM1.0 and PM2.5 and a risk assessment of bound trace metals in Harbin, China:  
<https://www.nature.com/articles/s41598-020-65187-7>

Study shows PM1 air pollution is most harmful  
[https://usa.chinadaily.com.cn/china/2013-10/28/content\\_17061997.htm](https://usa.chinadaily.com.cn/china/2013-10/28/content_17061997.htm)

The Three Types of Particulate Matter: All About PM10, PM2.5, and PM0.1  
<https://learn.kaiterra.com/en/air-academy/three-types-of-particulate-matter>

Understanding Air Quality: What is PM10?  
<https://asthma.net/living/pm10-air-quality>

What does PM 1 mean?  
<https://indianexpress.com/article/explained/what-does-pm-1-mean/>

What is PM10 and PM2.5?  
<https://www.irceline.be/en/documentation/faq/what-is-pm10-and-pm2.5>

PM1 in Ambient and Indoor Air—Urban and Rural Areas in the Upper Silesian Region, Poland  
[www.mdpi.com/2073-4433/10/11/662/pdf](http://www.mdpi.com/2073-4433/10/11/662/pdf)

A Work Group Report on Ultrafine Particles (AAAAI) Why Ambient Ultrafine and Engineered Nanoparticles Should Receive Special Attention for Possible Adverse Health Outcomes in Humans  
<https://pubmed.ncbi.nlm.nih.gov/27130856/>

Tire dust is pollution, and this invention will help vehicles clean up as they go  
[https://www.greencarreports.com/news/1129809\\_tire-dust-is-pollution-and-this-invention-will-help-vehicles-clean-up-as-they-go](https://www.greencarreports.com/news/1129809_tire-dust-is-pollution-and-this-invention-will-help-vehicles-clean-up-as-they-go)



**COMMENT LETTER 3: PATRICIA BORCHMANN**

Comment Letter 3.

**From:** patricia borchmann <pborchmann9@gmail.com>  
**Sent:** Friday, September 24, 2021 5:14:01 PM (UTC+00:00) Monrovia, Reykjavik  
**To:** RegionalPlanEIR <RegionalPlanEIR@sandag.org>  
**Cc:** patricia borchmann <pborchmann9@gmail.com>; Laura Hunter <laurahunter744@gmail.com>  
**Subject:** Public Comment on SANDAG 2021 Regional Plan EIR, Need to focus on Appendix AA, Regional Habitat Conservation Vision (May 2021)

**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

Public Comment on SANDAG 2021 Regional Plan EIR, Need to expand body of Regional Plan to focus on Appendix AA, Regional Habitat Conservation Vision (May 2021)

3-1 I join many other stakeholders who want to see **Appendix AA, Regional Habitat Conservation Vision (May 2021)** be brought forward into the body of the SANDAG Regional Plan, instead of taking a backseat by being concealed in an appendix that is largely unseen. In fact, the Draft EIR is incomplete, since this essential Appendix AA is not even listed in the EIR Table of Contents, or appendices.

3-2 The important policy priorities identified in **Appendix AA** need to play a central role in shaping SANDAG policy, and drive transportation options considered by decision makers to make informed choices on SANDAG 2021 Regional Plan. Stakeholders in San Diego highly value the region's biodiversity which makes San Diego the home to the highest diversity of endemic plants and animals found nowhere else in the world, so it is reasonable to demand an EIR which more fully reflects the hotspot resources which are at risk. Additionally, stakeholders demand that the SANDAG 2021 Regional Plan be expanded to analyze a transportation system in San Diego that applies a cohesive policy framework to support a land use pattern that accommodates our region's future employment and housing needs and **protects sensitive habitat and resource areas in San Diego for current and future generations.** Unless and until the EIR reflects the policy framework necessary to conform with SB 375 (Steinberg, 2008), then it appears that the Draft EIR and SANDAG 2021 Regional Plan (as currently written) fail to meet the Sustainable Communities Strategy (SCS) requirement.

3-4 On page AA-12 of the Regional Habitat Conservation Plan, the document states: *"While several barriers have been identified in implementing the vision for regional habitat conservation, the role of SANDAG as the regional planning agency and its commitment in its development of a Sustainable Communities Strategy will provide new opportunities to fulfill the promises made during the adoption of the region's various regional habitat conservation plans. SANDAG will establish a Nature-Based Climate Solutions Program that will provide the natural infrastructure that uses or mimics natural processes to benefit people and wildlife. SANDAG will prioritize resilience and innovative solutions in transportation infrastructure..... There are also further opportunities to expand upon ongoing efforts to assess the amount of carbon storage and sequestration potential of open space lands and the co-benefits from preserved open space, land management, and restoration activities."*

**RESPONSE TO COMMENT 3-1**

Appendix AA is part of the proposed Plan, which the EIR analyzes. Therefore, the EIR does not need to include Appendix AA because, by default, it is part of the Plan analysis. A description of conservation efforts as a key component of SANDAG's Sustainable Communities Strategy, including benefits to habitat preservation from the SCS land use pattern, has been added to Chapter 2 of the proposed Plan.

**RESPONSE TO COMMENT 3-2**

An analysis of biological impacts has been provided in Section 4.4, *Biological Resources*, of the EIR that addresses "hotspot resources," including sensitive vegetation communities, endemic plants and animals, and special-status species. These hotspot resources are conserved through the NCCPs and subregional plans, the approved documents of which are described in the EIR (see Section 4.4.2 of the EIR), and addressed in Impact BIO-4. For example, the California's NCCP Program focuses largely on conserving large areas of native habitat and the habitats that link those areas to help preserve California's native fauna and flora at the landscape and regional levels. While NCCPs are governed by the California NCCP Act, the FESA requires the issuance of HCPs. The proposed Plan protects the County's sensitive biological resources through consistency with the NCCPs, and commits to funding and implementing future conservation efforts, including \$2,087 million for an enhanced habitat conservation, management, and monitoring program (see Land Use and Habitat programs in Appendix B of the proposed Plan), a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (see Climate Adaptation and Resilience programs in Appendix B of the proposed Plan and mitigation measure GHG-5c in Section 4.8, *Greenhouse Gas Emissions*, of the EIR), and \$300 to \$500 million of land acquisition and restoration for habitat mitigation of transportation projects (incorporated in project costs presented in Appendix A of the proposed Plan).

**RESPONSE TO COMMENT 3-3**

The proposed Plan meets SB 375 requirements. The proposed Plan is required to reduce GHG emissions from passenger vehicles and light-duty trucks by 19 percent per capita by 2035 compared to 2005 levels,

as mandated by SB 375. Implementation of the proposed Plan would not conflict with SB 375 emission reduction targets for 2035 because it would result in a 20 percent reduction in per capita CO<sub>2</sub> emissions from passenger cars and light-duty trucks from 2005 levels by 2035, which exceeds the 2035 target of a 19 percent reduction for the SANDAG region.

Also, SB 375 requires that the collective land use plans of the region identify areas sufficient to house all economic segments of the population. The 6th Cycle Regional Housing Needs Assessment (RHNA) Plan sets a strategy for sustainability that focuses housing and job growth in urban areas where there is existing and planned transportation infrastructure, protects the environment and helps ensure the success of smart growth land use policies by preserving sensitive habitat and open space, and addresses the housing needs of all economic segments of the population. In the long term, housing located near transit and jobs should provide opportunities for residents to take more trips by bus or train and live closer to where they work, reducing VMT and GHG emissions.

#### **RESPONSE TO COMMENT 3-4**

As an initial matter, this comment raises issues with the proposed Plan, not the Draft EIR.

Multiple resource topic discussions in the EIR and Appendix C, *Climate Change Projections, Impacts, and Adaptation*, acknowledge that increased temperatures and decreased rainfall will likely result in decreased plant productivity and reproduction. As fewer or less robust plants pull less carbon dioxide out of the atmosphere, soil erosion and loss will increase and there will be less carbon from dead plants available to become incorporated into the soil, thus reducing soil carbon sequestration. As such, SANDAG acknowledges that it is important to continue monitoring innovative new technologies and methods of increasing carbon storage and sequestration potential in the region. SANDAG, in collaboration with relevant resource agencies, will present additional details as a part of the Nature-Based Climate Solutions Program. As detailed in response to comment Borchmann 3-2, SANDAG has committed to funding future habitat conservation, land acquisition, and land management and monitoring to conserve and manage the County's biodiversity in perpetuity.

3-4  
cont.

My personal observation is the current SANDAG 2021 Regional Plan fails to meet the promises outlined in Appendix AA, Regional Habitat Conservation Vision, and is unacceptable in its current form. Please do not allow a substandard Regional Plan by SANDAG diminish the unparalleled biodiversity hotspot characteristics in San Diego that are found nowhere else in the world. We are counting on SANDAG to honor the promises and opportunities identified in Appendix AA to protect and preserve natural resources in San Diego for current, and future generations.

*Thank you for thoughtful consideration of my personal comments.*

**COMMENT LETTER 4: MIKE BROWER**

Comment Letter 4

**From:** James Chagala <[jchagala@hotmail.com](mailto:jchagala@hotmail.com)>  
**Sent:** Monday, October 11, 2021 11:22:46 PM (UTC+00:00) Monrovia, Reykjavik  
**To:** RegionalPlanEIR <[RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)>  
**Subject:** Fw: SANDAG's 2021 Regional Plan

**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

Jim Chagala

James Chagala & Associates  
 555 West Country Club Drive, #254  
 Escondido, CA 92026  
 760-751-2691

**From:** Mike Brower <[mikebrower@live.com](mailto:mikebrower@live.com)>  
**Sent:** Monday, October 11, 2021 3:16 PM  
**To:** James Chagala <[jchagala@hotmail.com](mailto:jchagala@hotmail.com)>  
**Subject:** RE: SANDAG's 2021 Regional Plan

Hi Jim.

Not sure if I give my comments to you or who, but here is my stab at this.

Pg 22

4-1 Managed lanes – good concept of re-purposing of shoulders, but what happens if breakdown or emergency vehicles to utilize this space?

4-2 Rural Corridors – curve straightening. At what cost and purpose? These type of items are why people like to live rural. The assumption is a lot of the items is that we will be happy with one big metropolis

Pg 23

**RESPONSE TO COMMENT 4-1**

The comments in this letter relate to the contents of the proposed Plan, and not the analysis contained within the Draft EIR.

Many of the Complete Corridor projects in the proposed Plan utilize existing right-of-way and, in many cases, existing roadway shoulders without encroaching into any additional land. This will greatly reduce environmental impacts, speed project delivery, and reduce costs.

SANDAG will continue to coordinate with Caltrans for detailed engineering and environmental studies for Managed Lanes projects.

Public safety impacts of the proposed Plan are discussed in Section 4.16, *Transportation*, of the Draft EIR, specifically under Impact TRA-3, which analyzes any increases in hazards due to design features.

**RESPONSE TO COMMENT 4-2**

Rural corridors, such as SR 67, include investments such as shoulder widening, curve realignment, and technology improvements to address safety and operational improvements to facilitate ingress/egress during peak travel and emergency evacuation conditions. The costs of the rural corridor projects in the proposed Plan range from \$1M to approximately \$700M.

- 4-3 Smart Infrastructure – question the privacy laws on this about monitoring people. How did this really work in the public emergency situation of COVID App and tracking? (I don't think it did).
- 4-4 Electric Vehicle Infrastructure – while the system is needed for Public Charging it needs to be fee based or privately operated as fee based (this is not addressed in the commentary). The CA grid cannot accommodate current demand, so this needs to be addressed as well.
- Pg 24
- 4-5 Commuter Rail – would think I-15 up to Escondido would be included here
- Pg 26
- Mobility Hubs
- 4-6 Safe Streets – with volume of people expected, just like, Grand Central or Penn Station in NY, these Hubs will require additional security and needs to be addressed
- Supporting Amenities – should be pay for use vs taxes to masses
- Pg 38
- Regional Pricing Strategy
- 4-7 Trains, buses, public transportation, etc to pay for themselves and not subsidized by add'l or current taxes (current drivers pay similarly). (Pg 46 and other mentions are subsidies not fare or fee). These items need clarified.
- Road User charges vs an additional fee should be implemented by removing the CA gas tax.
- 4-8 What is not mentioned that I can see is dealing with the current I-5, I-15, Hwy 78, I-8 congestion. While this is the future plan, this issue exists now and will for most of our future as well.
- If I need help understanding my role, please let me know.
- Thanks
- 4-9 I will also go back to my comments of our meeting. The governmental entities, in this case SANDAG, need to be financially conscience and responsible as well.

**From:** James Chagala <[jchagala@hotmail.com](mailto:jchagala@hotmail.com)>  
**Sent:** Tuesday, September 7, 2021 4:33 PM  
**To:** Sponsor Group 2 <[SponsorGroup2@groups.outlook.com](mailto:SponsorGroup2@groups.outlook.com)>  
**Subject:** Fw: SANDAG's 2021 Regional Plan

These are more details on the SANDAG plan. Please review as comments are due October 12. This is only one stage and there will be other points to comment. I will be establishing a subcommittee on September 23 to deal with this, so be thinking if you would like to be involved. The members we recommended in August are also eligible, as you do not have to be a member of the group to serve on a sub-committee.

**RESPONSE TO COMMENT 4-3**

SANDAG will rely on coordination with other agencies in California and the State Department of Transportation to integrate the selection of technology, collection methods, and account management. California has strict data privacy laws to protect consumer privacy. In line with this, SANDAG remains committed to protecting personal privacy, and it will be a strong consideration for SANDAG and other agencies around California when selecting technology and methods to administer the program.

**RESPONSE TO COMMENT 4-4**

The proposed Plan commits SANDAG to making investments to support the region’s transition to electric cars, trucks, and buses. As SANDAG develops vehicle and infrastructure programs, it will continue to coordinate with SDG&E as well as community choice energy (CCE) providers in the region on their programs to provide clean power and manage load. San Diego Community Power is committed to providing entirely clean and renewable electricity by 2035 or sooner, and the State requires utilities, including SDG&E, to provide a minimum of 50 percent renewable power by 2030 leading up to the State’s carbon neutrality goal for 2045.

In addition to regional scale load management that is led by the utility, CCEs, and larger power users, SANDAG’s EV programs will encourage the use of load management tools and integrated renewable energy at the project level. SANDAG’s current EV charger rebate program is the CALeVIP San Diego County Incentive Project, with information available at <https://calevip.org/incentive-project/san-diego-county>. This and future charger programs will provide rebates for workplace chargers to enable a greater number of drivers to charge during the day when renewable energy is most available.

SANDAG continues to support progress toward an adequate EV charging infrastructure for both freight and passenger vehicles in collaboration with public agency and private industry stakeholders. This support includes planning through the Comprehensive Multimodal Corridor Plans (CMCPs) that include federally designated zero-emission vehicle corridors and commensurate charging infrastructure as well as the development of a Blueprint for Medium-/Heavy-Duty (MD/HD) ZEV Infrastructure. A SANDAG Board resolution was passed to work collaboratively to establish the framework and agreement for a joint EV

charging incentive program with the California Energy Commission, County Air Pollution Control District, and Center for Sustainable Energy as part of the Regional Vehicle Charging Program partnership program. SANDAG will continue to coordinate with Caltrans in their efforts to plan the deployment of potential medium- and heavy-duty truck charging infrastructure in conjunction with parking identified through the California State Truck Parking Study that is currently underway.

**RESPONSE TO COMMENT 4-5**

Regarding commuter rail along the I-15 corridor, the I-15 Corridor is difficult to serve with rail because of the development patterns that resulted in widely spread out communities. This area is served by Rapid bus routes, which will be expanded in the future with more services. However, the California High Speed Rail project is reflected in Figure 2.3 of the proposed Plan as it is slated to connect Los Angeles to San Diego via the Inland Empire with stations planned in Murrieta/Temecula and Escondido, which would provide some rail service in the vicinity of I-15. This project would be implemented and funded by the California High Speed Rail Authority. SANDAG will track the project as it is developed by the State.

**RESPONSE TO COMMENT 4-6**

Mobility Hubs will be centers of activity where transportation investments of the proposed Plan will come together along with strategic decisions about land use. Each Mobility Hub will require different services and amenities depending on the surrounding community. SANDAG will work closely with local jurisdictions, community members, and other stakeholders within each Mobility Hub area to identify specific needs of the area, such as safety, security, accessibility, first-last mile connections, and increased amenities.

Each regional Mobility Hub coverage area was identified based on a variety of factors, including existing and projected population and job growth along with information on where and how people travel. Many existing trip destinations fall within areas that have been identified as a regional Mobility Hub, yet some of these communities lack convenient transit service or safe streets to walk, bike, or use other micro-mobility options.

**RESPONSE TO COMMENT 4-7**

Various funding sources are being considered to implement the proposed Plan. The proposed Plan assumes local, State, and federal

revenue sources including sales tax, impact fees, fuel tax, tolls, passenger fares, fees, general funds, ridehailing service fees, a road usage charge, cap and trade, and financing. New sources of revenue such as the road usage charge or a new sales tax will be studied and will include input from the public and other stakeholders.

Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals such as GHG emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenue currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.

The road usage charge, which is being studied by both the federal and State governments, is being considered to replace an old tax system that is no longer relevant. SANDAG recognizes that this is a challenge and respects the concerns raised. SANDAG is committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.

Fare subsidies would likely be attached to sales tax measures, but could be paid for by other sources as they become available.

Further details regarding funding and revenue can be found in Appendix V of the proposed Plan..

#### **RESPONSE TO COMMENT 4-8**

State laws have changed from requiring congestion relief (usually solved in the short term by widening roadways) to reducing VMT and GHG emissions (usually solved by people living closer to destinations and using alternative modes of transportation such as walking, biking, carpooling, and public transit). These bold changes are necessary to address unprecedented challenges facing the region and state. SANDAG understands the near-term need for congestion relief and is working to

find near-term ways to implement flexible fleet pilot projects and expand service and frequency of public transportation.

**RESPONSE TO COMMENT 4-9**

SANDAG will maintain transparency with the public and stakeholders regarding funding sources for projects outlined in the proposed Plan through associated project and program implementation, in addition to activities related to the development of Plan updates.



thanks,

Jim Chagala

James Chagala & Associates

555 West Country Club Drive, #254

Escondido, CA 92026

760-751-2691

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**From:** Turner, Jessica <[Jessica.Turner@sdcounty.ca.gov](mailto:Jessica.Turner@sdcounty.ca.gov)>  
**Sent:** Tuesday, September 7, 2021 7:25 PM  
**To:** Alyssa Burley (Valle De Oro) <[alyssa@alyssaburley.com](mailto:alyssa@alyssaburley.com)>; Billie Jo Jannen (Campo) <[campoplanninggroup@nym.hush.com](mailto:campoplanninggroup@nym.hush.com)>; Bob Uribe (Potrero) <[rduribe@gmail.com](mailto:rduribe@gmail.com)>; Carol Hake (Lakeside) <[lakesidecpg@gmail.com](mailto:lakesidecpg@gmail.com)>; Cherry Diefenbach (Jacumba) <[csdiefenbach@sbcglobal.net](mailto:csdiefenbach@sbcglobal.net)>; Dan Neirinckx (Jamul-Dulzura) <[jdcpgsd2@gmail.com](mailto:jdcpgsd2@gmail.com)> <[jdcpgsd2@gmail.com](mailto:jdcpgsd2@gmail.com)>; Delores Harmes (Valley Center) <[dee\\_valleycenter@gmail.com](mailto:dee_valleycenter@gmail.com)>; Donna Tisdale <[tisdale.donna@gmail.com](mailto:tisdale.donna@gmail.com)>; Douglas S. Dill <[theddills@att.net](mailto:theddills@att.net)>; Eileen Delaney (Fallbrook) <[Eileen.Fallbrook@gmail.com](mailto:Eileen.Fallbrook@gmail.com)>; Harriet G. Taylor <[harriettaylor@cox.net](mailto:harriettaylor@cox.net)>; Jan Hedlun (Potrero) <[janwrites2013@yahoo.com](mailto:janwrites2013@yahoo.com)>; Jim Chagala (Hidden Meadows) <[jchagala@hotmail.com](mailto:jchagala@hotmail.com)>; Jim Custeau (Spring Valley) <[jimcusteausvcpg@cox.net](mailto:jimcusteausvcpg@cox.net)>; Karen Binns (Twin Oaks) <[royalviewranch@aol.com](mailto:royalviewranch@aol.com)>; Kerry Forrest <[descansocpg@gmail.com](mailto:descansocpg@gmail.com)>; Kiki Munshi (Julian) <[kiki@skagenranch.com](mailto:kiki@skagenranch.com)>; Kristi Mansolf (Ramona) <[kmansolf@gmail.com](mailto:kmansolf@gmail.com)>; Patrick Brown <[patrickeng@sbcglobal.net](mailto:patrickeng@sbcglobal.net)>; Paul T. Georgantas <[Georgantas@aol.com](mailto:Georgantas@aol.com)>; Rebecca Falk <[rebalk7@gmail.com](mailto:rebalk7@gmail.com)>; Robert Carlyle <[rcarlyle@outlook.com](mailto:rcarlyle@outlook.com)>; Robin Joy Maxson (Ramona) <[robinjoymaxson@gmail.com](mailto:robinjoymaxson@gmail.com)>; Sanda Farrell (Twin Oaks) <[sjfarrell@cox.net](mailto:sjfarrell@cox.net)>; Stephen Stonehouse <[stephen.stonehouse@cox.net](mailto:stephen.stonehouse@cox.net)>; Steve Norris (Bonsall) <[stevenorris.bsa@gmail.com](mailto:stevenorris.bsa@gmail.com)>; Travis Lyon <[travislyonacpg@gmail.com](mailto:travislyonacpg@gmail.com)>; Vern Denham <[PineValleyPlanningGroup@gmail.com](mailto:PineValleyPlanningGroup@gmail.com)>; Wally Riggs <[wrplanning@gmail.com](mailto:wrplanning@gmail.com)>  
**Cc:** Tessitore, Lynnette <[Lynnette.Tessitore@sdcounty.ca.gov](mailto:Lynnette.Tessitore@sdcounty.ca.gov)>; Christman, Scott <[Scott.Christman@sdcounty.ca.gov](mailto:Scott.Christman@sdcounty.ca.gov)>  
**Subject:** SANDAG's 2021 Regional Plan

Good Afternoon,

Staff has requested that I send the below information.

If you have questions, please contact Lynnette Tessitore, Chief of Long Range Planning, at [lynnette.tessitore@sdcounty.ca.gov](mailto:lynnette.tessitore@sdcounty.ca.gov).

Thank you,

Jessica Turner  
Planning & Development Services  
5510 Overland Ave., Suite 310  
San Diego, CA 92123  
858-495-5336

NOTICE OF RELEASE OF SANDAG's 2021 Regional Plan (Transportation)	
<p><b>Public Input on <a href="#">Environmental Impact Report (EIR)</a> for 2021 Regional Transportation Plan (RTP)</b></p> <p><b>Lead Agency:</b> San Diego Association of Governments (SANDAG)</p> <p><b>Notice:</b> The draft EIR can be viewed at <a href="#">Draft EIR (sdforward.com)</a>. Comments due <b>October 11, 2021</b>.</p> <p><b>Project Description:</b> SANDAG officially released the <a href="#">draft 2021 Regional Plan</a> for public comment on May 28<sup>th</sup>, 2021 – August 6<sup>th</sup>, 2021. The draft EIR reviews the effects the Regional Plan will have on the community, including factors such as air quality, noise, land use, and more. Preparing the EIR is a requirement of the California Environmental Quality Act.</p> <p><b>Submit your comment</b></p> <p>The <a href="#">draft EIR</a> is available for public comment from <b>August 27 through October 11, 2021</b>. After the public comment period concludes, SANDAG will prepare written responses to comments in the final EIR, anticipated to be released in late 2021. Public comments are accepted:</p> <ul style="list-style-type: none"> <li>• Online: (<a href="#">English</a>   <a href="#">Español</a>)</li> <li>• Email: <a href="mailto:RegionalPlanEIR@sandag.org">RegionalPlanEIR@sandag.org</a></li> <li>• Voicemail: 619.699.1934, toll free 877.277.5736 and TTY 619.699.1904</li> <li>• Fax: 619.699.1995</li> <li>• Mail: Attn: Kirsten Uchitel Associate Planner, SANDAG, 401 B Street, Suite 800, San Diego CA, 92101</li> </ul>	<p>San Diego Association of Governments (SANDAG)</p>

**COMMENT LETTER 5: MIKE BULLOCK**

Comment Letter 5

**Mike Bullock**  
 1800 Bayberry Drive  
 Oceanside, CA 92054

October 11, 2021

San Diego Association of Governments  
 401 B Street, Suite 800  
 San Diego, CA 92101  
 C/O Kirsten Uchitel, Associate Planner

Via E-mail: [RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)  
 Subject: Regional Plan DEIR

SANDAG,

I appreciate the opportunity to comment on this important subject.

Since the DEIR is based on the 2021 Regional Transportation Plan, I will start by considering that plan and what environmental impacts it will cause.

**Environmental Impact Consideration of the Region Transportation Plan**

**Chapter 1: A Bold New Vision for the 2021 Regional Plan**

You introduce the 5 "Big Moves," an approach which seems to reflect a recognition that we need fundamental change. However, before you even identify the strategies, this sentence appears, suggesting a falsehood. The falsehood it suggests is that the primary task is to enhance mobility while achieving "state and federal requirements", regarding climate change and air pollution.

You write, regarding the 5 Big Move, that you are about to identify (emphasis added in bold type):

*These interdependent strategies are designed to address the greatest transportation and mobility challenges that we face: safety and traffic congestion, social inequities, and **state and federal requirements to reduce greenhouse gas (GHG) emissions and air pollution.***

This statement shows a fundamental misunderstanding of the climate emergency that we face. By far, our greatest "mobility challenge" is to design and adopt a regional transportation plan (RTP) that will guarantee that the GHG emissions from *cars and light-duty trucks* (the "Light-Duty Vehicle" or "LDV" category called out in SB 375) will meet the climate-stabilizing requirements provided by climate science. The first climate-stabilizing requirement is for LDVs to emit GHG at no more than 80% below the level they emitted in 1990, by no later than the end of 2030 (Reference 1). The later requirement will be relatively easy, if we meet the 2030 requirement, or "target."

Comments on SANDAG's Draft EIR for Its 2021 RTP

1 of 16

**RESPONSE TO COMMENT 5-1**

SANDAG recognizes that substantial reductions in global, state, and regional GHG emissions are an urgent priority, and strives in its regional plans and programs to do its part in reducing GHG emissions from all sources. The proposed Plan includes many strategies to reduce GHG emissions from light-duty vehicles.

Draft EIR Section 4.8.1 properly describes existing conditions related to GHG emissions, including background information on various greenhouse gases, their sources, and their potential to trap heat in the Earth's atmosphere and contribute to global warming. The Draft EIR describes the main sources of GHG emissions in the state and in the San Diego region. The effects of climate change ("climate destabilization") are summarized, with detailed description based on scientific studies of how climate change is anticipated to impact California and the San Diego region provided in Draft EIR Appendix C. Section 4.8 also describes the regulatory setting for GHG emissions, including descriptions of State legislation and EOs B-30-15 and S-3-05 goals for statewide GHG reductions. The statewide GHG reduction goals adopted by the Legislature and expressed by the Governor's EOs are based on limiting global warming to levels necessary to avoid potentially catastrophic climate change impacts.

The Draft EIR properly evaluates the significant environmental impacts of the proposed Plan and concludes that the Plan would have significant and unavoidable GHG emissions impacts. The Draft EIR then identifies mitigation measures and alternatives to the proposed Plan that would reduce this significant impact. For more detail see Draft EIR Section 4.8 and Chapter 6, *Alternatives Analysis*.

5-1 cont.

The later requirement is to have LDVs and all other GHG emitters emit no more than what can be offset by carbon sequestration. This is the "net zero" emission level of 2045 or perhaps 2050. Often, governments only speak of the "net zero" requirement of 2045 or 2050, without mentioning the more-difficult 2030 requirement. This may be because plans to achieve the 2030 requirement must be built upon the math connecting fleet efficiency in year 2030 and the per-capita driving in 2030 with the 2030 climate-stabilization requirement. The math must account for the percent of our electricity that is renewable.

Therefore, the math must derive the following two items:

- So-called, "fleet efficiency" (CO2 emitted per mile of all the cars on the road, for a given year, given the percent of electricity that is from renewables) and
- per-capita driving

that will combine to achieve the "90% below 1990 level" requirement.

The peer-reviewed Reference 1 does this. It shows 4 cases of fleet-efficiency requirements and the per-capita driving that could be allowed, given the 2030, climate-stabilization requirement stated above.

For the benefit of readers that don't want to look at Reference 1, here is Table 1, showing the 4 cases:

**Table 1 4 Cases that Support the 2030 Climate-Stabilizing Requirement**

**Note: Purple denotes difficult; red, impossible.**

	Case Designations			
	Balanced_1	Balanced_2	2005 Driving	Mary Nichols
% Renewable Electricity	85.0%	90.0%	90.0%	90.00%
% ZEVs, Year 2018	2.0%	2.0%	2.0%	2.70%
% ZEVs, Year 2017	2.0%	2.0%	2.0%	2.70%
% ZEVs, Year 2016	3.0%	3.0%	3.0%	5.11%
% ZEVs, Year 2019	4.0%	4.0%	4.0%	7.53%
% ZEVs, Year 2020	6.0%	6.0%	6.0%	9.94%
% ZEVs, Year 2021	20.0%	15.0%	82.0%	12.35%
% ZEVs, Year 2022	35.0%	25.0%	97.0%	14.76%
% ZEVs, Year 2023	55.0%	45.0%	99.0%	17.18%
% ZEVs, Year 2024	60.0%	70.0%	99.0%	19.59%
% ZEVs, Year 2025	94.0%	95.0%	99.0%	22.00%
% ZEVs, Year 2026	97.0%	97.0%	99.0%	37.60%
% ZEVs, Year 2027	98.0%	98.0%	99.0%	53.20%
% ZEVs, Year 2028	99.0%	99.0%	99.0%	68.80%
% ZEVs, Year 2029	99.0%	99.0%	99.0%	84.40%
% ZEVs, Year 2030	99.0%	99.0%	99.0%	100.00%
% Reduction in Per-Capita Driving With Respect to Year 2005	32.0%	32.0%	0%	50.5%

5-2

**RESPONSE TO COMMENT 5-2**

This comment provides background information about Reference 1, but does not identify any specific deficiencies in the EIR's GHG impact analysis. SANDAG recognizes that substantial reductions in global, state, and regional GHG emissions are an urgent priority, and strives in its regional plans and programs to do its part in reducing GHG emissions from all sources. The proposed Plan includes many strategies to reduce GHG emissions from light-duty vehicles. Draft EIR Section 4.8.1 properly describes existing conditions related to GHG emissions, including background information on various greenhouse gases, their sources, and their potential to trap heat in the Earth's atmosphere and contribute to global warming. The Draft EIR describes the main sources of GHG emissions in the state and in the San Diego region. The effects of climate change ("climate destabilization") are summarized, with detailed description based on scientific studies of how climate change is anticipated to impact California and the San Diego region provided in Draft EIR Appendix C. Section 4.8 also describes the regulatory setting for GHG emissions, including descriptions of state legislation and EOs B-30-15 and S-3-05 goals for statewide GHG reductions. The statewide GHG reduction goals adopted by the Legislature and expressed by the Governor's EOs are based on limiting global warming to levels necessary to avoid potentially catastrophic climate change impacts.



**RESPONSE TO COMMENT 5-3**

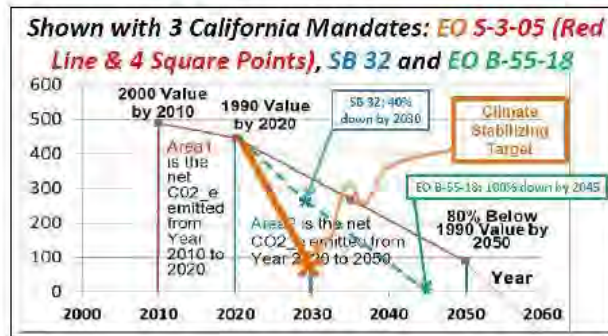
This comment provides information about the California Democratic Party platform. The “Plan” noted in the comment is a policy position by a private organization and is not a “state plan.”

The only difference between the “Balanced\_1” case and the “Balanced\_2” case is the increased percentage of electricity that is from renewables, goes from 85% to 90%. That improvement allows the per-cent of new cars that are ZEVs to increase at a less-difficult pace. The “2005 Driving” case is done to prove that it is not feasible. It proves that we must reduce driving. The Mary Nichols case is based on statements made by the retired CARB Chair. CARB does not seem capable of understanding the more-complex 2030 requirement. Therefore, I doubt that Former-Chair Nichols understood that her schedule would need per-capita driving to drop 50.5%, which would be very difficult. CARB and indeed the state of California seem to be pretending that if we achieve the net-zero requirement by 2045, the earth’s climate will not destabilize. However, SANDAG cannot go along with this misinformation.

The derivation of the 2030 climate-stabilizing requirement (target) is shown on Page 6 of Reference 1. Reference 2 is used to present Reference 1. The derivation of the 2030 climate-stabilizing requirement (target) is shown on Slides 11 and 12 of Reference 2. That result is shown here in Figure 1.

5-2  
cont.

**Figure 1 The 2030 Climate Stabilization Target Compared to State Mandates**



5-3

It should be noted that Reference 1 is exactly what the most important environmental-advocacy organization in California, the California Democratic Party (the CDP, AKA the CADEM) has in their Platform. The Party Platform is their official policy. This can be seen in Reference 3, where it says, “Demand a state plan specifying how cars and light-duty trucks can meet climate-stabilizing targets by defining enforceable measures to achieve necessary fleet efficiency and per-capita driving limits.”

5-3  
cont.

Such a plan is noted here as a "Plan". CARB has no such Plan. Nor does SANDAG. Given our climate predicament, any project that needs an EIR, that has to do with driving, needs such a Plan. If any discretionary project that has to do with driving needs an EIR, such as the RTP being considered, if it cannot be shown to conform to such a plan, then it must be assumed to be contributing to climate destabilization.

**Critical Information Left Out of Chapter 1 and the Regional Transportation Plan (RTP)**

Many of the fatal errors of Chapter 1, and the RTP/DEIR in general, can be attributed to the RTP not explaining, up front, the parameter of humanity's Code Red Climate Emergency, as if it plays no role in writing an EIR for the 2021 Regional Transportation Plan. At the front of the RTP's EIR, the following information is needed.

5-4

Figure 2 shows the rise of the world's atmospheric CO2 over the last 50 years. Figure 3 shows both atmospheric temperature (averaged over a year and averaged over the earth, derived from an isotope analysis) and atmospheric CO2 (from air bubbles in ice-core samples), over 800,000 years. It could be noted that our species is only around 300,000 years old. Figure 3 shows that when climate deniers say that climate is always changing and so therefore climate change is normal, they are correct, except for one important consideration. There is nothing normal about the outrageous, recent run-up of atmospheric CO2, to over 410 PPM, in such a short time that it appears to be an instantaneous spike, on Figure 3. Figure 4 shows just 1% (which is just 1,000 years) of the distance on Figure 3, from current time to 100,000 years into the past. For Figure 4, the conventions have been switched: the red line is the earth's atmospheric CO2 and temperature is blue. Figure 4 shows that the CO2 spike is the result of our combustion of fossil fuels because it starts at the start of our industrial revolution. Figure 4 covers the time of the development of our civilization. It shows that everything was normal until about 150 years ago, which is the start of our industrial revolution, when we started to burn fossil fuels. By doing extensive calculations, we know how much CO2 we have produced from the combustion of fossil fuels. Then, by directly measuring the atmospheric CO2 and the acidity of the oceans, we know where that CO2 currently resides. We also know that atmospheric CO2 traps heat. There is no doubt that we have an Anthropogenic Global Warming catastrophe in the making. We are living in a spike of CO2. Neither the magnitude nor the slope have occurred in millions of years. Achieving climate-stabilizing requirements (targets) is our only hope.

5-5

It should also be clearly stated that LDVs, by far, emit more GHG than any other category of emission. Electricity emits the 2<sup>nd</sup> most. However, electricity has a good chance to achieve the 2030 climate-stabilization requirement derived in Reference 1 and shown in Figure 1. Unfortunately, that cannot be said for LDVs. The implementation of Reference 1 or some other Plan like Reference 1 is our only hope, for LDVs.

**RESPONSE TO COMMENT 5-4**

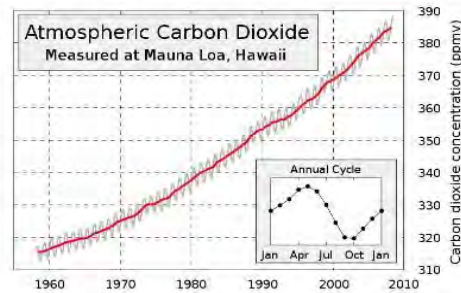
Consistent with CEQA requirements, the Draft EIR properly describes the proposed Plan, evaluates the significant environmental impacts of the proposed Plan, and concludes that the Plan would have significant and unavoidable GHG emissions impacts. The Draft EIR then identifies mitigation measures and alternatives to the proposed Plan that would reduce this significant impact. For more detail see Draft EIR Section 4.8 and Chapter 6.

**RESPONSE TO COMMENT 5-5**

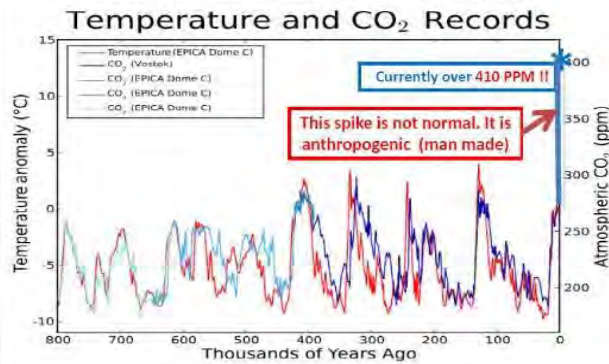
SANDAG recognizes that substantial reductions in global, state, and regional GHG emissions are an urgent priority, and strives in its regional plans and programs to do its part in reducing GHG emissions from all sources. The proposed Plan includes many strategies to reduce GHG emissions from light-duty vehicles. Draft EIR Section 4.8.1 properly describes existing conditions related to GHG emissions, including background information on various greenhouse gases, their sources, and their potential to trap heat in the Earth's atmosphere and contribute to global warming. The Draft EIR describes the main sources of GHG emissions in the state and in the San Diego region. The effects of climate change ("climate destabilization") are summarized, with detailed description based on scientific studies of how climate change is anticipated to impact California and the San Diego Region provided in Draft EIR Appendix C. Section 4.8 also describes the regulatory setting for GHG emissions, including descriptions of State legislation and EOs B -30-15 and S-3-05 goals for statewide GHG reductions. The statewide GHG reduction goals adopted by the Legislature and expressed by the Governor's EOs are based on limiting global warming to levels necessary to avoid potentially catastrophic climate change impacts.

5-6

**Figure 2 Atmospheric CO<sub>2</sub>, Increasing Over Recent Decades**



**Figure 3 Atmospheric CO<sub>2</sub> and Mean Temperature, from 800,000 Years Ago, with Current CO<sub>2</sub> Spike**



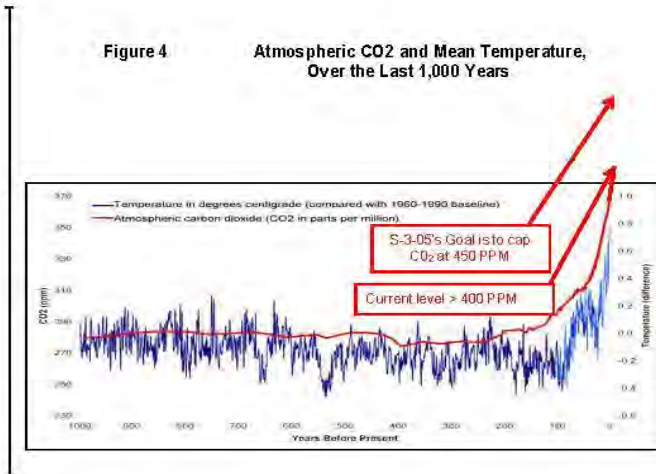
Comments on SANDAG's Draft EIR for its 2021 RTP

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**RESPONSE TO COMMENT 5-6**

In the Draft EIR, SANDAG properly evaluates the significant environmental impacts of the proposed Plan and concludes that the proposed Plan would have significant and unavoidable GHG emissions impacts. The Draft EIR then identifies mitigation measures and alternatives to the proposed Plan that would reduce this significant impact. For more detail see Draft EIR Section 4.8 and Chapter 6. Also, please see response to comment Bullock 5-5.

5.8  
cont.



**Primary Challenges Misstated**

Figure 5 is from Section 1 of the EIR of the RTP. It is said to show our "three primary challenges"

Our *Code Red Climate emergency* is mankind's primary challenge. It means that our *Region's* primary challenge is to do its part to ensure that the emission of GHG from our LDVs support climate stabilization.

Reference 1 shows how that can be done. We will need to significantly reduce VMT, as proven in Reference 1 and as shown in Table 1. When that is done, there will be no congestion and, given that fact, it is not correct to assert that *Congestion* is a primary challenge. *Social Equity* is a goal, like "*Democracy*" or "*Equal Opportunity*" that we must always move towards, as fast as we can. However, when "*Social Equity*" is discussed in the context of our Anthropogenic climate change problem, the harm of living close to pollution caused by our reliance on fossil fuels is often mentioned. That harm will be reduced and, in some cases (refineries will be closed), eliminated, if we meet our climate-change challenge. The largest "*Social Inequity*" would be climate destabilization because it would cause a "devastating collapse of the human population" to quote from the June 2008 issue of *Scientific American's* article, *Ethics and Economics of Climate Change*. Many reliable sources write that human extinction will be an outcome of climate change failure, which is the path we are on now. This will be the ultimate *inequity* if it happens and make no mistake, it will probably happen.

5.7

**RESPONSE TO COMMENT 5-7**

SANDAG recognizes that substantial reductions in global, state, and regional GHG emissions are an urgent priority, and strives in its regional plans and programs to do its part in reducing GHG emissions from all sources. Draft EIR Section 4.8.1 properly describes existing conditions related to GHG emissions, including background information on various greenhouse gases, their sources, and their potential to trap heat in the Earth's atmosphere and contribute to global warming. The Draft EIR describes the main sources of GHG emissions in the state and in the San Diego region. The effects of climate change ("climate destabilization") are summarized, with detailed description based on scientific studies of how climate change is anticipated to impact California and the San Diego Region provided in Draft EIR Appendix C. Section 4.8 also describes the regulatory setting for GHG emissions, including descriptions of State legislation and EOs B -30-15 and S-3-05 goals for statewide GHG reductions. The statewide GHG reduction goals adopted by the Legislature and expressed by the Governor's EOs are based on limiting global warming to levels necessary to avoid potentially catastrophic climate change impacts.

The purpose of the Draft EIR is "to identify the significant effects on the environment of a project, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided" (PRC Section 21002.1[a]). The Draft EIR analyzes the significant environmental effects of the proposed Plan, identifies feasible mitigation measures to avoid or reduce these impacts, and presents alternatives to the proposed Plan that could avoid or reduce significant impacts.


In the Draft EIR, SANDAG properly evaluated the significant environmental impacts of the proposed Plan and concludes that the Plan would have significant and unavoidable GHG emissions impacts. The Draft EIR then identified mitigation measures and alternatives to the proposed Plan that would reduce this significant impact. For more detail see Draft EIR Section 4.8 and Chapter 6.



5-7  
cont.

Climate destabilization, as described in Reference 1, will end most life forms and almost certainly our own species. This environmental impact must be fully explained in a legal EIR. The DEIR has no such discussion or explanation.

**Figure 5 The DEIR's Erroneous Claim of "Three Primary Challenges", for our Region**



5-8

**Need to Reimagine**  
I agree with Chapter 1's Page 7 statement that there is an "urgent need to reimagine our regional transportation system".

**Reimagine Example Left Out**  
That is one of the places (Chapter 1's Page 7) where SANDAG should state that we must stop widening freeways. Instead of widening freeways, as called for in the current, fatally flawed, version of the *Transnet* sales tax, we should be reducing the size of our freeways. The well-understood principal of *Induced Traffic Demand* informs us that adding more lanes will not reduce congestion, but it will increase VMT. *Induced Traffic Demand* also informs us that removing lanes will not increase congestion, but it will decrease VMT. As shown in Reference 1 and Table 1, we must reduce VMT. The *Transnet Ordinance* can be changed in an emergency. We have an emergency.

**Vision, Goals, Strategies, and Actions Are Useless if Our Earth's Climate is Destabilized**  
Page 13 starts a discussion which seems to be written for some other planet or for some other time on our planet. Climate destabilization would lead to a collapse of our human population that would lead to our extinction. Therefore, Page 13's

5-9

- *Vision, Goals, Strategies, and Actions* must be replaced with
- *A Requirement, Vision, Goals, Strategies, and Actions.*

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**RESPONSE TO COMMENT 5-8**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

SANDAG is required to analyze induced demand impacts of the proposed Plan, which are documented in Appendix D to the proposed Plan. The activity-based model and other analyses used to inform the Plan have been reviewed through SANDAG's peer review process and documented in the technical methodology submitted to CARB, also included in Appendix D.

Where possible, the Plan proposes repurposing of general purpose lanes or shoulders to create Managed Lanes. The Managed Lane system is important for supporting the transit network and Flexible Fleets envisioned in the proposed Plan. The Regional Plan is updated every 4 years, providing opportunities to reflect changes in the network. Improvements to the freeway system in the proposed Plan are limited to Managed Lanes using existing infrastructure such as general purpose lane conversion and shoulders to facilitate additional transit and high occupancy vehicle travel.

**RESPONSE TO COMMENT 5-9**

This comment addresses the proposed Plan and aforementioned information about Reference 1. No further response is required.

5-9 cont. The *Requirement* is to ensure that our transportation system supports the climate-stabilization requirement of 2030, as shown in Figure 1 of this letter. Reference 1 shows how this can be done, for LDVs. Most of the fleet-efficiency requirements are show in Table 1 of this letter. (All of the needed fleet-efficiency requirements are described in Reference 1.) Table 1 also shows the driving reduction that is computed in Reference 1. It is a 32% reduction in per-capita VMT, with respect to year 2005. It's expressed using the SB 375 conventions for expressing driving reductions. Even though SB 375 states that it is about a *GHG* reduction, it is really about a *VMT* reduction, because SB 375 clearly states that the Metropolitan Planning Organizations (MPOs, like SANDAG) can take no credit for GHG reductions accomplished by the state. The state has the fleet-efficiency responsibility. The Metropolitan Planning Organizations (MPOs, like SANDAG) have the responsibility to reduce driving. Therefore, the SB 375 reductions in LDV GHG must be produced by SANDAG measures to reduce LDV VMT. In other words, SANDAG's responsibility is to reduce driving.

5-11 **The Fatal Flaw of Not Saying What's Important**  
 On Page 13 of Chapter 1, it says, "The 2021 Regional Plan reduces per capita GHG emissions from cars and light duty trucks by 20% below 2005 by 2035". The document does not say whether-or-not this is enough to support climate stabilization. Tragically, it is *not* enough to support climate stabilization. The 2030 climate-stabilization requirement is derived in Reference 1 and is shown in Figure 1 of this letter. Similarly, Chapter 1 lists key goals, policies, and Executive Orders that were considered. They are shown in Figure 6.

5-12 The problem is that the document is supposed to be an EIR, which is to say it must report on the environmental impacts of what is being done. The environmental impacts are what will happen in the physical world, not in the legislative or judicial world. To figure out what will happen in the physical world, the resulting emissions need to be compared to what the climate scientist are telling us we must accomplish if we want to stabilize the climate at a livable level.

That information is nowhere to be found in the current DEIR. That is clearly illegal because the decision makers and the public need to understand what will happen to our planet if all transportation planning followed the path described by SANDAG as in the "cumulative effects" consideration.

The "cumulative impacts" consideration means that no one can get by using an argument that a discretionary project being considered is "too small to matter".

Figure 6 is an admission of guilt because it is described as containing SANDAG's "key goals". No climate-stabilization requirement is listed. SANDAG might be, technically, within CEQA law for the 2045 to 2050 requirement of zero net emissions because this happens to be covered by the EO B-55-18 executive order. However, SANDAG needs to state that zero net emissions by 2045 is our second climate-stabilizing target and that is covered by EO B-55-18. Where SANDAG clearly is in violation of CEQA law is that it does not state that the industrialized world's first climate-stabilization requirement (target), which is for 2030, is to emit GHG at no more than 80% below

**RESPONSE TO COMMENT 5-10**

Draft EIR Section 4.16 (Impact TRA-2) properly analyzed whether the proposed Plan would achieve the substantial VMT reductions needed to help achieve statewide GHG reduction goals, finding a significant and unavoidable transportation impact. Nevertheless, Impact TRA--2 does show that the proposed Plan would achieve substantial reductions in per capita VMT.

**RESPONSE TO COMMENT 5-11**

This comment addresses the proposed Plan and aforementioned information about Reference 1. Also, please see response to comment Bullock 5-7.

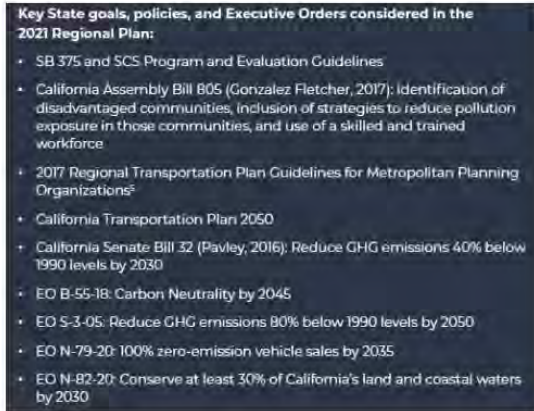
**RESPONSE TO COMMENT 5-12**

The purpose of the Draft EIR is "to identify the significant effects on the environment of a project, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided" (PRC Section 21002.1[a]). Consistent with CEQA requirements, the Draft EIR analyzes the significant environmental effects of the proposed Plan, identifies feasible mitigation measures to avoid or reduce these impacts, and presents alternatives to the proposed Plan that could avoid or reduce significant impacts.

The Draft EIR properly evaluates the significant environmental impacts of the proposed Plan, including using a net-zero significance threshold (Impact GHG-1), and concludes that the Plan would have significant and unavoidable GHG emissions impacts (Impact GHG-5). The Draft EIR then identifies mitigation measures and alternatives to the proposed Plan that would reduce this significant impact. For more detail see Draft EIR Section 4.8 and Chapter 6.

what we emitted in 1990. SANDAG needs to redo its RTP using a Plan like that shown in Reference 1.

**Figure 6 SANDAG's Admission of Guilt Because These Do NOT Cover Achieving the Industrial World's 2030 Climate-Stabilizing Target.**



5-12  
cont.

Achieving the industrialized world's 2030 Climate-Stabilizing Requirement would obviously be a "Key policy" and accomplishment for SANDAG. Figure 6 and the stated organization of the DEIR means that there is no need for me to read further to know that SANDAG has made no effort to consider what it would take for the RTP to conform to achieving the 2030, climate-stabilizing requirement. Page 13 of Chapter 1 presents the RTP's Visions and Goals. There is nothing there about stabilizing the climate at a livable level. That is shown in Figure 6, which is taken from Chapter 1 of the RTP.

5-13

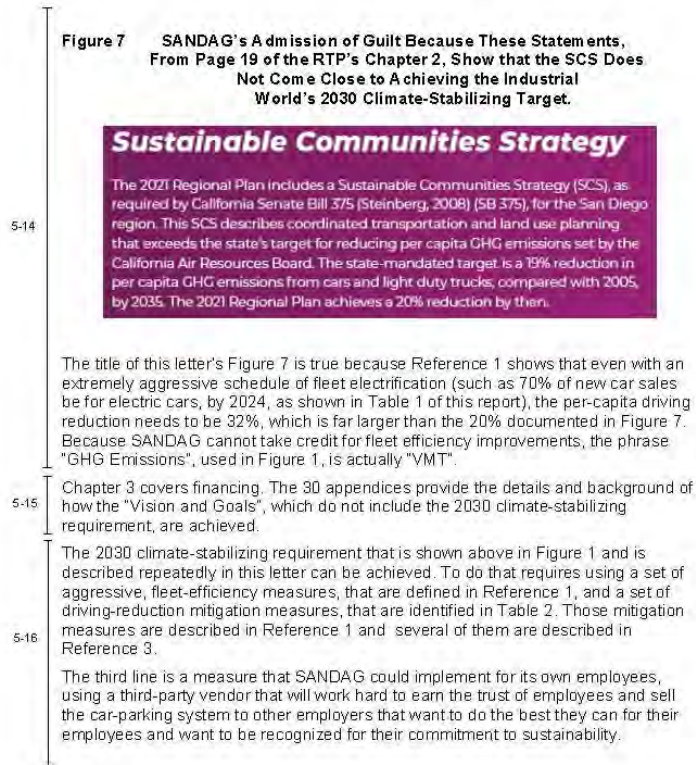
Also, Chapter 2 is defined on Page 15 of Chapter 1. It says there that Chapter 2, the Transportation Plan's Regional Sustainable Community Strategy (SCS, which is required by SB 375), describes "the land use strategies, and programs that will achieve our Vision and Goals."

Chapter 1 has described SANDAG's "Vision and Goals". None of them include achieving the 2030 climate-stabilizing requirement, or "target".

**RESPONSE TO COMMENT 5-13**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

The proposed Plan was developed through a data driven planning process. The forecasted development pattern for the proposed Plan's SCS is driven by regional goals for sustainability, mobility, housing affordability, and economic prosperity. The SCS land use pattern uses areas in the region known as Mobility Hubs to concentrate future development. Mobility Hubs are communities with a high concentration of people, destinations, and travel choices. The SCS land use pattern represents a continuing trend in the San Diego region to provide more housing and job opportunities in the existing urbanized areas of the region.



5-14

5-15

5-16

**RESPONSE TO COMMENT 5-14**

SB 375 required CARB to set regional targets for reducing GHG emissions from passenger vehicle use. SANDAG's State-mandated target is to reduce regional emissions of GHGs from cars and light trucks by 15 percent, per capita, by 2020, compared with a 2005 baseline (CARB 2017). By 2035, a 19 percent reduction is required. The Sustainable Communities Act does not require CARB to establish post-2035 targets.

To achieve the targets, SANDAG and other MPOs are required to develop an SCS as a component of the RTP. The SCS is required by Government Code Section 65080(b)(2)(B) to:

- Identify the general location of uses, residential densities, and building intensities within the region.
- Identify areas within the region sufficient to house all the population of the region, including all economic segments of the population.
- Identify areas within the region sufficient to house an 8-year projection of the regional housing need for the region.
- Identify a transportation network to serve the transportation needs of the region.
- Gather and consider the best practically available scientific information regarding resource areas and farmland in the region.
- Consider specified State housing goals.
- Set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks, to achieve, if there is a feasible way to do so, the GHG emission reduction targets approved by CARB.
- Allow the RTP to comply with federal Clean Air Act requirements related to air quality conformity.

Appendix D of the proposed Plan documents compliance with these SCS requirements and provides SCS-related background information.

**RESPONSE TO COMMENT 5-15**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

**RESPONSE TO COMMENT 5-16**

In the Draft EIR, SANDAG properly evaluated the significant environmental impacts of the proposed Plan and concludes that the Plan would have significant and unavoidable GHG emissions impacts.

The Draft EIR then identified mitigation measures and alternatives to the proposed Plan that would reduce this significant impact. For more detail see Draft EIR Section 4.8 and Chapter 6.

SANDAG developed a *Parking Strategies for Smart Growth* guide, referenced on page 4.16-13 of the Draft EIR, as part of its *Planning Tools for the San Diego Region*. This guide provides a benchmark and compares the various parking regulations within the region, as well as how those regulations compare to national standards. Additionally, the guide provides example policies on how jurisdictions can implement smart growth parking policies and programs. SANDAG also developed a regional Parking Management Toolbox that provides jurisdictions within the San Diego region with a framework for evaluating, implementing, and managing parking management strategies that support their economic development, sustainability, and mobility goals. One of the proposed Plan's implementation strategies includes updating the Toolbox to account for newer modes and more flexible curb space strategies.

SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and GHG emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.

The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.



5-16 cont.

**Table 2 Enforceable Measures to Reduce 2030 Per Capita Driving By 32% With Respect to 2005 Per Capita Driving**

Driving-Reduction Requirments	Per-Cent Reduction	Factor
Legislated (SB 375) Plans to Reduce Driving	12%	0.88
Value-Priced Road Use Charge (RUC)	10%	0.90
Value-Priced Parking (Unbundling the Cost)	8%	0.92
Transfer Highway Expansion Funds to Transit	2%	0.98
Increase Height & Density by Transit Stations	2%	0.98
"Complete Streets", "Road Diet" (walk/bike)	1%	0.99
Pay-to-Graduate Bicycle Traffic-Skills Class	1%	0.99
Bicycle Projects to Improve Access	1%	0.99
<b>Product of Factors</b>		<b>0.68</b>
<b>% Reduction</b>		<b>32%</b>

California designs and implements this

Local governments do this with a 3<sup>rd</sup> party vendor

The first line, "Legislated (SB 375) Plans to Reduce Driving" reflects an assumption that the RTPs in California, which are often required to achieve 19% by 2035, will achieve 12%, five years before the 2<sup>nd</sup> year target of SB 375, which is 2035. Reference 4 has more detail about the 3<sup>rd</sup> line's Value-Priced, car-Parking system. Reference 5 describes the system for all types of parking and even includes a congestion-pricing algorithm. Reference 6 describes the system with an emphasis on employee car parking and how the system could earn extra money for all employees. Reference 7 is a Draft *Requirements Document* that would support an RFP process to identify the best 3<sup>rd</sup> party vendor to design, install, and operate the car-parking system. The selected 3<sup>rd</sup> party vendor would also be good at financing, building, and operating solar canopies; selling electricity to energy districts; and financing, building, and operating charging stations. These tasks need to be added to Reference 7. Reference 8 has more detail about the 2<sup>nd</sup> line's Road Use Charge. It the kind of Road Use Charge (RUC) we need in California. SANDAG and other MPOs need to lobby California to design and implement such a system, ASAP.

5-17

**Consideration of the Draft EIR for the Region Transportation Plan**

Executive Summary

**Table ES-1, Summary of Environmental Impacts and Mitigation Measures**

The GHG-3 line says:

Comments on SANDAG's Draft EIR for Its 2021 RTP

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**RESPONSE TO COMMENT 5-17**

This comment addresses the Draft EIR Executive Summary, Table ES-1, Summary of Environmental Impacts and Mitigation Measures (pages ES-4 to ES-24) and asserts that achieving the GHG emissions reductions level of Impact GHG-3 (at least 30 percent reduction in per capita GHG emissions from the entire on-road transportation sector by 2035 compared to existing conditions [2016]) would not be consistent with reducing emissions 80 percent below 1990 levels by 2030, which the commenter refers to as the "industrialized world's 2030 climate stabilizing requirement." As explained in the Draft EIR (page 4.8-28), Impact GHG-3 is based on the target that the SANDAG Board of Directors asked staff to consider when drafting the 2021 Regional Transportation Plan (SANDAG Board Resolution No. 2021-17). Moreover, the Draft EIR also includes four other significance criteria to evaluate GHG emissions generated under implementation of the proposed Plan, including Impact GHG-5, which evaluates regional GHG emissions under proposed Plan implementation using California's targets and goals for Statewide GHG emissions reductions. Specifically, Impact GHG-5 evaluates whether implementation of the proposed Plan would be inconsistent with the State's ability to achieve the Statewide 2030 reduction target of SB 32 and the long-term reductions goals of EO B-55-18 (statewide carbon neutrality no later than 2045) and EO S-3-05 (statewide emissions levels reduced 80 percent below 1990 levels by 2050).

This comment also addresses Impact GHG-5 in Table ES-1, and asserts that the GHG mitigation measures summarized in the table are too vague, with a specific reference to mitigation measure TRA-2, Achieve Further VMT Reductions for Transportation and Development Projects. As explained on Draft EIR page ES-3, this table provides a summary of environmental impacts and mitigation measures to avoid or reduce significant impacts. The full text of mitigation measure TRA-2, which includes a detailed list of project-level VMT reduction measures that SANDAG shall, and the County of San Diego, cities, and other local jurisdictions can and should, implement during the project design and project-level CEQA review phase of transportation network improvements and land development projects (Draft EIR pages 4.16-53 to 4.16-54). No further response is required.

**GHG-3 Conflict with or impede achievement of an at least 30% reduction in per capita GHG emissions from the entire on-road transportation sector by 2035 compared to existing conditions (2016)**

There are no mitigation measures and yet the "Level of Significance After Mitigation" is shown to be "Less-than-significant impact in 2035."

California did not meet its 2020 EO S-3-05 target, which was our 1990 emission level, until around 2019. (This was a case where California achieved a target early.) Therefore, our emission in 2016 exceeded our 1990 level of emission. Therefore, only achieving a "30% reduction in per capita GHG emissions from the entire on-road transportation sector by 2035 compared to existing conditions (2016)" would be an unmitigated environmental disaster. If other MPOs followed this example, we would be unable to stabilize our climate because we would be well past our (the industrialized world's) 2030 climate-stabilizing requirement, of 80% below our 1990 level.

The line for GHG-5 is too vague, in terms of mitigation measures. To have any hope of achieving significant reductions by 2030, measures need to be mature enough to start soon. The mitigation measures shown in this line are little more than wishful thinking. As San Diego County Superior Court Judge Taylor wrote in a ruling in favor of the plaintiffs in their CEQA complaint against the County's woefully inadequate Climate Action Plan, "enforceable measures are needed now". That ruling was issued 9 years ago. SANDAG too often does not listen to me or others that urge enforceable measures that can be started now.

SANDAG instead seems to like words like (these are also from the GHG-5's, "mitigation measures"):

*TRA-2 Achieve Further VMT Reductions for Transportation and Development Projects*,

How would that be done? The "measure" is too ill defined to have any value.

Alternative 3 should be improved upon to conform with Reference 1 and then implemented as fast as possible. TRANSNET need to be modified to align with the improved-upon Alternative 3.

**Table 2-8, Proposed Plan Estimated SB 375 Greenhouse Gas Emissions Reductions for Cars and Light Trucks**

The Proposed Plan's 2035 reduction of 20% is so small that it would help to bring about an environmental disaster.

5-17  
cont.

5-18

5-19

**Phased Next OS Network Improvements and Investments, Page 2-66**

**RESPONSE TO COMMENT 5-18**

Please refer to Master Response 1 for discussion regarding accelerating elements of the Plan. There are constraints on when money becomes available during the lifespan of the proposed Plan. The SANDAG Board of Directors may review the TransNet ordinance and discuss possible updates. This process is outside of the development the proposed Plan. This comment and your support for Alternative 3 is noted for the record and will be forwarded to the SANDAG Board of Directors for its consideration prior to making a decision on adoption of the proposed Plan.

**RESPONSE TO COMMENT 5-19**

Implementation of the proposed Plan would result in a 20 percent reduction in per capita CO<sub>2</sub> emissions from passenger cars and light-duty trucks from 2005 levels by 2035, which exceeds the 2035 target of a 19 percent reduction set by CARB for the SANDAG region. As discussed in Section 4.8 of the EIR, however, the proposed Plan's GHG emissions would be inconsistent with the State's ability to achieve the goals of EO B-55-18 and S-3-05. Mitigation measures would help reduce regional GHG emissions by reducing VMT, increasing use of zero-emission fuels, sequestering carbon from the atmosphere, and other measures; they would reduce inconsistency of the proposed Plan's GHG emissions with the State's ability to achieve the SB 32, EO B-55-18, and EO S-3-05 GHG reduction goals. However, implementation of the many other changes required to achieve these goals is beyond SANDAG's and local agencies' current jurisdiction and authority. As such, impacts were identified as significant and unavoidable.

5-20 Considering our 2030 climate-stabilization target and the derivations of Reference 1, the car-parking system described in References 1 through 7 needs to have numerous successful implementations and be well on the way to being widely implemented by 2025. The words “dynamic curb management”, for 2035, is not encouraging. The car-parking system proposed by this letter and since 2010 by this author certainly includes dynamic curb management. However, SANDAG needs to reach out to get help on this important aspect of the Next OS. I hope we can meet soon.

Likewise, on Pages 2-66 to 2-67 and on Page 2-71 to 2-72, there are hopeful signs that SANDAG could help to foster the changes we need. I would love to meet to discuss these topics.

**Climate Change Destabilization Could Include our Weather**

5-21 Page 3-1 has a description of our current climate and how climate change could change our weather. It needs a statement that destabilization of climate systems (such as the melting of our permafrost or unleashing large amounts of methane from beneath our arctic region, or burning up an enormous expanse of forests, including our Amazon rain forest) could cause much larger variations if these destabilizing systems accelerate and set off other climate-destabilizing systems. The freeze experienced by Texas and measurement of 120 Degrees in Canada show that, when it comes to climate, we are already in uncharted territory. The description of San Diego County’s “current climate” needs a statement that, given the fact that our atmospheric CO2 is at 420 PPM, when it should be at 280 PPM, we really don’t know what might be possible, in terms of current weather.

**Mitigation Measures for Existing Development**

5-22 On Page 4-3, it says, “The EIR includes three broad types of mitigation measures: (1) plan- and policy-level mitigation measures assigned to SANDAG; (2) mitigation measures for transportation network improvements and programs, assigned to SANDAG and other transportation project sponsors; and (3) mitigation measures for development projects implementing regional growth and land use changes, which local jurisdictions implement.”

This will be too little too late and it is an arbitrary decision to do what is easiest. It does not make sense, given the fact of our Code Red Climate Emergency, as explained in this letter. For example, TDM Ordinances need to apply to existing developments. SANDAG should provide no help to municipal governments that fail to have a powerful TDM for their own employees, to set an example, for other employers. The TDM would include the car-parking system described in Reference 1 – 7. SANDAG should do this for their own employees, ASAP, using Reference 7 to start the generation of a Systems Definition document to support an RFP process to identify a good 3<sup>rd</sup> party vendor.

**4.8’s Paragraph on “Global Climate Change”**

Comments on SANDAG’s Draft EIR for Its 2021 RTP

13 of 16

**RESPONSE TO COMMENT 5-20**

Thank you for providing the included resources for SANDAG’s consideration. Between now and 2050, it is anticipated that the drive alone mode share will be significantly reduced. Cars will still play a part in the mobility ecosystem, but effective parking and curb management strategies will be needed as multimodal options within communities increase. The key will be to make the right amount of parking available when it is needed and price it so that alternative commutes are encouraged, and accessibility, equity, and economic development are promoted. Tiered pricing will need to be implemented; for example, free and lower priced parking in outlying, more suburban communities including “gateway” (i.e., end-of-line Transit Leap stations) compared to market-rate pricing in our urban core and other denser communities.

Parking Management is one of the key policy areas included in the proposed Plan. As part of the Plan, SANDAG has designated program funding towards working with local jurisdictions to implement parking management strategies such as parking pricing. In addition, SANDAG develops technical resources to provide jurisdictions with guidance on implementing parking policies, such as the 2014 Parking Management Toolbox. One of the proposed Plan’s implementation strategies includes updating the Toolbox to account for newer modes and more flexible curb space strategies.

**RESPONSE TO COMMENT 5-21**

Appendix C, *Climate Change Projections, Impacts, and Adaptation*, of the EIR describes how climate may change in the San Diego region in the future due to the effects of global warming, and how those changes could affect each of the resource areas discussed in the EIR. The EIR sections evaluate whether the proposed Plan would exacerbate a climate change impact (e.g., creating more housing development in high wildfire risk zones).

**RESPONSE TO COMMENT 5-22**

The Plan proposes a Transportation Demand Management Ordinance that would require employers over a certain size to provide transportation benefits and amenities that encourage sustainable transportation choices. These types of TDM ordinances exist in other regions across the state. A near-term implementation action is to complete a Transportation Demand Management Ordinance Policy Analysis. This policy analysis would detail the employers that the



5-23 This paragraph needs to quantify what we have done to our earth's atmospheric level of CO<sub>2</sub>. We should be at 280 PPM. We are at 420 PPM. This letter's Figures 1, 2, and 3 should be included. The text should make it clear that we are living in a dangerous CO<sub>2</sub> spike.

The paragraph should make the difference between climate change (before the spike) and Anthropogenic climate change (within the spike) clear to the reader.

Thank you for including the 280 PPM and 413 PPM (in 2020) levels in the paragraph on Carbon Dioxide. This needs to be elevated to the first paragraph with the plots. The plot of 800,000 years, showing how outrageous it is that we have created the spike of CO<sub>2</sub>, needs to be shown.

5-23 The discussion at the top of Page 4.8-6 should introduce the reader to the concept of "destabilization" or going over a "climate tipping point" or a "climate cliff." It is a lie by omission to not state that we are in line to experience a devastating collapse of the human population, leading to extinction or near extinction. Our Code Red Climate Emergency should not be hidden. We are in great danger. Some say climate change is an existential threat. In fact, it is a near certainty that anthropogenic climate change will end our existence. Theoretically we could still stabilize the climate at a livable level. We should not give up. However, given what is needed by 2030, along with the public's general disinterest in the details, it is highly unlikely we will avoid destabilization, leading to our demise.

**CARB Does Too Little Too Late**

On Page 4.8-10 it says, "**Mobile Source Strategy**. Developed by CARB to provide an integrated planning perspective and common vision for transforming the mobile sector to achieve air quality and climate change goals."

5-24 We know from the other statements in this document that the "climate change goals" do not include achieving the 2030 climate-stabilizing target of 80% below our 1990 level. This is one reason why Reference 1 is important. Reference 1 derives the mathematical relationships between achieve a reduction in emissions, fleet efficiency, per-capita driving, a low-carbon fuel standard, and the renewable content of electricity.

**Section 4.8: Greenhouse Gas Emissions**

**4.8.4 Significance**

CEQA's Appendix G asks as follows:

VII. GREENHOUSE GAS EMISSIONS. Would the project:

a) Generate greenhouse gas emissions, either directly or indirectly,

ordinance would apply to and mechanisms for implementation and enforcement.

**RESPONSE TO COMMENT 5-23**

This comment addresses the discussion of "Global Climate Change" in Draft EIR Section 4.8.1 (page 4.8-1) and asserts that additional context should be included in this section, including comparison of existing emissions concentrations to pre-industrial levels and information about climate "destabilization" or "tipping points." This section of the DEIR has been revised as follows to include additional information on the latest climate change science as reported by the IPCC in August 2021.

Increases in fossil fuel combustion and deforestation have exponentially increased concentrations of GHGs in the atmosphere since the Industrial Revolution. According to the Intergovernmental Panel on Climate Change (IPCC), human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years (IPCC 2021). In addition, the IPCC reported with high confidence that in 2019 CO<sub>2</sub> concentrations were higher than at any time in at least 2 million years, and reported with very high confidence that 2019 concentrations of CH<sub>4</sub> and N<sub>2</sub>O were higher than at any time in at least 800,000 years (IPCC 2021). Rising atmospheric concentrations of GHGs in excess of natural levels enhance the greenhouse effect, which contributes to global warming of the Earth's lower atmosphere. This warming induces large-scale changes in ocean circulation patterns, precipitation patterns, global ice cover, biological distributions, and other changes to the Earth's system that are collectively referred to as *climate change*. The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years (IPCC 2021). The IPCC also reports that many changes in the climate system become larger in direct relation to increasing global warming, including increases in the frequency and intensity of hot extremes, marine heatwaves, and heavy precipitation, agricultural and ecological droughts in some regions, and proportion of intense tropical cyclones, as well as reductions in Arctic sea ice, snow cover, and permafrost (IPCC 2021). In addition, low-likelihood outcomes, such as ice sheet collapse, abrupt ocean circulation changes, some compound extreme events and warming substantially larger than the assessed very likely range of future warming cannot be ruled out (IPCC 2021). Climate change impacts in this analysis are evaluated in the relevant resource sections (e.g., climate change effects

to water supply are discussed in Section 4.18, *Water Supply*, and climate change's influence on wildfire are discussed in Section 4.19, *Wildfire*, and similarly for other sections) and covered in detail in the *Climate Change Projections, Impacts and Adaptation* report in Appendix C.

**RESPONSE TO COMMENT 5-24**

is commenter asserts that the Mobile Source Strategy, which is a plan prepared by CARB to identify the level of transition to cleaner mobile source technologies needed to achieve California air quality, climate change, and community risk reduction goals, does not include a "2030 climate-stabilizing target of 80% below our 1990 level." The 2020 Mobile Source Strategy was approved by the CARB Board on October 28, 2021. This comment is not related to the adequacy of the Draft EIR and no further response is required.

**RESPONSE TO COMMENT 5-25**

This comment references OPR's Discussion Draft report on CEQA and Climate Change and asserts that "a project that will have significant impacts on driving" is required to "conform to a plan showing how LDVs (light-duty vehicles) can achieve our climate-stabilizing targets..." Refer to response to comment Bullock 5-22, which explains that the Draft EIR includes Impact GHG-5, which evaluates regional GHG emissions under proposed Plan implementation using California's targets and goals for statewide GHG emissions reductions. Specifically, Impact GHG-5 evaluates whether implementation of the proposed Plan would be inconsistent with the State's ability to achieve the statewide 2030 reduction target of SB 32 and the long-term reductions goals of EO B-55-18 (statewide carbon neutrality no later than 2045) and EO S-3-05 (statewide emissions levels reduced 80 percent below 1990 levels by 2050).

that may have a significant impact on the environment?

Considering cumulative effects of the proposed RTP, the answer is yes, especially for LDVs. The next question about conflicting with an applicable plan does not matter, given the result of the "letter a" criterion.

Section XVII also applies because it explicitly mentions cumulative impacts and asks:

c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?

Nothing short of a full exchange of nuclear weapons could be worse for people than climate destabilization.

From OPR's Reference 9 with emphasis added:

Each public agency that serves as a CEQA lead agency should develop its own approach to performing a climate change analysis for projects that generate greenhouse gas emissions. A consistent approach should be applied for the analysis of projects, and the analysis must keep pace with scientific knowledge and regulatory schemes. (*Cleveland National Forest Foundation v. San Diego Assn. of Governments, supra*, 3 Cal.5th at 519.) For these projects, compliance with CEQA entails three basic steps: identify and quantify the greenhouse gas emissions; determine the significance of those emissions **in the context of climate change**; and if the impact is found to be significant, identify alternatives and/or mitigation measures that will reduce the impact below significance.

"In the context of climate change" means that the climate science must be applied to the situation. From that, to be legal, a project that will have significant impacts on driving, including its feasible (technologically possible and cost effective) mitigation measures, must conform to a plan showing how LDVs can achieve our climate-stabilizing targets, especially our 2030 target because it occurs so soon. This again shows the importance of Reference 1 or some other such Plan.

Thank you for Tables 4.8-7 and 4.8-8 showing the importance of reducing VMT.

Table 4.8-9 is key. However, its results are insufficient to support climate stabilization. Reference 1 shows we need a 32% value by 2030, which is 5 years sooner than 2035.

Figure 7 shows that the DEIR does not consider what the climate scientists are telling us, which is what we must achieve to stabilize the climate at a livable level. The state mandates shown are not enough to achieve our 2030 climate-stabilizing requirement, which is to emit at a level that is no more than 80% below our 1990 emission level.

**Figure 7 SANDAG's DEIR Section on GHG Does NOT Consider Achieving the Industrial World's 2030 Climate-Stabilizing Target.**

### RESPONSE TO COMMENT 5-26

The proposed Plan is required to reduce GHG emissions from passenger vehicles and light-duty trucks by 19 percent per capita by 2035 compared to 2005 levels, as mandated by SB 375. Reducing GHG emissions and achieving State goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, State agencies, and other partners to reduce emissions beyond what is achieved by the proposed Plan. The proposed Plan would provide travelers with more travel and mobility options in residential and employment centers that can lead to a reduction in VMT.

### RESPONSE TO COMMENT 5-27

This comment addresses Draft EIR Chapter 7, *Other Considerations Required by CEQA*, Section 7.2.9, which evaluates GHG emissions impacts under a maximum theoretical buildout scenario, and asserts that "state mandates" are insufficient to reduce 2030 emissions to no more than 80 percent below 1990 emissions levels. Refer to response to comment Bullock 5-22, which explains that the Draft EIR includes Impact GHG-5, which evaluates regional GHG emissions under proposed Plan implementation using California's targets and goals for statewide GHG emissions reductions. Specifically, Impact GHG-5 evaluates whether implementation of the proposed Plan would be inconsistent with the State's ability to achieve the statewide 2030 reduction target of SB 32 and the long-term reductions goals of EO B-55-18 (statewide carbon neutrality no later than 2045) and EO S-3-05 (statewide emissions levels reduced 80 percent below 1990 levels by 2050).

5-27  
cont.

**7.2.3 GREENHOUSE GAS EMISSIONS**

Compared to existing conditions, the proposed Plan's GHG emissions would decrease for all horizon years (2025, 2035, and 2050). Under maximum theoretical buildout conditions, regional growth and land use change would result in some increases in GHG emissions, but there would still be net decreases compared to existing conditions.

Development under the maximum theoretical buildout scenario would likely continue in a similar pattern as under the proposed Plan, which encourages compact development, supporting rather than impeding adopted Climate Action Plans (CAPs), GHG reduction plans, and/or sustainability plans relevant to the proposed Plan. Because 2030 GHG emissions under the proposed Plan are higher than the AB 32-based regional reference point, emissions under maximum theoretical buildout are expected to continue to exceed this reference point, which would be a significant impact related to conflicts with AB 32.

Under maximum theoretical buildout, development would likely continue in a similar pattern as under the proposed Plan, which encourages compact development, although per capita GHG emissions from passenger vehicles would somewhat increase. However, the maximum theoretical buildout scenario would likely still achieve, and not conflict with, Senate Bill (SB) 375's per capita GHG emission reduction targets set by the California Air Resources Board (CARB) for the San Diego region.

The proposed Plan would be inconsistent with the State's ability to achieve 2045 and 2050 reference points of net zero and 5.2 million metric tons of carbon dioxide equivalence (MMTCo<sub>2</sub>e), respectively (based on the goals of Executive Orders 2-3-05 and B-5-19). Because GHG emissions would be higher under maximum theoretical buildout, these inconsistencies, which are a significant impact, would be worse. As with the proposed Plan, this would be reduced with the mitigation identified in Section 4.8, Greenhouse Gas Emissions, but impacts would remain significant and unavoidable.

The second paragraph states that the 2030 emissions under the proposed Plan are higher than the AB 32-based regional reference point. Figure 1 of this letter shows that this means the 2030 value is worse than the SB 32 value (40% down from the 1990 value) which is much more emission than the climate-stabilizing value of 80% down.

**In Closing**

Thank you for your leadership in performing your critical work. Thank you for reading this material and for providing the comments and response as required for any comment letter on a DEIR. Please let me know if you would like to meet to discuss this letter or related topics.

5-28

Regards,



Mike Bullock  
1800 Bayberry Drive  
Oceanside, CA 92054  
760-754-8025

**References**

5-29

All references were attached to the email sent with this letter. They are all available from Mike Bullock at [mike\\_bullock@earthlink.net](mailto:mike_bullock@earthlink.net)

**RESPONSE TO COMMENT 5-28**

Thank you again for your participation in the environmental review process and for the detailed comments for SANDAG's consideration. Please continue to follow along in this process by visiting [SDForward.com](http://SDForward.com).

**RESPONSE TO COMMENT 5-29**

SANDAG has reviewed the attached reference documents and responded above to those Draft EIR comments that cite or use information from these references documents. No responses to the attachments specifically have been included because they do not contain comments specific to the EIR and/or proposed Plan.

**COMMENT LETTER 6: CLIMATE ACTION CAMPAIGN**



**RESPONSE TO COMMENT 6-1**

Thank you for your comment. SANDAG appreciates your input and support of the proposed Plan.

**RESPONSE TO COMMENT 6-2**

As noted in the comment and as detailed in Section 4.8, *Greenhouse Gas Emissions*, the proposed Plan would be inconsistent with the State's ability to achieve the goals of SB 32, EO B-55-18, and S-3-05. The comment also states that the proposed Plan alone will not achieve these goals. As discussed under Impact GHG-5, additional mitigation measures have been identified at the Plan- and project-specific levels to substantially lessen the amount of proposed Plan GHG emissions in 2030, 2045, and 2050. Furthermore, as discussed in Chapter 2, *Project Description*, SANDAG updates the Regional Plan every 4 years, and, as the State continues to identify new plans and technologies to meet the mid-century GHG emission targets, SANDAG will be able to implement these features into future plans to further the region's progress toward the State's goal of carbon neutrality by 2045.

This comment addresses the proposed Plan and is not related to the adequacy of the EIR.

**RESPONSE TO COMMENT 6-3**

This comment addresses the proposed Plan and is not related to the adequacy of the EIR.

SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the proposed Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, are reflected in Appendix A, Attachment 1 of the proposed Plan.

6-4 Finally, critical to a more sustainable, equitable region is increased affordable housing at existing and future transit stops. The Sustainable Communities Strategy should include a suite of aggressive policies that stop sprawl and support infill. Smart land use is essential to slashing emissions.

6-5 This plan represents an important first step in the shift away from auto-centric planning, and towards a more climate-just, climate-ready transportation future. We look forward to continued engagement with this critical plan, to ensure it is as strong as possible for climate action.

Sincerely,

Noah Harris,  
Policy Advocate  
Climate Action Campaign

**RESPONSE TO COMMENT 6-4**

This comment addresses the proposed Plan and is not related to the adequacy of the EIR.

Appendix B of the proposed Plan presents the Implementation Action strategies proposed to incentivize sustainable growth and development in the San Diego region.

**RESPONSE TO COMMENT 6-5**

Thank you for your participation in this process and for your organization's support of the proposed Plan



**COMMENT LETTER 7: CITY OF CARLSBAD**

Comment Letter 7



Oct. 11, 2021

SANAG Regional Plan EIR  
 San Diego Association of Governments  
 401 B Street, Suite 800  
 San Diego CA 92101  
 C/O Kirsten Uchitel, Associate Planner.  
 Via: [RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)

RE: City of Carlsbad Comments on Draft Environmental Impact Report for the 2021 Regional Plan

Dear Ms. Uchitel:

7-1

The City of Carlsbad ("city") appreciates the opportunity to provide comments on the draft Program Environmental Impact Report ("PEIR") for the 2021 Regional Plan ("Plan"), dated Aug. 27, 2021. This is an important plan for the region and will guide the next phase of growth for the member agencies of the San Diego Association of Governments ("SANDAG"), including the city. An effectively designed and implemented regional transportation plan would help ensure improved transportation options for area residents, businesses and other community members, as well as meaningful reductions in greenhouse gas ("GHG") emissions and improved quality of life as we grow our communities.

The city previously submitted comments on the Plan to SANDAG staff on August 6, 2021 (Attachment 1), expressing multiple concerns about the Plan, its implementation and its potential impacts on the environment. Additionally, the city sent a follow up letter on September 30, 2021 (Attachment 2), to clarify the city does not wish to remove El Camino Real (project CB32) from the Regional Arterials Project List. Copies of the city's prior letters are included here as Attachment 1 and Attachment 2, respectively. Both letters are incorporated herein by this reference as additional comments on the adequacy of the PEIR and should be included in the administrative record of SANDAG's proceedings concerning the Plan and the PEIR.

7-2

The California Environmental Quality Act ("CEQA") is intended "to afford the fullest possible protection to the environment within the reasonable scope of the statutory language." (*Friends of Mammoth v. Board of Supervisors* (1972) 8 Cal.App.3d 247, 259.) With narrow exceptions, CEQA requires an EIR whenever a public agency proposes to approve or to carry out a project or activity that may have a significant effect on the environment. (CEQA Guidelines § 15002(f).) The basic purpose of an EIR is to provide public agencies and the public in general with detailed information about the effect that a proposed project or activity is likely to have on the environment and to identify ways in which the significant effects might be reduced or avoided. (Public Resources Code § 21061; CEQA Guidelines § 15003.) The EIR and its associated process create layers of accountability and must "reflect a good faith effort at full disclosure." (*Kings County Farm Bureau v. City of Hanford* (1990) 221 Cal. App. 3d 692, 712, citing CEQA Guidelines § 15151.) The EIR process must provide meaningful information for an environmental assessment so that the public will know the basis on which decisions are made on a proposed project or activity and can respond accordingly to action with which it disagrees.

Transportation & Community Development Departments  
 1635 Faraday Avenue | Carlsbad, CA 92008 | 760-602-2710 t

**RESPONSE TO COMMENT 7-1**

This comment includes opening remarks and describes prior letters submitted to SANDAG. No further response is required.

**RESPONSE TO COMMENT 7-2**

This comment largely describes the CEQA framework under which the proposed Plan and Final EIR have been developed. The Final EIR informs decisionmakers and the public generally of the significant environmental effects of the proposed Plan, identifies ways to minimize the significant effects, and describes reasonable alternatives to the proposed Plan (CEQA Guidelines Section 15121(a)). The Final EIR properly considers cumulative impacts (CEQA Guidelines Section 15168(b)(2)), identifies a baseline (CEQA Guidelines Section 15125), describes a range of reasonable alternatives to the proposed Plan (CEQA Guidelines Section 15126.6), and describes feasible mitigation measures that would minimize significant adverse environmental impacts (CEQA Guidelines Section 15126.4).

City of Carlsbad Comments on Draft Environmental Impact Report for 2021 Regional Plan  
 Oct. 11, 2021  
 Page 2

7-2 cont. In this case, the city seeks to ensure that SANDAG prepares an environmental document that is adequate, complete and fully discloses the potential significant adverse effects of the Plan. Further, to implement the principles of CEQA, SANDAG should not truncate the requisite cumulative impact analysis (CEQA Guidelines section 15168(b)(2)), use improper baselines (CEQA Guidelines section 15152), or foreclose the consideration of any alternative or mitigation measure that would ordinarily be part of CEQA review of a regional plan (CEQA Guidelines section 15004(b)(2)(B)). If the EIR fails to provide decision-makers and the public with all of the relevant information regarding a project that is necessary for informed decision-making and public participation, the environmental document is flawed and deficient and the agency's decision will be set aside (*Kings County Farm Bureau v. City of Hanford, supra*, 221 Cal. App. 3d at p. 712).

7-3 CEQA prescribes review procedures a public agency must follow before approving or carrying out proposed projects. Those procedures emphasize the importance of public participation in the CEQA process, including mandatory opportunities for public review and comment and the lead agency's obligation to provide meaningful responses to comments received. A Notice of Preparation (NOP) was issued on November 14, 2016 and a public scoping meeting was held on December 8, 2016. Although the early consultation with affected agencies and organizations was appreciated, and a necessary procedural step per CEQA Guidelines section 15082, SANDAG subsequently made a material change in the scope of the project to encompass the vision of 5 Big Moves, without providing an opportunity for additional scoping and consultation with the public and affected agencies. SANDAG failed to re-engage the public and affected agencies to provide them with sufficient information regarding the revised Plan and its potential environmental effects to enable them to make a meaningful response about the scope and content of the anticipated environmental work. Due to this procedural error, the public and affected agencies have been denied the opportunity to provide SANDAG with specific detail about the significant environmental issues and reasonable alternatives and mitigation measures that needed to be explored in the draft PEIR, early enough in the CEQA process for SANDAG to have considered their comments in preparing the draft PEIR. In addition, SANDAG failed to comply with CEQA by conducting the scoping and public review process for the Plan and the draft PEIR separately, which has resulted in a disconnected, piecemeal and rushed process in which previous comments on the Plan were not responded to or incorporated into the draft PEIR.

7-4 The disjointed and rushed process for public participation continues to the present. According to SANDAG staff, responses to comments on the Plan will be published at the end of October, several weeks after public and agency comments are due on the draft PEIR. Thus, the public and affected agencies like the city must submit comments on the PEIR without knowing whether or how SANDAG has responded to previous comments on the Plan. SANDAG has already indicated that the SANDAG Board will review and consider the Plan and the Final PEIR in December 2021. Thus, there appears to be insufficient time for SANDAG to evaluate comments received on the draft PEIR, prepare meaningful responses and make those responses available as required by CEQA Guidelines sections 15087 and 15088. As such, SANDAG is foreclosing on a "meaningful public participation process" and subjecting itself to a claim that SANDAG is prejudicing the outcome of the environmental review process by ensuring there is little opportunity for public comments to influence the Plan's program and design. ("Environmental review derives its vitality from public participation" (*Ocean View Estates Homeowners Assn. v. Montecito Water Dist.* (2004) 116 Cal. App. 4th 396, 400.) If the issues that were addressed in the city's August 6, 2021 comment letter on the Plan (Attachment 1) are not addressed in the PEIR, the PEIR will be insufficient as an informative document and it will reduce the validity and efficacy of the Plan, including its use of faulty assumptions regarding land use and population growth to comply with

**RESPONSE TO COMMENT 7-3**

This comment inaccurately characterizes the 5 Big Moves as a material change to the scope of the project in the NOP issued on November 14, 2016. In fact, the 5 Big Moves are planning strategies used to develop the proposed Plan, which consists of the Regional Transportation Plan and Sustainable Communities Strategy that identify the San Diego region's future transportation investments and growth through 2050 as described in the NOP.

The statement that the public and affected agencies have been denied the opportunity to provide SANDAG with specific detail about the significant environmental issues and reasonable alternatives and mitigation measures is also inaccurate. As noted by the comment, SANDAG initiated the EIR scoping process on November 14, 2016, through the circulation of a NOP. Receipt of the NOP by the State Clearinghouse (Clearinghouse) at the California Office of Planning and Research on November 14, 2016, initiated a 60-day comment period that ended January 13, 2017.

The NOP provided formal notification consistent with the CEQA Guidelines to all federal, State, and local agencies involved with funding, and to other interested organizations and members of the public, that an EIR will be prepared for the proposed Plan. The NOP was intended to encourage interagency communication concerning the proposed Plan and provide sufficient background information so that agencies, organizations, and individuals could respond to SANDAG

with specific comments and questions on the scope and content of this EIR. Appendix A to the Final EIR summarizes the issues raised in the NOP comments and identifies the EIR section(s) that address that issue or provides another response to the issue raised as appropriate. The NOP is provided in full in Appendix A-1. The written comments are provided in full in Appendix A-2.

In addition, SANDAG noticed and held a public scoping meeting, consistent with CEQA (PRC Section 21083.9), on December 8, 2016, at SANDAG's office at 401 B Street, San Diego, CA 92101. The purpose was to receive perspective and input from agencies, organizations, and individuals on the scope and content of the environmental information to be addressed in the EIR.

The comment also mischaracterizes the CEQA requirements for review of the Draft EIR. There is no CEQA requirement to conduct the public



comment period for the Draft EIR required by CEQA Guidelines Section 15087 simultaneously with the public comment period required by Government Code Section 65080 for the proposed Plan. There is also no CEQA requirement for comments on the Draft Plan to be responded to or incorporated into the Draft EIR. The Draft EIR properly evaluates the Draft Plan and preparation of each has run concurrently consistent with CEQA Guidelines Section 15004. SANDAG has evaluated comments received on environmental issues and prepared written responses consistent with CEQA Guidelines Section 15088. Responses to comments received on the Draft EIR are included herein (Appendix P.1 of this Final EIR)..

#### **RESPONSE TO COMMENT 7-4**

This comment mischaracterizes the process for public participation in the Draft and Final EIRs. There is no CEQA requirement to conduct the public comment period for the Draft EIR required by CEQA Guidelines Section 15087 simultaneously with the public comment period required by Government Code Section 65080 for the proposed Plan. There is also no CEQA requirement for comments on the Draft Plan to be responded to or incorporated into the Draft EIR. The Draft EIR properly evaluates the Draft Plan and preparation of each has run concurrently consistent with CEQA Guidelines Section 15004. SANDAG has evaluated comments received on environmental issues and prepared written responses consistent with CEQA Guidelines Section 15088. Responses to comments received on the Draft EIR are included herein (Appendix P.1 of this Final EIR), and responses to comments received on the proposed Plan are included in Appendix P.2 of the Final EIR.

This comment also incorrectly asserts that the EIR uses faulty land use assumptions. Government Code Section 65080(b)(2)(B) provides that an SCS “use most recent planning assumptions considering local general plans and other factors.” It also requires that the SCS “set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the proposed Plan.

Specific to public outreach conducted by SANDAG, there have been extensive opportunities for meaningful public participation in the proposed Plan and EIR. SANDAG initiated the EIR scoping process on November 14, 2016, through the circulation of an NOP. Receipt of the NOP by the State Clearinghouse at the California Office of Planning and Research on November 14, 2016, initiated a 60-day comment period that ended January 13, 2017. The NOP provided formal notification to all federal, State, and local agencies involved with funding, and to other interested organizations and members of the public, that an EIR will be prepared for the proposed Plan. The NOP was intended to encourage interagency communication concerning the proposed Plan and provide sufficient background information so that agencies, organizations, and individuals could respond to SANDAG with specific comments and questions on the scope and content of this EIR. Appendix A summarizes the issues raised in the NOP comments and identifies the EIR section(s) that address that issue or provides another response to the issue raised as appropriate. The NOP is provided in full in Appendix A-1. The written comments are provided in full in Appendix A-2.

Consistent with CEQA (PRC Section 21083.9), SANDAG noticed and held a public scoping meeting on December 8, 2016, at SANDAG's office at 401 B Street, San Diego, CA 92101. The purpose was to receive perspective and input from agencies, organizations, and individuals on the scope and content of the environmental information to be addressed in the EIR.

To support the development of the proposed Plan, SANDAG implemented a comprehensive public outreach and involvement program consistent with State and federal requirements. Early in the planning process, SANDAG developed a Public Involvement Plan (PIP) to guide the public outreach program, which was updated in mid-2019. The PIP identifies public engagement techniques to involve the public and collect input for the proposed Plan, including public workshops, social media, visualizations, and other means. It describes how to connect with hard to reach communities such as tribal nations and low-income and minority populations. A detailed description of the PIP can be found in Appendix G of the proposed Plan.

The Draft EIR for the proposed Plan was released to the public on August 27, 2021, and was available for a 45-day public review period, as required by CEQA. SANDAG published a Notice of Availability (NOA) for the Draft EIR in local newspapers on August 27, 2021, and mailed the

NOA to an extensive distribution list. SANDAG also filed a Notice of Completion (NOC) with the State Clearinghouse to indicate the availability of the Draft EIR for public review and comment on August 27, 2021. The Draft EIR was distributed to the agencies, organizations, and individuals that provided written comments on the NOP, the SANDAG Board of Directors, SANDAG member agencies, and other interested parties and stakeholders. Agencies, organizations, and individuals were invited to provide written comments on the Draft EIR during the public review period from August 27 to October 11, 2021.

The Draft EIR and all appendices were available for review online at [www.sdforward.com](http://www.sdforward.com), at SANDAG offices located at 401 B Street, Suite 800, San Diego, California 92101, and at the San Diego Central Library located at 330 Park Boulevard, San Diego, California 92101. The Central Library will facilitate inter-library transfers upon request by a member of the public in order to provide access at local libraries. On a case-by-case basis, the San Diego Central Library can also digitize documents and transfer them to other libraries. No such requests were made of the Central Library with respect to the Draft EIR, nor were any requests made of SANDAG with respect to providing access to the Draft EIR during the Public Comment Period.

There will be a further opportunity for public participation on December 10, 2021, at the SANDAG Board of Directors meeting where decision makers will consider certification of the Final EIR and adoption of the proposed Plan.

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state and federal mandates, such as the Sustainable Communities Strategy and greenhouse gas reduction targets. These faulty assumptions misrepresent the vital land use-transportation planning connections and do nothing to reduce greenhouse gasses and will instead result in unplanned increases to traffic, greenhouse gases, and result in increased housing unaffordability.

7-4  
 cont.

While the city supports the main concepts of the Vision in the Regional Plan, the 5 Big Moves, there needs to be an adequate analysis on how the Plan will be implemented, and what will occur if there are changes to the projected growth, technology, and/or state law impacting existing conditions. The city's residents, businesses, and property owners would have benefited from more time to read the details in the Plan and draft EIR. After years of public outreach that lacked detail of the assumptions and projects proposed in the Plan, the Plan is now being rushed to decision by the SANDAG Board of Directors by the end of 2021. This is a procedural error and not adequate for the purposes of CEQA.

7-5

The city also restates its prior request that the following language be added to the Regional Plan for additional clarification on land use authority: "Land use authority is reserved to local jurisdictions because they are best positioned to effectively implement the objectives outlined in the Plan through understanding of the unique needs of their communities and geographies." This language is needed to clarify that land use authority rests with the local jurisdiction. Although this principle should be obvious, the inconsistencies between the Plan and the city's General Plan discussed below suggest that it has been ignored. Further the draft EIR should identify how the Program EIR will be utilized for streamlining with later activities and/or for use with subsequent EIRs and negative declarations in compliance with CEQA Guidelines section 15168(c) and (d).

In addition, the city has the following substantive comments on the adequacy of the PEIR:

1. The PEIR fails to disclose the Plan's inconsistencies with the Carlsbad General Plan and to analyze the related potential environmental impacts. The Legislature has declared a policy "to protect California's land resource, to ensure its preservation and use in ways which are economically and socially desirable in an attempt to improve the quality of life in California." (Gov. Code § 65030.) To further this policy, each of the state's cities and counties is required to adopt a comprehensive, long-term general plan for the physical development of that city or county. (Gov. Code § 65300.) Accordingly, the city adopted a General Plan in compliance with state law and most recently updated it in 2015. the city's General Plan "sets forth land use compatibility policies applicable to future development in the vicinity." These policies are designed to ensure that future land uses in the surrounding area will be compatible with the realistically foreseeable activity in the city.

7-6

Growth projections for the region are based on population, vehicle trends and land use plans developed by the cities and the County of San Diego ("County") as part of their general plans. Many different regional documents rely on the same information to develop water demand projections, air quality performance standards, emission inventories, and emission reductions. The Plan would result in an increase in residential land use resulting in corresponding increases in indirect and cumulative vehicle miles traveled ("VMT"), GHG emissions and air pollutant emissions, as well as inconsistencies with RAQS, SIP, and regional traffic modeling. This is not disclosed in the draft PEIR. CEQA Guidelines section 15125(a) requires EIRs to contain a description of the physical environmental conditions in the vicinity of the project, as they exist at the time the NOP is published, or if no NOP is published, at the time environmental analysis is commenced, from both a local and regional perspective. Existing general plans, including their Land Use Elements, should

**RESPONSE TO COMMENT 7-5**

The following language has been added to Chapter 2 of the proposed Plan: "Land use authority is reserved for local jurisdictions under state law, and because they understand the unique needs of their communities and geographies."

The comment inaccurately suggests that the City's General Plan has been ignored in the developing the proposed Plan. SANDAG relied upon local general plans and other factors to develop the forecasted development pattern for the region consistent with Government Code Section 65080(b)(2)(B). Consistency of the proposed Plan with relevant general plans is analyzed in Section 4.11, *Land Use*, of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions' general plans or other local planning documents. Consistency of individual second-tier projects with these policies would be considered during project-specific CEQA reviews.

The Draft EIR identifies how it can be utilized for streamlining with later activities and/or for use with subsequent environmental analyses in Section 2.6.1.

**RESPONSE TO COMMENT 7-6**

Consistency of the proposed Plan with relevant general plans and LCPs is analyzed in Section 4.11 of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions' general plans, LCPs, or other local planning documents. Consistency of individual second-tier projects with these policies would be considered during project-specific CEQA reviews.

Government Code Section 65080(b)(2)(B) provides that an SCS "use most recent planning assumptions considering local general plans and other factors." It also requires that the SCS "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board." The SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and

policies in the Plan. As the comment notes, the SCS land use pattern focuses growth and development in the Mobility Hub areas.

In July 2018, SANDAG received the RHNA Determination from the California Department of Housing and Community Development, requiring that the region plan for 171,685 housing units during the sixth housing element cycle, which covers the years 2021 through 2029. As described on page 4.14-9 of the Draft EIR, the SANDAG Board of Directors adopted the 6th Cycle RHNA Plan in July of 2020, which allocates housing units to jurisdictions based on each jurisdiction's share of transit and jobs within the region. The proposed Plan also accommodates the 6th Cycle RHNA Plan allocations consistent with Government Code section 65080(b)(2)(B).

This comment inaccurately asserts that the Draft EIR does not disclose analysis of VMT, GHG and air pollutant emissions, and inconsistencies with RAQs, SIP, and regional traffic modeling. The EIR evaluates each and the relevant identified impacts in Sections 4.3 (*Air Quality*), 4.8 (*Greenhouse Gas Emissions*), 4.11 (*Land Use*), 4.14 (*Population and Housing*), and 4.16 (*Transportation*), as well as Chapter 5 (*Cumulative Impact Analysis*), among others.

This comment also inaccurately asserts that the Draft EIR does not disclose the land use assumptions in the identified baseline for the proposed Plan. Section 3.3 describes the Existing Land Use and Development Patterns as of 2016, the year in which the NOP for this EIR was published. In addition, Figure 4.11-1 in Section 4.11 depicts the land use pattern for the entire San Diego region in 2016.

The comment inaccurately suggests that the City's General Plan has been ignored in the developing the proposed Plan. SANDAG relied upon local general plans and other factors to develop the forecasted development pattern for the region consistent with Government Code Section 65080(b)(2)(B). The thresholds for land use analysis in Appendix G of the CEQA Guidelines include an evaluation of whether the project causes a significant environmental impact due to a conflict with a land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect. A conflict alone does not necessarily result in a significant environmental impact. As stated above, consistency of the proposed Plan with relevant general plans is analyzed in Section 4.11 of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions' general plans or other local planning

documents. Consistency of individual second-tier projects with these policies would be considered during subsequent project-specific CEQA reviews.

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7-8  
 cont.

have been utilized for this baseline analysis and to derive future population and housing estimates. The draft PEIR is legally inadequate because it fails to plainly identify the specific assumptions included in its baseline for land use. (*San Joaquin Rescue Center v. County of Merced* (2007) 149 Cal. App. 4th 645.)

In the draft PEIR, SANDAG should have evaluated and clearly articulated the Plan's potential impacts on land use. Instead, the PEIR states that: "The forecasted development of the proposed Plan is based on the Series 14 Regional Growth Forecast SCS land use pattern, which is, in turn, based on the adopted general plans of the cities and County of San Diego and on the most recent planning assumptions, considering local general plans and other factors, as required by SB 375." This statement is incorrect. The Plan is inconsistent with the city's General Plan because it proposes residential land uses where such uses are not authorized by the General Plan. The PEIR appears to ignore this inconsistency in concluding there will be less than significant impacts for the years 2025, 2035 or 2050.

The city has two mobility hubs in the proposed Plan and draft PEIR: McClellan-Palomar Airport, the fifth largest employment center in the region; and Carlsbad State Beach and Carlsbad Village as "Tier 3 and Tier 4" employment centers. Attachment 1 shows a summary of the Mobility Hubs and housing units assumed in the Series 14 Growth Forecast for the year 2050. The assumptions in the updated Series 14 Growth Forecast contain inconsistencies with respect to at least three locations in which density is shown to be inconsistent with the city's General Plan, the Airport Land Use Compatibility Plan and good planning principles. These three problematic areas are:

- a. 736 units on parcels immediately adjacent to the McClellan-Palomar Airport runway. The location of the airport within this mobility hub was shared with SANDAG staff multiple times at workshops. This is inconsistent with the regulations provided by the San Diego County Regional Airport Authority and conflicts with standard planning principles for siting housing away from hazards;
- b. 2,755 units on existing developed resort properties and open space dedicated lands adjacent to Legoland; and
- c. 65 units in a preserved open space area.

7-7

The Plan proposes residential uses in areas which are not designated for such uses in the city's General Plan. This inconsistency results in potential significant impacts with respect to land use, public safety and noise. (See CEQA Guidelines, Appendix G, §§ IX(e), XI(b), XIII(c).) Because residential use is not authorized in those locations in the city's General Plan, the Plan's assumption that residential use will occur there results in an overstatement of the extent to which other impacts, such as those associated with VMT, GHG and other pollutant emissions, will be reduced and understates those potential impacts of the Plan. The only meaningful evaluation of the Plan's potential impacts is a brief qualitative description of the City of San Diego's community plan process. However, the PEIR does not meaningfully address the inconsistency with the general plans of the other 17 member jurisdictions, which if not implementing this plan will cause a significant environmental impact due to the conflict with any land use plan, policy or regulation adopted for the purpose of avoiding or mitigating an environmental effect.

As noted above, the Land Use, Hazards and Noise sections of the draft PEIR must include an evaluation of the inconsistencies with local land use plans. Multiple areas in Carlsbad are controlled as to their use and activity density and intensity through their spatial association with the McClellan-Palomar Airport. The McClellan-Palomar Airport is defined by the Federal Aviation Administration

### RESPONSE TO COMMENT 7-7

Government Code Section 65080(b)(2)(B) provides that an SCS "use most recent planning assumptions considering local general plans and other factors." It also requires that the SCS "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board." The SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the proposed Plan.

This comment mischaracterizes the impact of the land use assumptions underlying the proposed Plan on the VMT, GHG, and air quality resource analyses included in the Draft EIR. The proposed Plan focuses growth and development in the Mobility Hub areas. The allocation of housing units to subregional areas represents general areas projected for future growth, not specific parcels, for future housing development or housing unit type. Specifically, outputs are generated at the Master Geographic Reference Area (MGRA)-level for use as inputs to SANDAG's Activity Based Model (ABM). MGRAs are comparable in size to census blocks and cover the entire region. A number of land uses at the parcel level, aggregated up, comprise these general areas and VMT, GHG, and air quality impacts are analyzed at the regional level consistent with the programmatic nature of this EIR.

For Carlsbad, the SCS land use pattern forecasts 6,575 housing units from 2016 to 2050, which is within the total housing unit capacity of the City's general plan as provided to SANDAG (6,992 housing units) and accommodates the City's RHNA allocation of 3,873 housing units by 2035. The precise zoning at the parcel level is within local jurisdictions' land use authority. As such, future development projects would undergo separate, project-specific environmental review, and any impacts associated with conflicts with land use plans, policies or regulations, including the general plan and any applicable airport land use compatibility plans, would be evaluated and mitigated when the timing, location, and other specifications of a specific project have been defined.

The thresholds for land use analysis in Appendix G of the CEQA Guidelines include an evaluation of whether the project causes a

significant environmental impact due to a conflict with a land use plan, policy or regulation adopted for the purpose of avoiding or mitigating an environmental effect. A conflict alone does not necessarily result in a significant environmental impact. As stated above, consistency of the proposed Plan with relevant General Plans is analyzed in Section 4.11 of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions' general plans or other local planning documents. Consistency of individual second-tier projects with these policies would be considered during subsequent project-specific CEQA reviews.



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- 7-7 cont. ("FAA") as a commercial service airport that, in addition to private aircraft, has regularly scheduled commercial flights. The McClellan-Palomar Airport Land Use Compatibility Plan ("ALUCP") is prepared according to FAA requirements and adopted by the San Diego County Regional Airport Authority acting as the Airport Land Use Commission for the County of San Diego. Further detail on this is included in the city's August 6, 2021 comment letter (Attachment 1).
- 7-8 2. Additionally, looking at data provided by SANDAG, it is now clear why the citywide numbers only show moderate increases in population. Our analysis has shown that there is an assumed reduction of population by 2,310 persons in the areas within the city but outside of the mobility hubs. This is likely due to assumed reductions in persons per household over time, but SANDAG should clarify the source and reasonableness of this assumption. If housing is provided outside the Mobility Hubs consistent with these areas, is it still reasonable to assume persons per household will be reduced in 2050? The PEIR also fails to consider the effect of Senate Bill 9 ("SB 9"), which will allow duplex or quadplex development in any area previously zoned for single family use. As a result of the new law, housing growth would be expected to increase in single-family residential areas. By failing to take into account the effect on population growth of developing additional housing outside the Mobility Hubs, the PEIR results once again in an understatement of the Plan's potential impacts and an overstatement of the Plan's beneficial effects on VMT, GHG and other pollutant emissions.
- 7-9 3. Furthermore, this reduction in population is not limited to the city of Carlsbad. There is an approximately 85,000 person reduction in population assumed outside of mobility hubs regionwide. SANDAG needs to address if that is a reasonable assumption and if this will result in other impacts to public and private projects that will rely on this growth forecast, and the associated Activity Based Model (2+) to project future impacts to transportation, GHG, air quality and noise.
- 7-10 4. A project will normally have a significant effect on the environment if it will conflict with adopted environmental plans and goals of the community where it is located (see Appendix G to the CEQA Guidelines). The facts and analysis in the PEIR don't support a finding of less than significant impact for consistency with general plans beyond the year 2025, where at least there is a correlation, intentional or otherwise, with the current Regional Housing Needs Allocation that each jurisdiction is planning for. Beyond 2025, the assumptions in the land use chapter have had a more in-depth analysis, and if not substantiated, should be designated as significant and unavoidable. If there are impacts determined to be significant and unavoidable, mitigation measures should be designed to lessen the impact; the current draft EIR includes no related mitigation measures. In *Citizens for a Sustainable Treasure Island v. City and County of San Francisco* (2014) 227 Cal. App. 4th 1036, the Court of Appeal for the First Appellate District held that an EIR must satisfy the substantial evidence standard of review as to all of the required elements of an EIR; address the environmental impacts of the proposed project to a degree of specificity consistent with the underlying activity being approved; and properly allow for supplemental review that may be necessary in the future. Therefore, the draft PEIR must be revised to explain the nature and magnitude of a proposed project or activity with respect to land use and planning checklist criteria (Appendix G to the CEQA Guidelines).
- 7-10 4. Since these projections are related to the GHG reductions and compliance with Senate Bill 375, it puts the entire evaluation and basis for compliance into question. If these assumptions are not made, it will have significant impacts to the GHG emissions, and the metric tons of annual emissions that comprise over 40 percent of the regional total. As currently drafted, the Plan's land use assumptions related to GHG contributions do not comply with other specific state and federal mandates including SB 375, which achieves targets set by the California Air Resources Board and

**RESPONSE TO COMMENT 7-8**

Proposed Plan Appendix F, *Series 14 Regional Growth Forecast and SCS Land Use Pattern*, details the development of the population and job growth projections that are reflected in the Draft EIR. The Series 14 Regional Growth Forecast aligns with the regional population projection from the California Department of Finance released in January 2020 and reflects population declines or lower population growth in certain areas in the region. These assumptions, described in Regional Plan Appendix F, include an increase in the region's vacancy rate to 4 percent by 2040, an accounting of vacation rentals and second homes as "unoccupiable," and a decrease in household size from 2.75 persons per household in 2016 to 2.62 persons per household by 2036. Data for all the counties in the United States show that as the population ages, household size declines, and the Series 14 Regional Growth Forecast assumes that due to the aging population in the region, a similar pattern will be observed. This is achieved by converging to household formation rates from the 2010 decennial census by 2035, which are held at that level through the end of the forecast.

With respect to SB 9, this State legislation was approved in September 2021 and will not take effect until January 1, 2022. The Series 14 Regional Growth Forecast incorporates assumptions for about accessory dwelling units (ADUs) occurring in the local jurisdictions as potential future capacity for housing unit development in recognition of recent legislation that had already been passed at the state level when the forecast was developed. ADUs were assumed to be available on 5 percent of all single-family lots in the region that were 5,000 square feet or larger. This equates to about 20,000 additional units of housing unit capacity throughout the region outside of the rural villages in the unincorporated area. This is consistent with a report from the San Diego Housing Commission that projected a rate of ADUs occurring on about 5 percent of available single-family zoned parcels. Including lots 5,000 square feet or larger ensures that ADUs are assumed to be possible in all areas of the region, including the more urbanized areas where lot size is smaller.

Specific to the SCS Land Use Pattern and its beneficial effects, SB 375 requires the SCS to "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a

feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the Plan by focusing growth and development in mobility hub areas. Here, the comment describes a speculative impact resulting from SB 9.

With respect to future development projects, the degree of specificity required in an EIR will correspond to the degree of specificity involved in the underlying activity (CEQA Guidelines Section 15146). As a programmatic document encompassing the entire region, the proposed Plan and its EIR do not analyze project-specific impacts of future development projects implemented by the local jurisdictions or private developers.

#### **RESPONSE TO COMMENT 7-9**

This comment inaccurately generalizes the thresholds for land use analysis in Appendix G of the CEQA Guidelines. The thresholds do not include evaluating consistency with the “goals of the community,” but rather an evaluation of whether the project causes a significant environmental impact due to a conflict with a land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect. To reflect the programmatic level of analysis and the unique characteristics of the proposed Plan, this EIR analyzed whether implementation of the proposed Plan would cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation (including, but not limited to, the general plan, LCP, or zoning ordinance) and result in a physical change to the environment not already addressed in the other resource chapters of this EIR.

The thresholds for land use analysis in Appendix G of the CEQA Guidelines include an evaluation of whether the project causes a significant environmental impact due to a conflict with a land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect. A conflict alone does not necessarily result in a significant environmental impact. As stated above, consistency of the proposed Plan with relevant general plans is analyzed in Section 4.11 of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions’ general plans or other local planning documents. Consistency of

individual second-tier projects with these policies would be considered during subsequent project-specific CEQA reviews.

**RESPONSE TO COMMENT 7-10**

This comment asserts that the land use assumptions of the proposed Plan do not comply with State and federal mandates including SB 375, federal civil rights (Title VI) requirements, environmental justice considerations, air quality conformity, and public participation. The comment also asserts that CEQA Guidelines Section 15125 regarding discussion of the environmental setting in an EIR “helps establish the basis for compliance” with Government Code requirements regarding the planning assumptions of the proposed Plan’s SCS, and that existing general plan land use maps “should have been used as the most recent planning assumptions” to develop 2035 GHG targets set by CARB.

The proposed Plan has been prepared in compliance with applicable State and federal requirements, as explained below. Proposed Plan Appendix D describes how the proposed Plan fulfills the requirements of an SCS as described in SB 375, including requirements for public involvement. The proposed Plan’s compliance with SB 375 requirements for public involvement are further documented in proposed Plan Appendix G. Proposed Plan Appendix G also addresses how the proposed Plan’s Public Involvement Program is consistent with Title VI of the federal Civil Rights Act of 1964 (42 USC 2000d), Executive Order 12898 on Environmental Justice, and other relevant laws and guidance to ensure social equity, environmental justice, and accessibility in the planning process. Refer to proposed Plan Appendix H for information about social equity and the proposed Plan.

Proposed Plan Appendix F describes how data used to develop the SCS land use pattern are based on the most recent planning assumptions, considering local general plans and other factors, per SB 375 (Government Code Section 65080[b][2][B]). Contrary to the commenter’s assertion, CEQA requirements regarding discussion of the environmental setting in an EIR have no relationship to SB 375 requirements to use the most recent planning assumptions in an SCS.

Proposed Plan Appendix C describes how the proposed Plan complies with transportation air quality conformity determination requirements by providing a demonstration of conformity for the 2008 and 2015 ozone NAAQS for the proposed Plan.

- 7-10 cont. compliance with federal civil rights (Title VI) requirements, environmental justice considerations, air quality conformity, and public participation. Please refer to Attachment 1 for more background discussion about the city's concerns regarding the technical methodology used to estimate GHG emissions from the sustainable communities strategy. Pursuant to CEQA, the environmental baseline for GHG emissions shall be established based upon the physical conditions at the project site at the time of the NOP, or no NOP, at the time the environmental analysis commenced. The environmental setting requirements of CEQA Guidelines section 15125, which directs SANDAG to utilize existing general plan land use maps, helps establish the basis for compliance with Government Code section 65080(b)(2)(H) and (J) as those land use map regulations existed at the time of the NOP or when the environmental analysis commenced; and should have been used as the most recent planning assumptions to develop per capital passenger vehicle-related greenhouse gas emissions targets for 2035 set by the California Air Resources Board.
- 7-11 5. The Transportation chapter of the draft EIR lacks sufficient detail and explanation to adequately understand and provide comment on the transportation analysis that was used to determine the project impacts and related performance metrics such as Average Daily Trips (ADT), VMT and travel mode share. The following comments are intended to provide this additional information and a better understanding of the identified transportation impacts:
- 7-12 a. The analysis methodology used for the Transportation chapter does not provide a description of how the ABM2+ analysis outputs such as Average Daily Trips (ADT), Mode Share, and Vehicle Miles Traveled (VMT) are calculated for each of the travel modes. Without this information, it is difficult to understand how the transportation network improvements impact these analysis metrics for future year conditions and for consideration of potential project mitigations.
- 7-13 b. Section 4.16.4 "Transportation Environmental Impact and Mitigation Measures" should provide a description of the proposed transportation projects for each travel mode by horizon year with reference to Appendix B of the EIR document.
- 7-14 c. In order to directly compare the project list with the project impacts found in section 4.16.4, it is recommended to reorganize the tables found in Appendix B by travel mode and horizon year with indication of project mileage.
- 7-15 d. Does the EIR consider the long term or permanent impact of COVID-19 on travel behavior patterns throughout the region? Was the ABM2+ model adjusted to account for changes in travel behavior due to the COVID-19 pandemic? Were additional adjustments made to key mode choice variables such as rates for tele-work, vehicle ownership, and traveler sensitivity to use transit or carpool as a result of these travel behavior changes?
- 7-16 e. As mentioned above, significant issues need to be addressed in the Plan which should also be addressed in the EIR including:
- 7-17 i. Grade separation in Carlsbad from Cannon Road to the northern border.
- ii. The impacts of implementing roundabouts in the Complete Corridors.
- iii. Alternative analysis for moving the grade separated 110mph transit leap commuter rail to the east thereby reducing all the negative impacts of having the current North County Transit District (NCTD) alignment running along the sensitive coastline, lagoons

**RESPONSE TO COMMENT 7-11**

Footnote 2 on page 4.16-1 of the Final EIR has been updated to include the following link which provides a detailed description of the background, data sources, methodologies, and outputs associated with ABM2+.

Link:

<https://www.sandag.org/index.asp?subclassid=120&fuseaction=home.subclasshome>.

**RESPONSE TO COMMENT 7-12**

References to Appendix B have been added to pages 4.16-31, 4.16-35, and 4.16-39 of the Draft EIR. As the comment notes, the references have been added to direct the reader to the descriptions of the proposed transportation projects for each travel mode by horizon year.

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed 2021 Regional Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects under the Plan are subject to environmental review and will follow applicable laws and regulations, including coordination and permitting requirements of the local jurisdictions within which future development and transportation improvements fall.

**RESPONSE TO COMMENT 7-13**

Appendix A of the proposed Plan has been revised to present proposed transportation projects for each travel mode by horizon year.

**RESPONSE TO COMMENT 7-14**

Due to data/survey availability, ABM2+ largely relies on pre-pandemic survey (2016/2017 household behavior, 2019 SB1 TNC, and 2015 transit onboard surveys); therefore, the pandemic's impact on behaviors such as transit/carpool usage and auto ownership are not reflected in ABM2+. Based on information from the National Household Travel Survey, California Household Travel Survey, 2016/17 Household Behavior Survey, and the ACS, SANDAG developed a telework trend to project future telework rates. Researchers from the Institute of Transportation Studies at UC Irvine reviewed and confirmed the telework assumptions used in the proposed Plan. The increase of telework has a had steady increase that is reflected in ABM2+. It is

unclear what long-term travel behavior has changed as a result of the pandemic and if that change will be the “new normal.” SANDAG has a plan to update ABM2+ to ABM3 to reflect the “new normal” travel behaviors, once surveys conducted in a new normal year become available. The new normal condition is important for creating a long-range planning model. It is unclear at this moment, when and if the new normal has arrived and any modifications to the telework assumption used in ABM2+ would be speculative.

**RESPONSE TO COMMENT 7-15**

The proposed Plan includes a funding category for grade separations on the LOSSAN Corridor (included in Commuter Rail Route 398). Leucadia Boulevard grade separation is included in 2035 plus two yet to be determined locations by 2050. These would be determined at a later date. The degree of specificity required in an EIR corresponds to the degree of specificity involved in the underlying activity (CEQA Guidelines Section 15146). The proposed Plan is a programmatic document, and specific details concerning project-level impacts and mitigation will be evaluated during project-level environmental review (including Commuter Rail Route 398 project-level analysis).

**RESPONSE TO COMMENT 7-16**

Roundabouts, curb extensions, and similar traffic calming measures are included in the Mobility Hub complete streets investments as a means for slowing vehicular traffic in neighborhoods where a higher volume of multimodal travel to/from key destinations, particularly active transportation, is anticipated. The locations for these improvements are not defined in the proposed Plan and would be done in coordination with local jurisdictions.

**RESPONSE TO COMMENT 7-17**

The degree of specificity required in an EIR corresponds to the degree of specificity involved in the underlying activity (CEQA Guidelines Section 15146). The proposed Plan is a programmatic document, and specific details concerning project alternatives will be evaluated during project-level environmental review.

7-17 cont. and coastal open space, and coastal village land use that promote mobility and look to reduce bifurcation issues caused by the current at grade NCTD alignment. The potential bifurcation issues also constitute a potential significant impact on land use in that the Plan will exacerbate the alignment's effect on dividing the established downtown Carlsbad community.

6. The alternatives analysis does not describe a range of reasonable alternatives to the project because it does not include an analysis of an alternative that evaluates what will occur if the faulty land use, and therefore transportation, assumptions do not occur. The alternatives are constructed to reduce impacts through even more focused growth in Mobility Hubs and through increased value pricing and revenue generation. While it may be true these would reduce impacts, it does not provide policy makers or members of the public a reasonable range of alternatives as required by CEQA. Additionally, due to the aforementioned SB 9 being signed by the Governor, the reduction in population assumed in suburban areas outside of the mobility hubs is both inconsistent with reality and with planning principles required by the California Department of Housing and Community Development to not concentrate all future growth in certain locations. CEQA and the CEQA Guidelines require that an EIR describe all reasonable alternatives to the project and any feasible mitigation measures (*Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal. 3d 400, 404). Because the draft PEIR does not discuss future land use conflicts with applicable general plans, it fails to disclose ways to reduce or eliminate the environmental impacts of the project and to respond to the major environmental issues identified during the planning process (as a project alternative or as a mitigation measure) pursuant to Public Resources Code section 21002 (see *Friends of the Old Trees v. Department of Forestry & Fire Protection* (1997) 52 Cal. App. 4th 1383). The draft PEIR's analysis of the project alternatives and mitigation measures is incomplete and, therefore, inadequate.

7-18

Section 15126 of the CEQA Guidelines requires that all aspects of a project must be considered when evaluating its impact on the environment, including planning, acquisition, development, and operation. The implementation and challenges to fund the Plan have not been appropriately discussed. One of the project alternatives should accommodate transportation investments that can be reasonably funded within the horizon of the plan under the current ("known") funding mechanisms. Because the draft EIR does not discuss a financially constrained alternative, the analysis of the project alternatives and mitigation measures is incomplete, and therefore, inadequate.

7-19

7. Where regional planning processes have not resulted in the adoption of plans or regulations relating to the environment, CEQA requires public agencies to engage in an analysis of the impacts of the proposed project on the environment. (Public Resources Code §§ 21000; 21002.1; 21003.1(b); 21080(d); 21081; 21082.2(a).) Although there is a general analysis of projected growth in the region, there is a lack of detail with respect to growth inducement or reasonably foreseeable future projects implementing Public Resources Code section 21155 – 21155.4 (CEQA streamlining for SCS consistency) and/or other reasonably foreseeable development that may result. The provision or improvement of transportation infrastructure, utilities, water and sewer service to an area can induce growth by removing impediments to development. Once services are extended or improved in an area, economic incentives for development exist. The basic elements and principles of the Plan have been designed to facilitate future smart growth and concentrate population growth in areas that would be efficiently served by transportation facilities. The smart growth concept is the basis

7-20

**RESPONSE TO COMMENT 7-18**

As explained in Master Response 1, the Draft EIR does evaluate a reasonable range of alternatives that achieve most of the basic project objectives and that are potentially feasible.

This comment incorrectly asserts that the EIR uses faulty land use assumptions. Government Code Section 65080(b)(2)(B) provides that an SCS “use most recent planning assumptions considering local general plans and other factors.” It also requires that the SCS “set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the proposed Plan.

With respect to SB 9, this State legislation was approved in September 2021 and will not take effect until January 1, 2022. The Series 14 Regional Growth Forecast incorporates assumptions about ADUs occurring in the local jurisdictions as potential future capacity for housing unit development in recognition of recent legislation that had already been passed at the state level when the forecast was developed. ADUs were assumed to be available on 5 percent of all single-family lots in the region that were 5,000 square feet or larger. This equates to about 20,000 additional units of housing unit capacity throughout the region outside of the rural villages in the unincorporated area. This is consistent with a report from the San Diego Housing Commission that projected a rate of ADUs occurring on about 5 percent of available single-family zoned parcels. Including lots 5,000 square feet or larger ensures that ADUs are assumed to be possible in all areas of the region, including the more urbanized areas where lot size is smaller.

This comment also inaccurately characterizes the discussion in *Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal. 3d 376. The Court does not state that CEQA requires an EIR to describe *all* reasonable alternatives to the project. Rather, the Court in *Laurel Heights* stated that “[a]n EIR’s discussion of alternatives must contain analysis sufficient to allow informed decision making” (*Laurel Heights Improvement Assn. v. Regents of University of California* (1988)

47 Cal. 3d 376, 404). Moreover, CEQA Guidelines Section 15126.6 specifically states that “[a]n EIR need not consider every conceivable alternative to a project.”

Consistency of the proposed Plan with relevant general plans is analyzed in Section 4.11 of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions’ general plans or other local planning documents. Consistency of individual second-tier projects with these policies would be considered during subsequent project-specific CEQA reviews.

#### **RESPONSE TO COMMENT 7-19**

This comment mischaracterizes the requirements for a financially constrained RTP and inaccurately states that the implementation and challenges to fund the proposed Plan have not been appropriately discussed. Federal and State laws require SANDAG to develop a regional plan built on reasonable assumptions of the revenues that will be available during the period covered by that plan (Government Code Section 65080(b)(4); 23 CFR 450.322(f)(10)(ii)). New funding sources are revenues that do not currently exist or that may require additional steps before the MPO or transit agency can commit such funding to transportation project. (2017 RTP Guidelines for MPOs). Strategies for ensuring their availability must be identified and future revenues may be projected based on historical trends, including consideration of past legislative or executive actions (2017 RTP Guidelines for MPOs). The level on uncertainty in projects based on historical trends is generally greatest for revenues in the “outer years” (10 years or more) of an RTP. Appendix V of the proposed Plan explains the anticipated revenues to fund implementation of the proposed Plan. Table V.3 describes the availability assumptions for new revenue sources identified in Appendix V.

As explained in Master Response 1, the Draft EIR does evaluate a reasonable range of alternatives that achieve most of the basic project objectives and that are potentially feasible.

#### **RESPONSE TO COMMENT 7-20**

Population and growth impacts are analyzed in Section 4.14 of the EIR. As stated on pages 4.14-16 and 4.14-17: “the regional growth and land use change forecasted in the proposed Plan would be implemented by local jurisdictions through local plans and individual development

projects, and most transportation network improvements would be implemented by transportation project sponsors other than SANDAG. The proposed Plan has been developed to accommodate forecasted regional growth and failing to do so would be inconsistent with the federal and State requirements for RTPs. In addition, precluding growth would conflict with the requirements to provide sufficient housing for the region's population contained in SB 375. As discussed in Section 4.14.2, Government Code Section 65080(b)(2)(B)(ii) requires that the RTP/SCS must house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan.”

This comment also addresses future transit priority projects. As described above, future development projects would be implemented by local jurisdictions. CEQA Guidelines Sections 21155 through 21155.4 identify CEQA streamlining provisions for transit priority projects that are consistent with an MPO's SCS that has been accepted by CARB. Figures D.8 and D.9 in Appendix D of the proposed Plan identify potential areas for transit priority projects. The proposed Plan is an iterative planning document that is typically updated every 4 years to account for new data, analysis, policy, and experience. SANDAG looks forward to coordinating with the City on future Plan updates.



City of Carlsbad Comments on Draft Environmental Impact Report for 2021 Regional Plan  
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 cont.

for the framework for prioritizing public land use and transportation investments in the region. The smart growth concept identifies areas where smart growth development exists or could be built and provides a basis for planning transportation facilities and transit services in the proposed Plan. Smart growth areas identified receive prioritized infrastructure investments and transit services to support smart growth. This carries true to those smart growth areas that are accommodated by existing general plans, and for other areas that are not covered by existing general plans. CEQA requires that an EIR discuss the ways in which the proposed project could foster economic or population growth or the construction of additional housing, either directly or indirectly, in the environment surrounding the project. CEQA requires this discussion to include ways in which a project would remove obstacles to population growth or encourage and facilitate other activities that could significantly affect the environment (CEQA Guidelines section 15126.2(d)). The level of detail should reflect the level contained in the plan or plan element being considered (*Rio Vista Farm Bureau Center v. County of Solano* (1992) 5 Cal.App.4th 351), inclusive of new smart growth areas as designated.

7-21

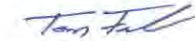
City staff looks forward to working with SANDAG on improving mobility and land use access in the region and building sustainable, equitable and healthy modes of transportation. We appreciate the opportunity to comment on the Plan that will help the region realize these goals. While at the same time, city staff also looks forward to helping SANDAG advance a legally adequate PEIR to support the disclosure and decision-making process. Since the major premise of CEQA is that it “be interpreted in such manner as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language” (*Friends of Mammoth v. Board of Supervisors*, supra, 247, 259), SANDAG should take all action necessary to alert the decision-makers and the public to the environmental changes associated with the project (*County of Inyo v. Yorty* (1973) 32 Cal. App. 3d 795, 810). There is no shortcut to CEQA - the EIR process protects not only the environment by also informed self-government (*Laurel Heights Improvement Assn. v. Regents of University of California*, supra, 376, 392). The SANDAG Board must certify that the final PEIR has been completed in compliance with CEQA and that it considered all of the information in the final EIR before approving or disapproving the project. As of this writing, the draft PEIR is not in compliance with CEQA.

If you have any questions related to comments on the transportation network, please contact Tom Frank, Transportation Director/City Engineer, at [Tom.Frank@carlsbadca.gov](mailto:Tom.Frank@carlsbadca.gov) or, if you need additional information related to comments on the land use assumptions, please contact Eric Lardy, Principal Planner, at [Eric.Lardy@carlsbadca.gov](mailto:Eric.Lardy@carlsbadca.gov).

Sincerely,



JEFF MURPHY  
 Community Development Director



TOM FRANK  
 Transportation Director/City Engineer

**RESPONSE TO COMMENT 7-21**

SANDAG has fully complied with the requirements of CEQA in the preparation of the Draft and Final EIRs for the proposed Plan.

Regarding disclosure of the proposed Plan’s physical impacts on the environment in the Draft and Final EIRs, SANDAG has disclosed impacts and identified mitigation measures for impacts on aesthetics and visual resources; agricultural and forestry resources; air quality; biological resources; cultural resources; energy; geology, soil, and paleontological resources; GHG; hazards and hazardous materials; land use; mineral resources; noise and vibration; population and housing; public services and utilities; transportation; tribal cultural resources; water supply; wildfire; and cumulative impacts, and has identified alternatives to the proposed Plan consistent with CEQA, the CEQA Guidelines, and the discussion in *Friends of Mammoth v. Board of Supervisors* (1972) 8 Cal.3d 247 referenced in the comment. For clarity with respect to the cited discussion in *County of Inyo v. Yorty* (1973) 32 Cal.App. 3d 795, the court states that an EIR is an “environmental ‘alarm bell’ whose purpose it is to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return” (*County of Inyo v. Yorty*, p. 810). The court also cites an earlier version of PRC Section 21000, which states that the government of the state should “take all action necessary to protect, rehabilitate, and enhance the environmental quality of the state” (*County of Inyo v. Yorty*, p. 802). The court in *County of Inyo v. Yorty* does not state that lead agencies “should take all action necessary to alert decision-makers and the public to the environmental changes associated with the project,” contrary to the comment’s assertion.

Prior to consideration and certification of the Final EIR, and consistent with the discussion in *Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal. 3d 376, SANDAG will provide the SANDAG Board of Directors with a Final EIR completed in compliance with CEQA Guidelines Section 15132 that reflects SANDAG’s independent judgment and analysis as required by CEQA Guidelines Section 15090 (a). SANDAG will also present the SANDAG Board of Directors with Findings consistent with CEQA Guidelines Section 15091, a Statement of Overriding Considerations consistent with Section 15093, and a Mitigation Monitoring and Reporting Program consistent with Section 15097 prior to the SANDAG Board of Directors’ consideration of the proposed Plan and Final EIR.

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Attachments:

1. City of Carlsbad Comment Letter on Draft Regional Plan (Aug. 6, 2021)
2. City of Carlsbad Comment Letter – Regional Arterials (Sept. 30, 2021)

cc: Scott Chadwick, City Manager  
Celia Brewer, City Attorney  
Geoff Patnoe, Assistant City Manager  
Ron Kemp, Assistant City Attorney  
Robby Contreras, Assistant City Attorney  
Gary Barberio, Deputy City Manager, Community Services  
Paz Gomez, Deputy City Manager, Public Works  
Mike Strong, Assistant Director, Community Development  
Don Neu, City Planner  
Nathan Schmidt, Transportation Planning and Mobility Manager  
Jason Geldert, Engineering Manager  
Eric Lardy, Principal Planner  
Scott Donnell, Senior Planner  
Corey Funk, Associate Planner

Attachment A



Aug. 6, 2021

San Diego Association of Governments  
 401 B Street, Suite 800  
 San Diego CA 92101  
 Via: [SDForward@sandag.org](mailto:SDForward@sandag.org)

RE: City of Carlsbad Comments on Draft 2021 Regional Plan

To Whom It May Concern,

The City of Carlsbad appreciates the opportunity to provide comments on the draft 2021 Regional Plan ("Plan"). This is an important plan for this region and will guide the next phase of growth for the member agencies of the San Diego Association of Governments ("SANDAG"). An effectively designed and implemented regional transportation plan would help ensure improved transportation options for area residents, businesses and other community members; meaningful reductions in greenhouse gas ("GHG") emissions; and improved quality of life as we grow our communities.

The City of Carlsbad ("city") is submitting comments based on the policies, projects, programs and other improvements included in the Plan. Our agency's comment letter is divided into two sections. The first section seeks clarity and other considerations that pertain to our agency's review of the Plan. The second section identifies the city's preliminary comments and recommendations.

Implementing the regional transportation network outlined in the Plan requires municipalities to support the regional vision and deliver on local infrastructure and services like the priority bus routes, local bus services, and pedestrian and cycling connections to major transit infrastructure. These components, which are delivered by municipalities, are essential to creating a coherent and comprehensive local transportation network that feeds into regional services. For that reason, an effective public review of the Plan should involve a transparent and thorough process for identifying and evaluating potential hazards, physical changes to the environment and indirect (off-site and cumulative) impacts that might result from implementation activities that may reasonably occur with the Plan.

The city's residents, businesses and other community members will greatly benefit from the involvement and technical assistance from the prospective Draft Environmental Impact Report ("EIR"). Therefore, what follows in this correspondence represents our agency's preliminary comments and recommendations. The city reserves the right to add, amend, change or replace comments and recommendations based on additional review and understanding of the Plan and the environmental analysis provided under the California Environmental Quality Act ("CEQA").

The city thanks SANDAG staff for meeting with city staff on Aug. 2, 2021, to discuss some of these comments in advance of this letter. Following that meeting, SANDAG provided language that they may recommend adding to the Regional Plan for additional clarification on land use authority. The language is, "Land use authority is reserved to local jurisdictions because they are best positioned to effectively implement the objectives outlined in the Plan through understanding of the unique needs of their communities and geographies." This language will be helpful to clarify that land use authority rests with

Transportation & Community Development Departments  
 1635 Faraday Avenue | Carlsbad, CA 92008 | 760-602-2710 t

**RESPONSE TO COMMENT 7-22**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

Please see responses to L59 through L74 in Appendix P.2.

7-22

## Attachment A

City of Carlsbad Comments on Draft 2021 Regional Plan  
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2. The city has three mobility hubs, associated with the Employment Centers Published supporting the SANDAG Regional Plan.<sup>1</sup> McClellan-Palomar Airport is the fifth largest employment center in the region, with Carlsbad State Beach and Carlsbad Village as "Tier 3 and Tier 4" employment centers. The city thanks SANDAG for providing data for analysis to determine impacts and provide for accurate comments on the Plan. Attachment 2 shows a summary of the Mobility Hubs and housing units assumed in the Series 14 Growth Forecast for the year 2050. In summary:
- a. The assumptions in the updated Series 14 Growth Forecast contain inconsistencies with the city's General Plan. The Carlsbad Palomar Major Employment Mobility Hub does include increases in density beyond what the citywide numbers appear to show when they are looked at in more detail.
    - i. There are three locations in which density is shown to be inconsistent with good planning principles, the city's General Plan and the Airport Land Use Compatibility Plan. The three most problematic areas (shown in Attachment 3) are:
      1. 736 units on parcels immediately adjacent to the McClellan-Palomar Airport runway. The location of the airport within this mobility hub was shared with SANDAG staff multiple times at workshops. This is inconsistent with the regulations provided by the San Diego County Regional Airport Authority and conflicts with standard planning principles for siting housing away from hazards.
      2. 2,755 units on existing developed resort properties and open space dedicated lands adjacent to Legoland.
      3. 65 units in a preserved open space area.
    - ii. SANDAG should provide additional detail why units were assumed in these areas, what planning principles those decisions were based on, and how SANDAG expects this to be implemented.
    - iii. Concentration of units in the mobility hubs alone appears to conflict with the direction received from the California Department of Housing and Community Development ("HCD") to implement new Affirmatively Furthering Fair Housing ("AFFH"), which seeks to combat housing discrimination, eliminate racial bias, undo historic patterns of segregation, and lift barriers that restrict access in order to foster inclusive communities and achieve racial equity, fair housing choice and opportunity for all Californians. The allocations of land use provided by SANDAG seem to focus all the higher density housing into one area of the city. (This is one of the largest points of analysis that each jurisdiction in the region needs to respond to in order to receive a certified Housing Element.)
  - b. Additionally, looking at the detailed data provided by SANDAG, it is now clear why the citywide numbers only show moderate increases in population. Our analysis has shown that there is an assumed reduction of population by 2,310 persons in the areas within the city but outside of the mobility hubs. This is likely due to assumed reductions in persons per household over time, but SANDAG should clarify the source and reasonableness of this assumption. If housing is not provided consistent with these areas, is it still reasonable to assume persons per household will be reduced in 2050?

7-22  
 cont.

<sup>1</sup> SANDAG Website: Employment Centers [SANDAG :: PROJECTS :: San Diego's Regional Planning Agency](#)

Attachment A

City of Carlsbad Comments on Draft 2021 Regional Plan  
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the local jurisdiction. The city still offers the following comments with the intent to support development of a defensible and realistic regional plan.

**SECTION 1: CLARITY AND OTHER CONSIDERATIONS**

City staff have attended the series of workshops that SANDAG hosted during the public review period, and respectfully starts this section with several questions related to the process of the Plan and the Draft EIR. By way of introduction, a jurisdiction's General Plan, such as the city's General Plan, identifies the expected population of the city and any lands outside of the city limits but within their Sphere of Influence where future growth is anticipated to occur. The city's General Plan identifies the subject area adjacent to the McClellan-Palomar Airport for development under the designation for limited and light industrial use.

For future land use planning, land use assumptions must reasonably proxy and be generally consistent with local planning standards and programs, to be considered growth accommodating rather than growth inducing. SANDAG has the authority under Government Code Section 65584 to determine existing and projected housing needs, as well as the share of housing needs to be allocated to cities and counties, but it is unclear if SANDAG has jurisdiction to allocate new housing growth to areas in a manner not consistent with Government Code Section 65584. Attachment 1 includes additional information on the applicable Government Code and standards. Therefore, and as indicated above, the build-out of properties within the Business Park and flight activity zone must be done in accordance with the city's General Plan Land Use Diagram, as amended, in accordance with city approval.

The initial questions on the planning process associated with developing the Plan are provided below:

1. The SANDAG website states, "The SANDAG Sustainable Communities Strategy and Final EIR from its 2015 Regional Plan will remain valid and in compliance for purposes of state funding eligibility and other state and federal consistency purposes until the SANDAG Board of Directors adopts a new Regional Plan and EIR, provided those actions are completed by the end of December 2021." SANDAG needs to clarify how the Draft EIR, Response to Comments and Adoption will be completed this year and what will occur if they are not completed by the end of this year. Additionally, please clarify when the Draft EIR will be available; it is difficult to completely assess the full impacts of this plan when the public review of the documents is piecemealed.
  - a. SANDAG should clarify how public comments on the Plan are going to be addressed in the Draft EIR prior to its release.
  - b. In the Draft EIR, SANDAG needs to clearly articulate the impacts to land use and if the Plan will cause a significant environmental impact due to a conflict with any land use plan, policy or regulation adopted for the purpose of avoiding or mitigating an environmental effect. Appendix F: Regional Growth Forecast and Sustainable Communities Strategy Land Use Pattern appears to be inconsistent with the city's General Plan and rezone program to accommodate the Regional Housing Needs Assessment, as well as the general plans of other jurisdictions such as the cities of Coronado, Del Mar and the County of San Diego. The Draft EIR should clarify how implementation of this Plan can occur if those changes are not made.

7-22  
 cont

Attachment A

City of Carlsbad Comments on Draft 2021 Regional Plan  
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 cont.

- c. Furthermore, this reduction in population is not limited to the City of Carlsbad. There is an approximately 85,000 reduction in population assumed outside of mobility hubs regionwide. SANDAG needs to address if that is a reasonable assumption and if this will result in other impacts to public and private projects that will rely on this growth forecast, and the associated Activity Based Model (2+) to project future impacts to transportation, GHG, air quality and noise.
  - d. The forecast has decreased in future population based on current trends, but it is not clear if there is enough housing provided with reductions and increases in some jurisdictions. Will the reduced amount of housing that will be provided result in an increased exacerbation of the affordability crisis?
  - e. There is a lack of clarity about how the Plan would be implemented at the municipal level. SANDAG should develop an approach for engaging with municipalities to ensure local support for delivering the regional transportation network. Staff from local jurisdiction have the knowledge and ability to share where there are land use assumptions that conflict with planning and zoning laws. Our analysis focused on the City of Carlsbad, but if these types of assumptions are made regionwide, it presents flaws in the overall analysis. These flaws put the assumed reductions in vehicle miles traveled ("VMT") and ability to implement the Regional Plan into question.
3. The area designated is controlled for use and activity density and intensity through its spatial association with the McClellan-Palomar Airport. The McClellan-Palomar Airport is defined by the Federal Aviation Administration ("FAA") as a commercial service airport that, in addition to private aircraft, has regularly scheduled commercial flights to Los Angeles International Airport ("LAX"). The McClellan-Palomar Airport Land Use Compatibility Plan ("ALUCP") is prepared according to FAA requirements and adopted by the San Diego County Regional Airport Authority acting as the Airport Land Use Commission for the County of San Diego.
- a. The ALUCP provides measures to minimize the public's exposure to excessive noise and safety hazards within areas around the airport and identifies areas likely to be impacted by noise and flight activity created by aircraft operations at the airport. These impacted areas include the Airport Influence Area ("AIA"), the Clear Zone and the Flight Activity Zone.
  - b. Within the AIA, the ALUCP establishes six safety zones for the purpose of evaluating safety compatibility of new/future land use actions. The safety zone boundaries depict relative risk of aircraft accidents occurring near the airport and are derived from general aviation aircraft accident location data and data regarding the airport's runway configuration and airport operational procedures. The ALUCP limits development intensities in these zones by imposing floor area and lot coverage maximums, by incorporating risk reduction measures in the design and construction of buildings, and/or by restricting certain uses altogether. For example, all residential and virtually all non-residential uses are considered incompatible land uses in some zones, while considered to be either compatible or conditionally compatible with the airport in other zones. Attachment 4 shows the McClellan-Palomar Airport, noise contours and SANDAG's proposed housing units.
  - c. If the proposed SANDAG land use assumptions are endorsed, an amendment to the city's General Plan would be required to change the land use designation to Mixed-Use Commercial or residential land uses within the existing Business Park in order to effectuate the underlying assumptions of SANDAG staff. This is not a realistic



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- assumption. Further, the protected airspace referenced in the AIA and the ALUCP must also be amended based on SANDAG's regional planning assumptions. (The FAA establishes airspace protection zones in the airspace above and surrounding airports in order to protect aircraft from obstructions such as buildings, towers, etc. in navigable airspace.)
- d. When a General Plan is adopted or amended, the allowable growth pattern of an area is identified and the expansion or updating of the various land uses as specified in the General Plan can occur throughout the planning horizon. Without such growth considerations, the expansion or intensification of existing land uses could be considered "growth inducing." Unplanned and uncontrolled growth may have significant adverse impacts on the environment. CEQA requires a discussion of how a "project" could increase population, employment or housing growth in surrounding areas and the impacts resulting from this growth. The CEQA Guidelines indicate that a "project" would normally have a significant effect on the environment if it would induce substantial growth or a substantial concentration of population.
4. At this point, it is not clear if SANDAG's assumptions adequately contemplate the development patterns included in the Sustainable Communities Strategy ("SCS"/Regional Transportation Plan ("RTP"), and Regional Air Quality Strategy ("RAQS"), local climate action planning business-as-usual estimates, sub-regional traffic modeling, or the airspace assumptions of AIA and the ALUCP.
5. The city seeks clarity on the Plan's underlying assumptions made to justify the proposed extensive high-speed rail network considering the significant changes in travel behavior which have occurred throughout the region as a result of the COVID-19 pandemic and due to the advancements in disruptive technologies such as telecommuting, autonomous vehicles, microtransit, etc.
- a. Recent North County Transit District ("NCTD") Coaster ridership data show riders are not returning to riding the Coaster in comparison to other modes of travel as shown in Attachment 5.
- b. This question is consistent with comments made by SANDAG's panel expert Bob Poole regarding the impact of the COVID-19 pandemic on transit ridership and mega-transit projects. (See comments by Bob Poole during the March 12, 2021 presentation to SANDAG starting at timestamp 1:30 p.m.: [https://youtu.be/q-e6bNYSJ\\_8?t=5410](https://youtu.be/q-e6bNYSJ_8?t=5410))
6. The city seeks clarity on why an alternatives analysis was not conducted with consideration of other transit alternatives such as automated /shared vehicle technologies and personalized zero emissions transit programs that are capable of utilizing the existing regional freeway infrastructure in response to these recent developments explained in the above comment.
7. The city seeks clarity on why the Plan does not incorporate policies to promote roundabouts over signalized intersections and include a budget line item under the Complete Corridors to fund the construction of roundabouts at new locations and to replace signalized intersections when found feasible. This clarification would support the Federal Highway Administration ("FHWA")'s project for *Accelerating Roundabout Implementation in the United States* and the *County of San Diego Air Pollution Control Board's support for implementing roundabouts to address GHG and reduce fatalities*.
8. The city seeks clarity on the project phasing proposed within the Plan. Specifically, the city is seeking to understand the timing of implementation of unfunded TransNet projects related to

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the new projects presented within the Regional Plan. To support this, the city is requesting that SANDAG input the information requested in Table 1 (Attachment 6).

9. The city seeks specific data on the proposed 200 miles of rail service contemplated in the Plan. To support this, the city is requesting that SANDAG input the information requested in Table 3 (Attachment 7). Specific questions:
  - a. Please provide more information about the scope of the high-speed rail alignments, potential vehicle technologies and their cost estimates.
  - b. Will the Coaster keep the same rail alignment?
  - c. What funding is programmed or planned for the Carlsbad Village railroad trench and the other projects along the current NCTD/Coaster Service right-of-way?
  - d. Will some of the tracks be at grade with fencing and trains traveling at 110 miles per hour speeds?

**SECTION 2: COMMENTS AND RECOMMENDATIONS**

In addition to the comments on process and the Draft EIR provided above, city staff remain concerned that there is not enough detail on the feasibility of implementation of this significant shift in transportation strategy. On specific content in the plans, we outline our recommendations and comments below:

1. *Paying for the Plan:*

The draft 2021 Regional Plan sets out an ambitious plan to build and operate a region-wide system of transportation projects, programs and other improvements. This is a substantial role for SANDAG to play in supporting both the construction and operation of these projects, programs and other improvements. SANDAG should set annual revenue targets to directly fund everything and should approve any recommended sustainable revenue tools to help meet these targets. Many of the funding strategies will require legislative changes, or voter-approved taxation. SANDAG should clarify what will occur if the funding is not available, if opposition to projects stops them from construction, and if General Plans in the region are not modified to implement the Plan.

2. *Appendix D: Sustainable Community Strategy Documentation:*

Appendix D includes the Sustainable Communities Strategy, which outlines assumptions included in the Activity Based Model 2+ ("ABM 2+"), updated for this. This model will be necessary for use by publicly and privately initiated land use projects preparing documents for consistency with VMT/CEQA Guidelines and Traffic Impact Analysis ("TIA") Evaluations. City staff respectfully request direction from SANDAG on how to conduct modeling with the service bureau and how to factor in these assumptions applied to ABM 2+. Specifically, the addition of pricing, parking costs for coastal communities, 10% teleworking and micromobility. SANDAG should provide direction on how this could be worked into General Plans that are updated every 5-20 years.

3. *Appendix A: Transportation Projects, Programs, and Phasing:*

Trips to and from school sites result in a significant congestion, VMT generation, and peak hour delay throughout the region. Additional funding and projects should be recommended with a specific focus on improving safety and multimodal access in and around school sites along with programs to incentivize non-single occupancy vehicle trips to schools.

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Table A.11: Given the proven success of the Carlsbad Connector microtransit pilot program, the city agrees with the Plan's recommendations to provide similar on-demand microtransit systems throughout North County at all mobility hub sites and major transit centers.

Table A.13: The segment of El Camino Real between Poinsettia Lane and Camino Vida Roble is proposed to be widened from two to three lanes to prime arterial standards. With the adoption of the city's General Plan, the city has determined that the widening of this portion of El Camino Real is not feasible due to constrained right-of-way and would result in negative impacts to other travel modes. City staff recommend removal of this proposed project recommendation CB32 (that is, a 'do nothing' scenario, or appraise and evaluate different mobility projects and/or alternative designs).

The preferred Interstate-5 freeway alternative identified in the North Coast Corridor ("NCC") Final EIR/EIS is the refined 8+4 Buffer alternative, with four freeway lanes and two managed lanes in each direction and completion by 2035. Appendix A, Table A.5 describes NCC project IDs CC004, 007 - 009 as "8F to 6F+4ML" with completion by 2050. While this might lead to further study, it is not clear why there is a different freeway configuration (i.e., reduction in freeway lanes) proposed. How does a reduction in lanes continue to meet NCC potential project benefits of maintaining or improving traffic operations and improving the safe and efficient regional movement of people and goods?

4. *Active Transportation:*

The city appreciates the Regional Plan's overall approach of providing a connected network of high-quality bicycle facilities throughout the region. Regional bikeways are recommended throughout the city including along Palomar Airport Road which will provide a key east-west connection and El Camino Real which will provide a new north-south bikeway connection through the city. Both roadways are proposed to include "on-street bikeways". Due to the high traffic volumes and vehicle speeds experienced along most of both corridors, the city recommends considering "off-street bikeways" or Class I facilities where feasible in order to stimulate the shift from personal motor vehicle use to people choosing to bike.

It is extremely important that municipal transportation plans align with regional transportation plans to achieve regional goals for land use and transportation and to promote the region working together to build a cohesive regional transportation network. Considering there are currently no mechanisms in place to ensure municipalities coordinate local transportation plans with regional planning documents, the Plan should provide an approach on how SANDAG plans to engage with municipalities, especially in areas of potential disagreement or conflict (as aforementioned in this subsection and others). It is also recommended that the Plan provide additional direction regarding the application of protected bikeways in a variety of applicable contexts. While vertical measures such as soft hit posts may be appropriate in lower volume and lower speed roadways, arterial roadways with high traffic volumes and high speeds warrant much more substantial physical protection from vehicles. In addition, special consideration should be given at intersections and driveways which may be impacted due to the additional width and visibility impacts created by protected bikeways.

City staff look forward to working with SANDAG on improving mobility and land use access in the region and building sustainable, equitable and healthy modes of transportation, and we appreciate the opportunity to comment on the Plan that will help the region realize these goals.

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If you have any questions related to comments on the transportation network, please contact Tom Frank, Transportation Director/City Engineer, at [Tom.Frank@carlsbadca.gov](mailto:Tom.Frank@carlsbadca.gov) or if you need additional information related to comments on the land use assumptions, please contact Eric Lardy, Principal Planner, at [Eric.Lardy@carlsbadca.gov](mailto:Eric.Lardy@carlsbadca.gov).

Sincerely,



**JEFF MURPHY**  
Community Development Director



**TOM FRANK**  
Transportation Director/City Engineer

Attachments:

1. Government Code 65020 (S.B. 375) Summary
2. City of Carlsbad Mobility Hubs
3. City of Carlsbad – Palomar Airport Road Mobility Hub Analysis
4. Palomar-McLellan Airport Flight Paths
5. Recent NCTD Coaster Ridership Data
6. Table 1 - Project Data Request
7. Table 3 - Detail of Proposed Rail Lines

cc: Scott Chadwick, City Manager  
Celia Brewer, City Attorney  
Geoff Patnoe, Assistant City Manager  
Ron Kemp, Assistant City Attorney  
Robby Contreras, Assistant City Attorney  
Gary Barberio, Deputy City Manager, Community Services  
Paz Gomez, Deputy City Manager, Public Works  
Mike Strong, Assistant Director, Community Development  
Don Neu, City Planner  
Nathan Schmidt, Transportation Planning and Mobility Manager  
Jason Geldert, Engineering Manager  
Eric Lardy, Principal Planner  
Scott Donnell, Senior Planner  
Corey Funk, Associate Planner

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Attachment 1: Government Code 65020 (S.B. 375) Summary

Government Code section (“GOV §”) 65080, also referred to as California Senate Bill 375 (Steinberg, 2008) (“SB 375”), is one area of law that provides SANDAG with guidance to which a regional transportation plan must be developed.

Among other things, the regional transportation plan that is developed “shall be an internally consistent document” (GOV § 65080 (b)) and shall include a “sustainable communities strategy prepared by each metropolitan planning organizations as follows” (GOV § 65080 (b)(2)(B)):

*Each metropolitan planning organization shall prepare a sustainable communities strategy, subject to the requirements of Part 450 of Title 23 of, and Part 93 of Title 40 of, the Code of Federal Regulations, including the requirement to utilize the most recent planning assumptions considering local general plans and other factors. The sustainable communities strategy shall (i) identify the general location of uses, residential densities, and building intensities within the region, (ii) identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan taking into account net migration into the region, population growth, household formation and employment growth, (iii) identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region pursuant to Section 65584, (iv) identify a transportation network to service the transportation needs of the region, (v) gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in subdivisions (a) and (b) of Section 65080.01, (vi) consider the state housing goals specified in Sections 65580 and 65581, (vii) set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board, and (viii) allow the regional transportation plan to comply with Section 176 of the federal Clean Air Act ( 42 U.S.C. Sec. 7506).*

The 2021 draft Regional Transportation Plan includes a Sustainable Communities Strategy (“SCS”), as required by SB 375 for the San Diego region (herein after called “draft Regional Plan”). The draft Regional Plan indicates that “SB 375 requires the SCS to include a pattern for forecasted growth and development that accomplishes the following: 1) When combined with the transportation network, the SCS will achieve the regional GHG emission–reduction targets; 2). The SCS accommodates the Regional Housing Needs Assessment (“RHNA”) Determination; and 3) The SCS utilizes the most recent planning assumptions. (Reference p. 19 of the 2021 Regional Plan.)

Predicting the effect of transportation plans or projects on land uses and land use planning is critical to developing context sensitive solutions for transportation projects. Therefore, utilization of the most recent planning assumptions is not only necessary but is required as specifically stated therein GOV § 65080. If inconsistencies are found in the land use assumptions or adverse impacts are anticipated, SANDAG should be actively engaged in the development of measures to address these issues.

The SANDAG Board of Directors approved the final RHNA plan with the final housing unit allocation on July 10, 2020, which was based on the most recent land use planning assumptions and an adopted methodology to allocate housing in accordance with GOV §§ 65584.04(d and m). The City of Carlsbad received a total RHNA allocation of 3,873 units as a result of RHNA plan adoption. The adopted April 6, 2021 city’s Housing Element accommodates its housing needs through current zoning and other programs

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Attachment 1: Government Code 65020 (S.B. 375) Summary

as needed to meet the city's RHNA obligation at all income levels. The land use inputs derived from this local planning document constitutes the most recent land use assumptions. On July 13, 2021 the Department of Housing and Community Development found "the adopted housing element is in substantial compliance with State Housing Element Law (Article 10.6 of the Gov. Code).

The most recent planning assumptions are critical for the development of the draft Regional Plan as the document must comply with other specific state and federal mandates including a SCS per California Senate Bill 375, which achieves GHG emissions reduction targets set by the California Air Resources Board and compliance with federal civil rights (Title VI) requirements, environmental justice considerations, air quality conformity, and public participation. To monitor compliance and attainment of state reduction goals in GHG, GOV § 65080 (b)(2) requires that:

*(H) Prior to adopting a sustainable communities strategy, the metropolitan planning organization shall quantify the reduction in greenhouse gas emissions projected to be achieved by the sustainable communities strategy and set forth the difference, if any, between the amount of that reduction and the target for the region established by the state board.*

*(J)(i) Prior to starting the public participation process adopted pursuant to subparagraph (F), the metropolitan planning organization shall submit a description to the state board of the technical methodology it intends to use to estimate the greenhouse gas emissions from its sustainable communities strategy and, if appropriate, its alternative planning strategy.*

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There is inevitably some uncertainty regarding the use of projected future conditions. However, what is certain is that the project will not operate under the conditions that exist today. There will be new residential and employment growth in the intervening years between now and the proposed build-out of the draft Regional Plan. Nonetheless, projections utilized should represent the best available information assembled by the local agencies with jurisdiction and expertise. Judgments about land use assumptions utilized in the draft Regional Plan should be based on and supported by facts, adopted plans, and "most recent planning assumptions," rather than speculation and personal opinions. The land use assumptions for "uses, residential densities, and building intensities within the region" (as required by GOV § 65080 (b)(2)(B)(i)) should also be the same, as that provided to the state board (as required per GOV §§ 65080 (b)(2)(H and J) in estimating and analyzing GHG from the SCS and the effect on growth and whether the effects of that growth would be significant in the context of the region's plans, natural setting, and growth patterns. Ultimately, the SCS must demonstrate whether SANDAG can meet the per capita passenger vehicle-related GHG emissions targets for 2035 set by the California Air Resources Board ("CARB").

SB 375 directs CARB to accept or reject the determination of SANDAG that its SCS submitted to CARB would, if implemented, achieve the region's GHG emissions reduction targets. CARB's technical evaluation of SANDAG's draft Regional Plan would be based on all the evidence provided, including the models, the data inputs and assumptions, the SCS strategies, and the performance indicators.

The transportation and planning assumptions are also extremely important as it is relied on for other master planning exercises. The Regional Air Quality Strategy ("RAQS") relies on information from CARB and SANDAG for information regarding projected growth in the cities and San Diego County. This in turn is utilized to address other state requirements, including the San Diego portion of the California State Implementation Plan ("SIP") and promulgating their own rules and regulations regarding air quality in the region or to address federal requirements.

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The analysis of land use impacts for transportation projects is guided by FHWA Technical Advisory T 6640.8 and the CEQA Guidelines.

Under the FHWA Technical Advisory T 6640.8 (G)(1), Guidance for Preparing and Processing Environmental, states:

*This discussion [of land use] should identify the current development trends and the State and/or local government plans and policies on land use and growth in the area which will be impacted by the proposed project. These plans and policies are normally reflected in the area's comprehensive development plan, and include land use, transportation, public facilities, housing, community services, and other areas.*

*The land use discussion should assess the consistency of the alternatives with the comprehensive development plans adopted for the area and (if applicable) other plans used in the development of the transportation plan required by Section [23 U.S. Code §] 134. The secondary social, economic, and environmental impacts of any substantial, foreseeable, induced development should be presented for each alternative, including adverse effects on existing communities. Where possible, the distinction between planned and unplanned growth should be identified.*

There is also a requirement to analyze the land use planning inconsistencies per CEQA Guidelines § 15126.2(a), which specifies that an EIR for a proposed project include:

*The Significant Environmental Effects of the Proposed Project. An EIR shall identify and focus on the significant effects of the proposed project on the environment. In assessing the impact of a proposed project on the environment, the lead agency should normally limit its examination to changes in the existing physical conditions in the affected area as they exist at the time the notice of preparation is published, or where no notice of preparation is published, at the time environmental analysis is commenced. Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and changes induced in population distribution, population concentration, the human use of the land (including commercial and residential development), health and safety problems caused by the physical changes, and other aspects of the resource base such as water, historical resources, scenic quality, and public services. The EIR shall also analyze any significant environmental effects the project might cause or risk exacerbating by bringing development and people into the area affected. For example, the EIR should evaluate any potentially significant direct, indirect, or cumulative environmental impacts of locating development in areas susceptible to hazardous conditions (e.g., floodplains, coastlines, wildfire risk areas), including both short-term and long-term conditions, as identified in authoritative hazard maps, risk assessments or in land use plans addressing such hazards areas.*

Since the new land use assumptions are being utilized, as described by this letter, the EIR that is prepared shall also analyze any significant environmental effects the project might cause by bringing development and people into the area affected. The following are the basic steps in analyzing land use impacts as part of the community impact assessment process:

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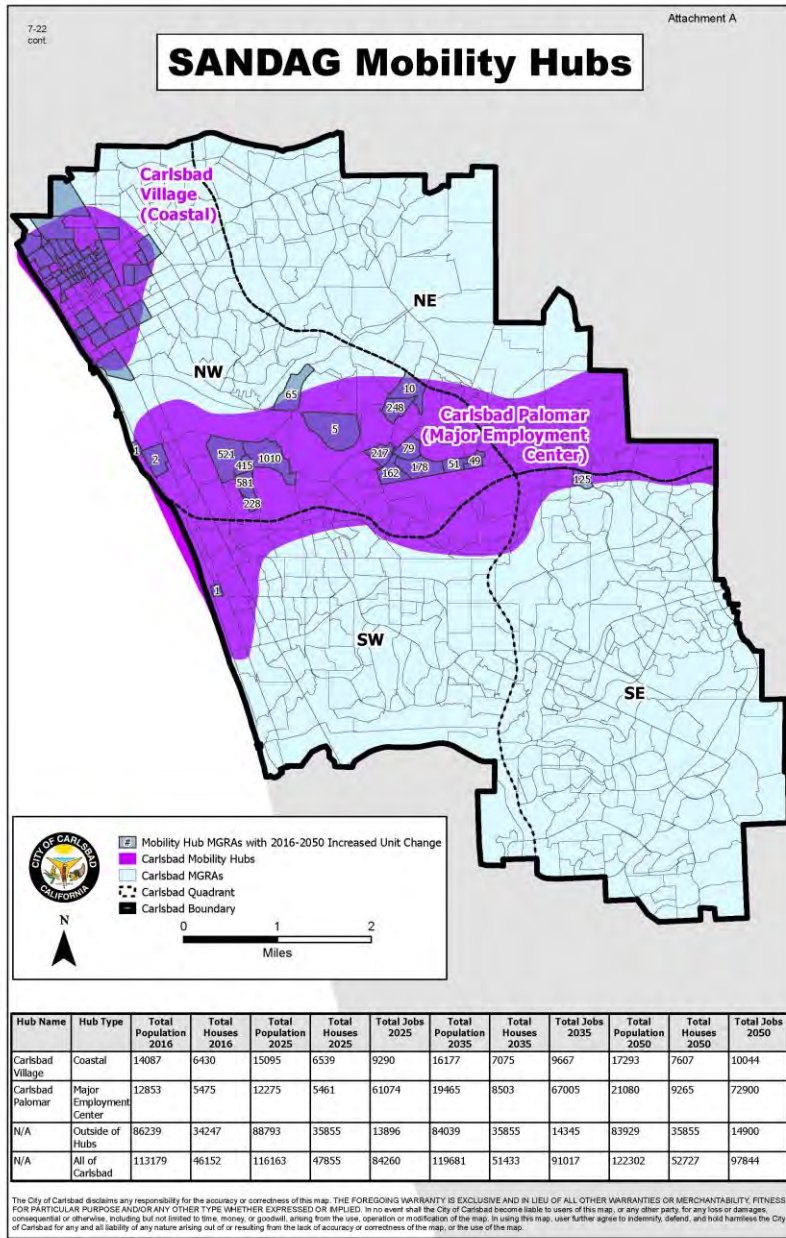
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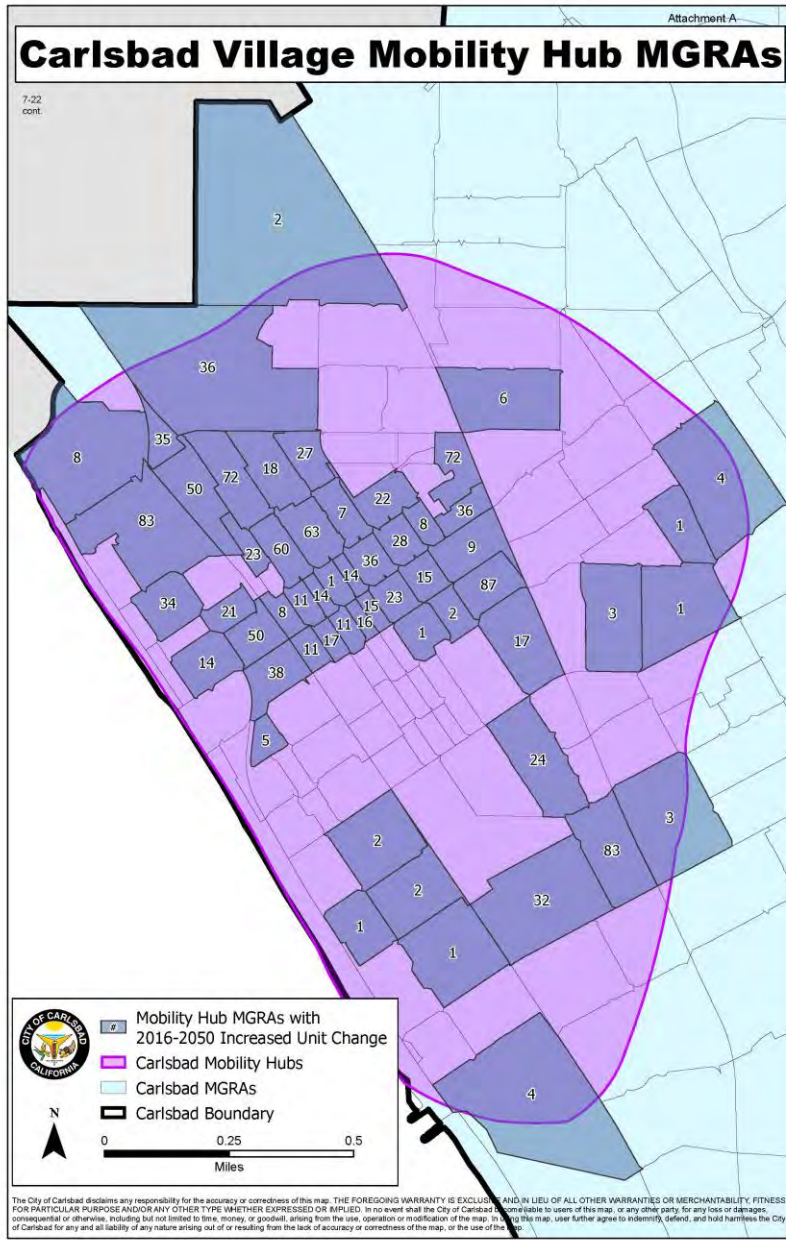
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1. Inventory the existing land use patterns (including undeveloped land), development trends, and transportation systems. The inventory of existing land uses should include the following land use types: residential, commercial, industrial, recreational, institutional, public services, community services, emergency services, transportation, utilities, agriculture, and undeveloped land in the study area. The study area should include the surrounding community that is generally associated with the project area within which community impacts could occur. The inventory should also address development trends and identify recent developments in the study area to include the development's name, size, status (planned, built, under construction), and the jurisdiction in which it is located. A map showing the location of existing and planned land uses in the area should also be prepared.
2. Determine whether the project is consistent with local and regional policies that govern land use and development. For the consistency analysis, the policies and programs considered in the analysis should include: transportation plans and programs (MTPs/RTPs and MTIPs/RTIPs), regional growth plans, local General Plans that establish land use and growth management policies for the study area, and any specific or pipeline development proposals. This analysis should also include a discussion of consistency with the Coastal Zone Management Act of 1972, California Coastal Act of 1976, the National Wild and Scenic Rivers Act (16 USC 1271) and the California Wild and Scenic Rivers Act (Pub. Res. Code § 5093.50 et seq.). After preparing a preliminary list of relevant plans to be considered in the analysis, the SANDAG planner should meet with the staff of the various agencies to review the list to determine if it is complete and revise the list as necessary.
3. Assess the changes that would occur in land uses and growth with and without the project.
4. The draft Regional plan and each project alternative should be considered separately since the results may be different.
5. Develop measures to avoid, minimize, and/or mitigate potential adverse effects.

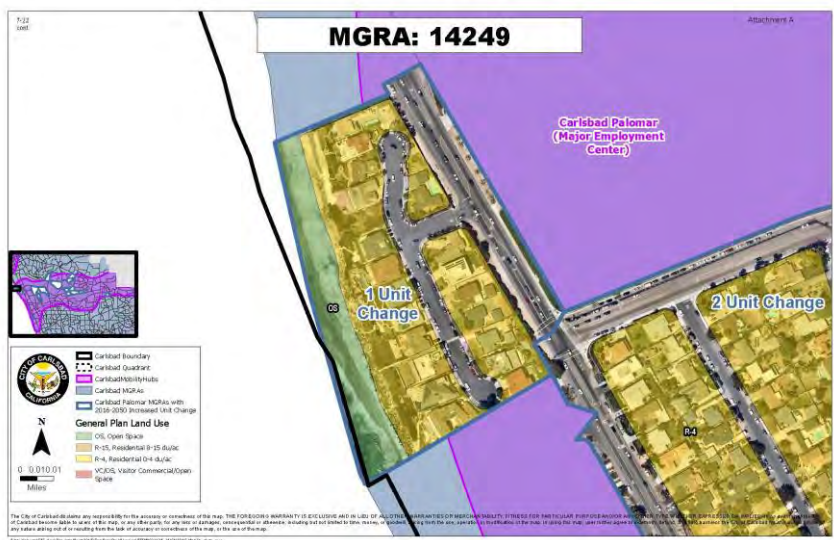
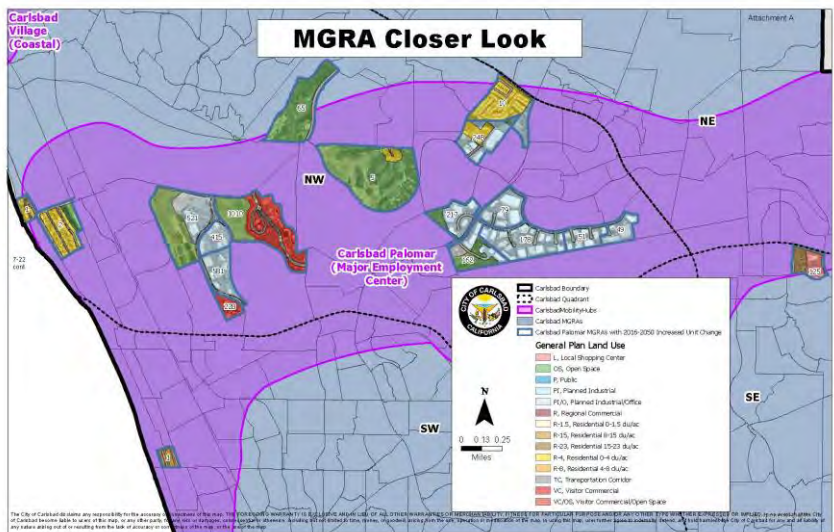
The resulting environmental analysis should identify the current development trends and the State and/or local government plans and policies on land use and growth in the area which will be impacted by the proposed project. These plans and policies are normally reflected in local General Plans. If found to be consistent, then the findings in the EIR should be documented in the report and no further analysis or action is necessary. When found not to be inconsistent with a policy or program, then consideration must be given to modifying the draft Regional Plan alternative to make it consistent, or measures to address the inconsistency must be developed. SANDAG should be actively engaged in the development of measures to address these issues and be prepared to assess the consistency of the draft Regional Plan and alternatives with the comprehensive development plans adopted for the area and (if applicable) other plans used in the development of the transportation plan required by Section 23 U.S. Code § 134. For any new land use growth assumptions, the secondary social, economic, and environmental impacts of any substantial, foreseeable, induced development should be presented for the draft Regional Plan and each alternative, including adverse effects on existing communities. The results should be shared with the public during the public involvement process, e.g., at community meetings, etc. Public input should be considered by SANDAG and if necessary, the findings of the analysis should be revised to reflect information gained through the public involvement process.

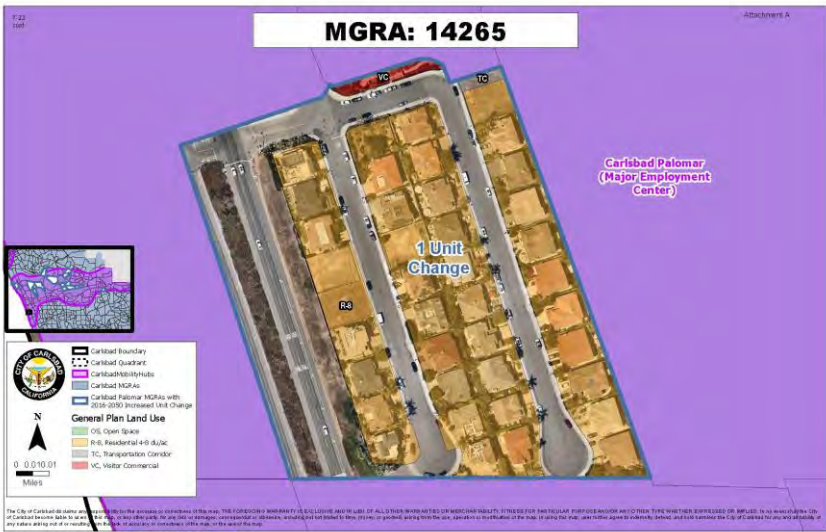
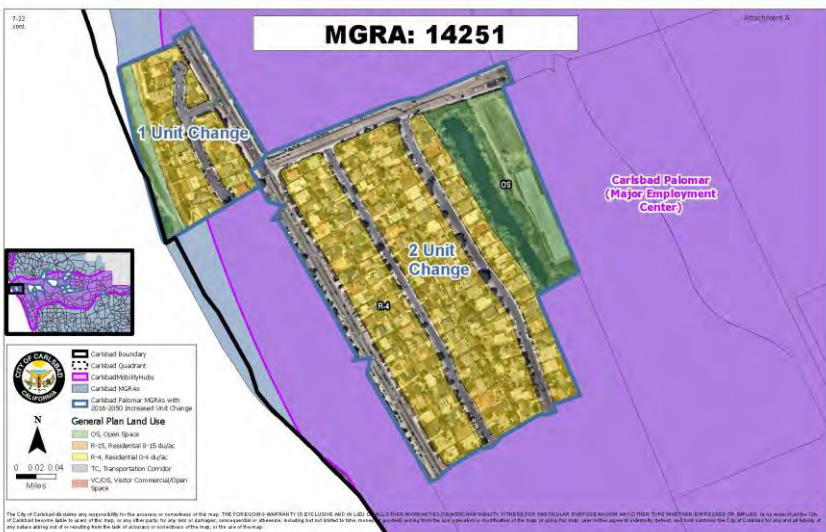


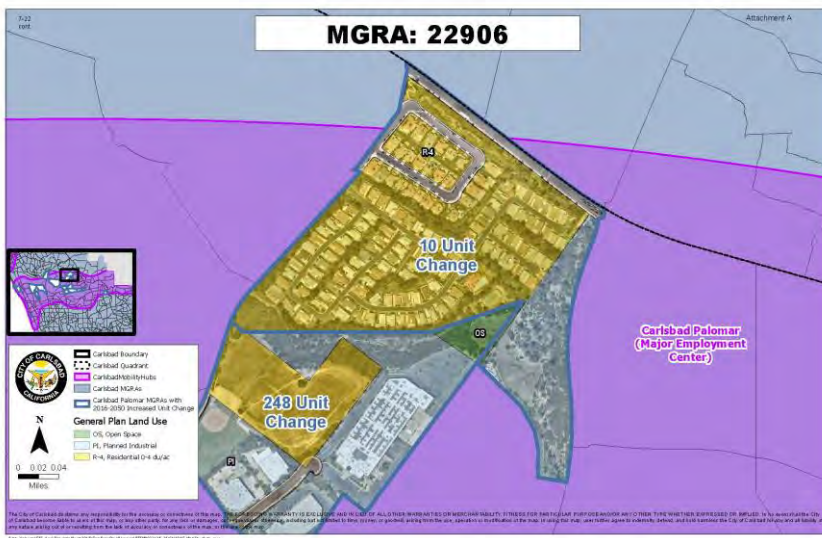
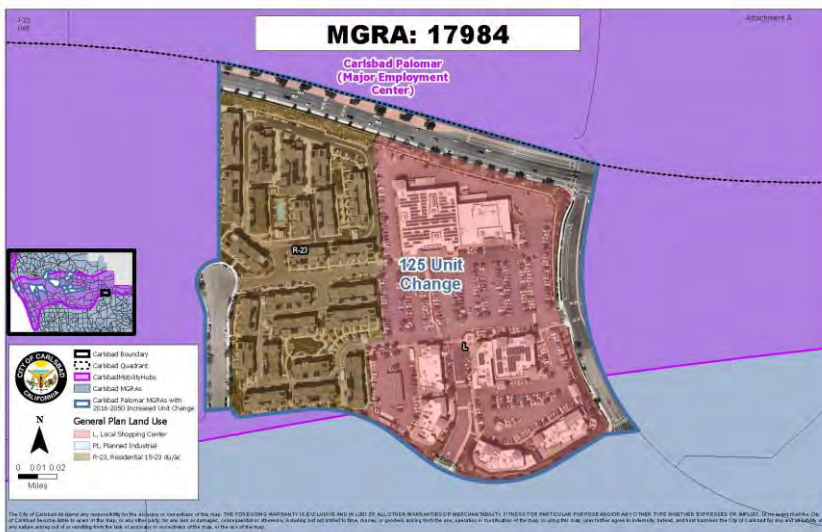




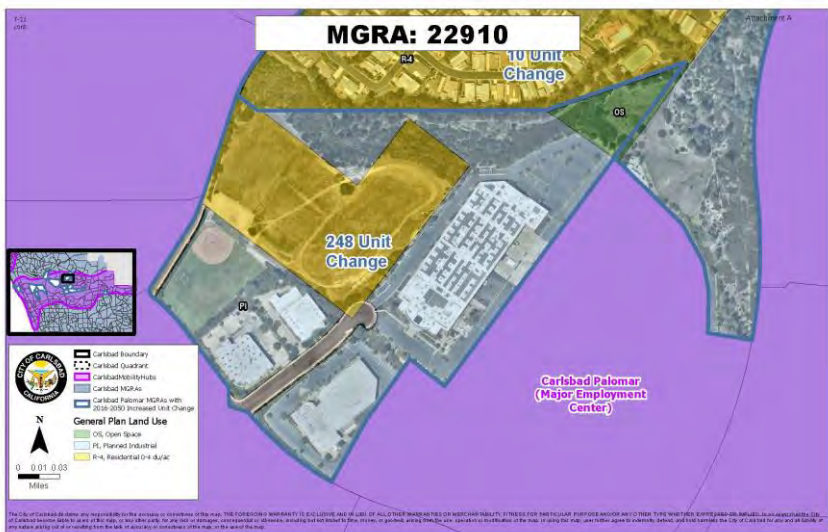
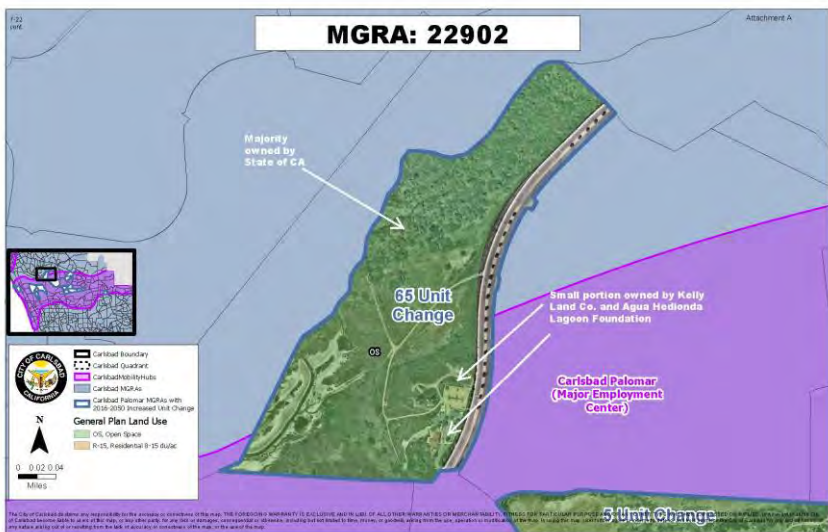


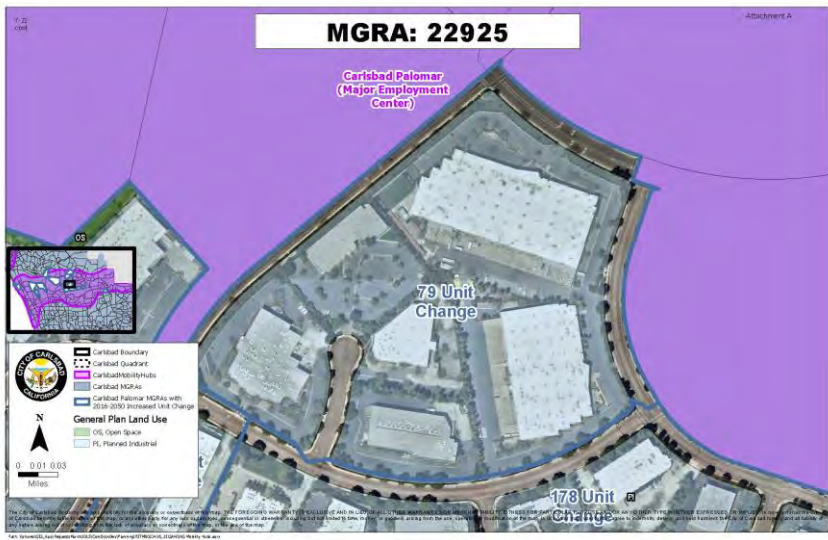
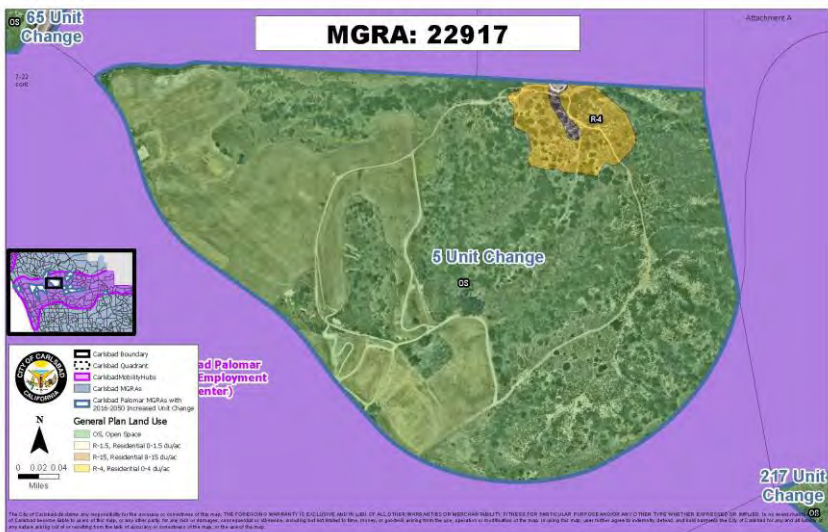


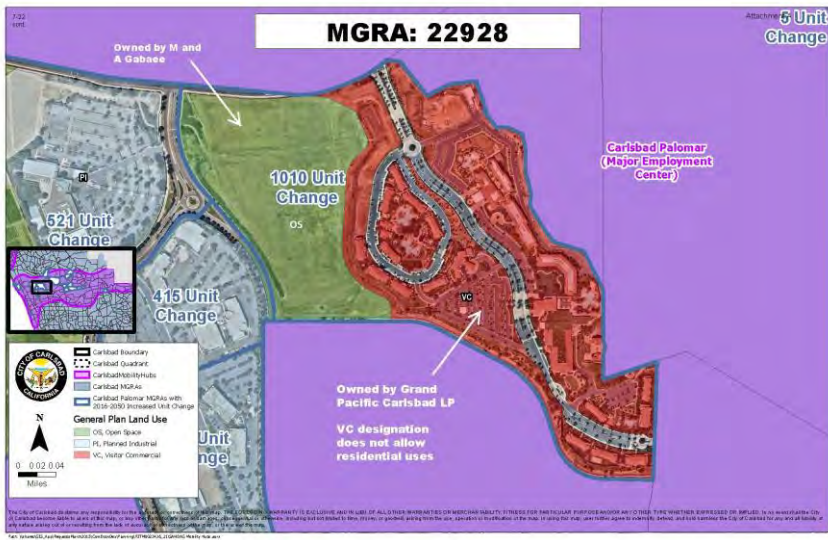
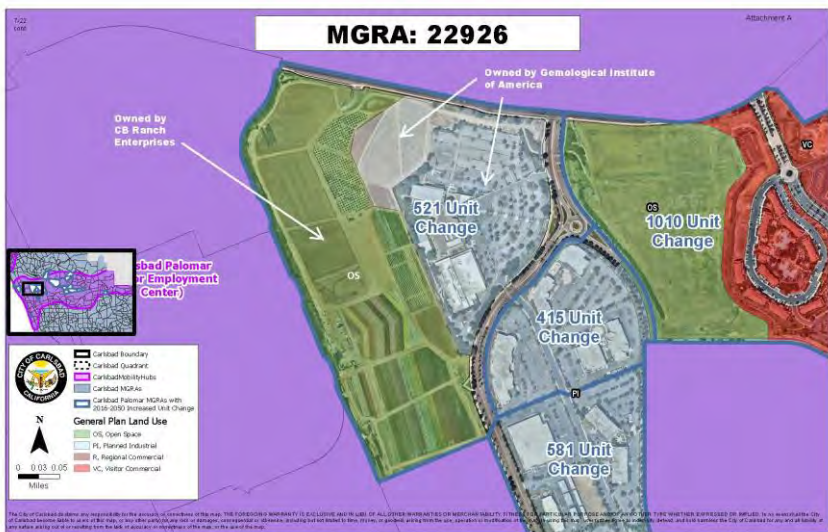




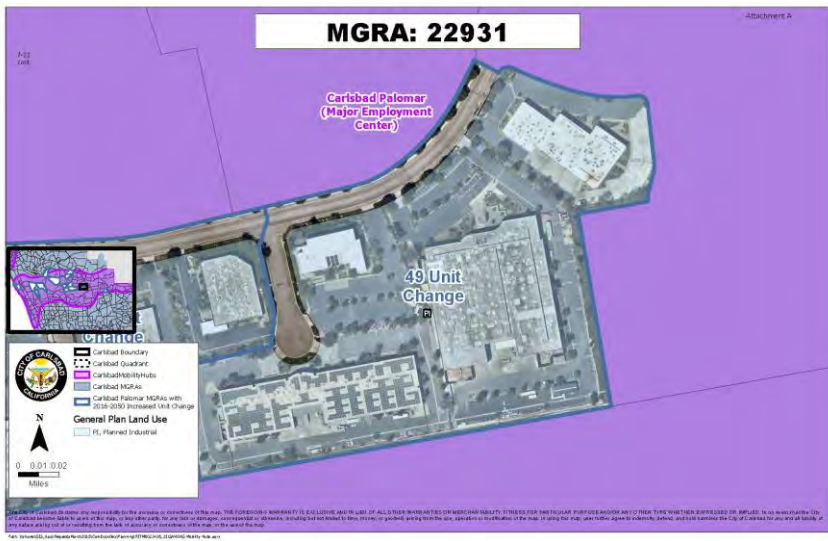


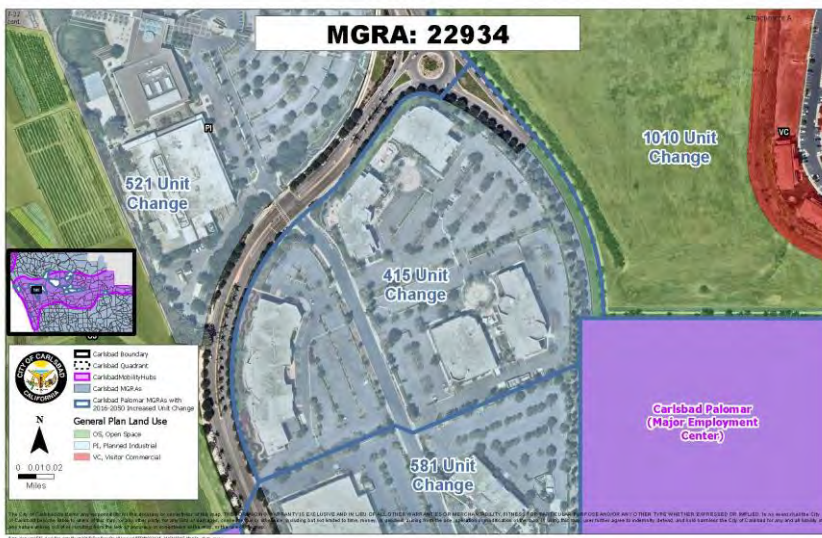




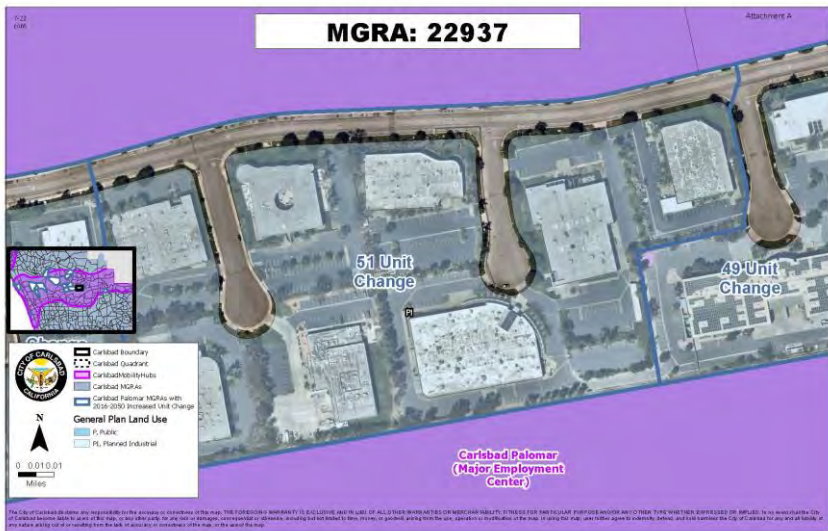
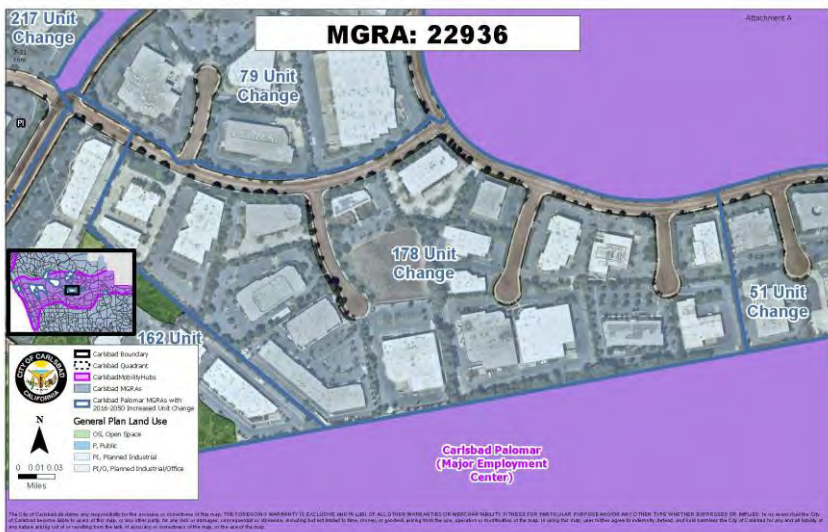


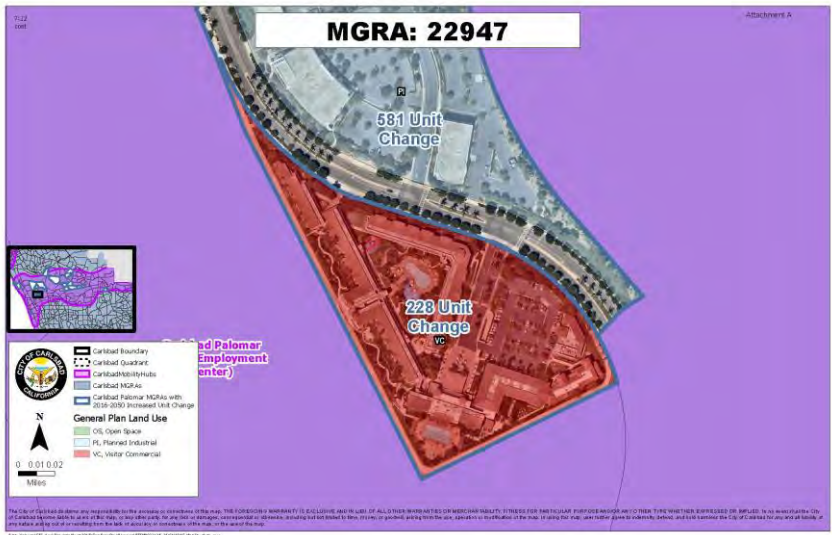
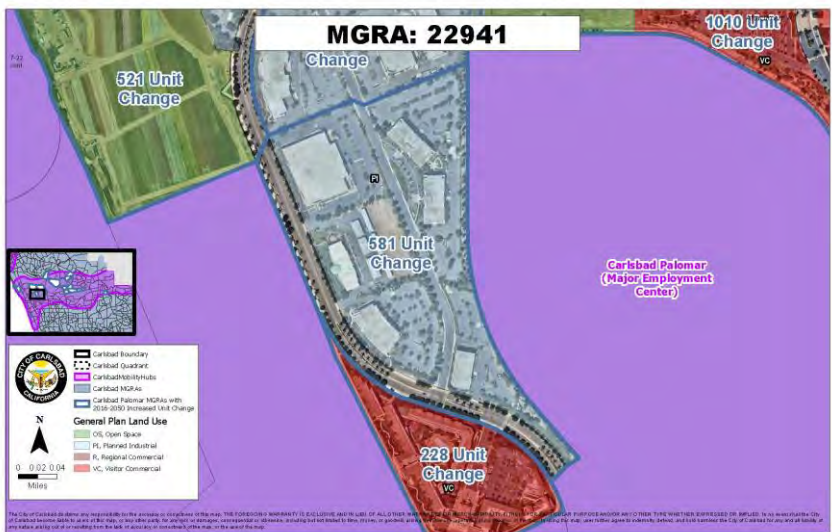


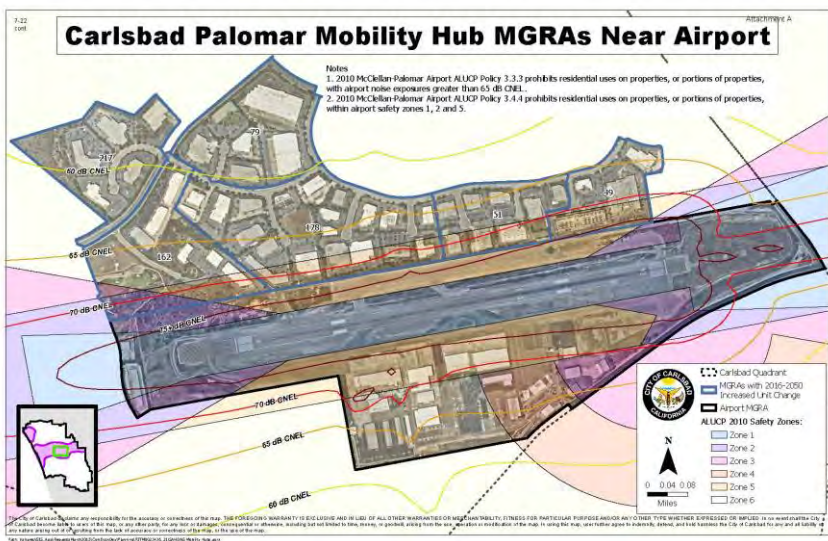












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PLEASE NOTE: PRELIMINARY RIDERSHIP DATA - UNAUDITED AND SUBJECT TO ADJUSTMENTS

Month	COASTER - TOTAL RIDERSHIP			
	FY21	FY20	Variance	%
July	10,263	149,615	(139,252)	(93.1%)
Aug	9,412	133,482	(124,070)	(92.9%)
Sept	10,020	114,233	(104,213)	(91.2%)
Oct	10,968	111,045	(100,077)	(90.1%)
Nov	9,232	94,651	(85,419)	(90.2%)
Dec	7,519	83,951	(76,432)	(91.0%)
Jan	6,848	98,791	(91,943)	(93.1%)
Feb	7,866	91,845	(83,979)	(91.4%)
Mar	11,203	48,510	(37,307)	(75.9%)
Apr	15,194	5,244	9,940	189.5%
May	19,214	6,207	13,007	209.6%
June**	44,978	8,734	36,244	415.0%
YTD Total	162,707	0	(781,461)	
FY Total	162,707	944,108		

\*\* Not final as of July 19, 2021

Month	COASTER - WEEKDAY			
	FY21	FY20	Variance	%
July	10,263	131,218	(120,955)	(92.2%)
Aug	9,412	112,100	(102,688)	(91.6%)
Sept	10,020	92,159	(82,139)	(88.1%)
Oct	10,968	105,601	(94,633)	(88.6%)
Nov	9,232	80,912	(71,680)	(88.8%)
Dec	7,519	75,634	(68,115)	(90.0%)
Jan	6,848	89,920	(83,072)	(92.4%)
Feb	7,866	84,613	(76,747)	(90.7%)
Mar	11,203	44,368	(33,165)	(74.7%)
Apr	15,194	5,244	9,940	189.5%
May	17,221	6,207	11,014	177.4%
June**	35,192	8,734	26,458	302.9%
YTD Total	150,928	0	(685,682)	
FY Total	150,928	836,610		

\*\* Not final as of July 19, 2021

Month	COASTER - SATURDAY			
	FY21	FY20	Variance	%
July	-	9,415	(9,415)	(100.0%)
Aug	-	14,348	(14,348)	(100.0%)
Sept	-	8,449	(8,449)	(100.0%)
Oct	-	3,247	(3,247)	(100.0%)
Nov	-	9,385	(9,385)	(100.0%)
Dec	-	4,387	(4,387)	(100.0%)
Jan	-	3,218	(3,218)	(100.0%)
Feb	-	5,181	(5,181)	(100.0%)
Mar	-	685	(685)	(100.0%)
Apr	-	0	0	
May	1,387	0	1,387	
June**	5,881	0	5,881	
YTD Total	7,268	0	(90,027)	
FY Total	7,268	57,295		

\*\* Not final as of July 19, 2021

Month	COASTER - SUNDAY			
	FY21	FY20	Variance	%
July	-	8,882	(8,882)	(100.0%)
Aug	-	7,034	(7,034)	(100.0%)
Sept	-	13,625	(13,625)	(100.0%)
Oct	-	2,197	(2,197)	(100.0%)
Nov	-	5,254	(5,254)	(100.0%)
Dec	-	4,030	(4,030)	(100.0%)
Jan	-	5,653	(5,653)	(100.0%)
Feb	-	2,051	(2,051)	(100.0%)
Mar	-	1,477	(1,477)	(100.0%)
Apr	-	0	0	
May	606	0	606	
June**	3,905	0	3,905	
YTD Total	4,511	0	(45,692)	
FY Total	4,511	50,203		

\*\* Not final as of July 19, 2021

7-22 cont.

Attachment A

ATTACHMENT 6 – Project Data Request

Table 1: Project Information Request

Project	Estimated Total Project Cost	Current Planned Year of Construction	Draft RTP Assumed Year of Construction	Assumed Federal/State Matching Funding (%)
San Dieguito Lagoon Double Track and Platform				
Batiquitos Lagoon Double Track and Bridge Replacement				
Eastbrook to Shell Double Track				
Carlsbad Village Trench				
La Costa to Swami Double Track				
San Onofre Bridge Replacements				
Rose Canyon Bridge Replacements				

7-22  
cont.

Attachment A

**ATTACHMENT 7 – Detail of Proposed Rail Lines**

**Table 3: Detail of Proposed Rail Lines**

	Rail Mode (CR, LR, HSR, Hybrid)	Directional Miles	% of Directional Miles Grade Separated/Tunnel	Number of Stations	Average Distance Between Stations	Average Speed Operated	Interoperable with COASTER equipment (Y/N)
New Rail Line							

7-22 cont.





Sept. 30, 2021

San Diego Association of Governments  
401 B street, Suite 800  
San Diego, CA 92101  
Via: [SDForward@sandag.org](mailto:SDForward@sandag.org)

RE: City of Carlsbad Comments on Draft 2021 Regional Plan

To whom it may concern,

This letter serves to inform SANDAG that the City does not wish to remove project CB32 from the Regional Arterials Project list.

Please disregard the comment regarding project CB32 from the attached letter sent to SANDAG on Aug. 6, 2021.

Thank you for bringing this to our attention, and please contact me if you have any other questions regarding the 2021 Regional Plan comment letter.

Best Regards,

A handwritten signature in blue ink, appearing to read "Tom Frank".

Tom Frank, PE  
Transportation Director/City Engineer

Attachment A: Letter to SANDAG dated Aug. 6, 2021

cc: Scott Chadwick, City Manager  
Celia Brewer, City Attorney  
Geoff Patnoe, Assistant City Manager  
Ron Kemp, Assistant City Attorney  
Robby Contreras, Assistant City Attorney  
Gary Barberio, Deputy City Manager, Community Services  
Paz Gomez, Deputy City Manager, Public works  
Mike Strong, Assistant Director, Community Development

Public Works Branch – Transportation Department  
1635 Faraday Avenue | Carlsbad, CA 92008 | 760-602-2766

### RESPONSE TO COMMENT 7-23

This comment is not related to the adequacy of the Draft EIR.

Project CB32 remains on the list of Regional Arterials projects in the proposed Plan.

7-23



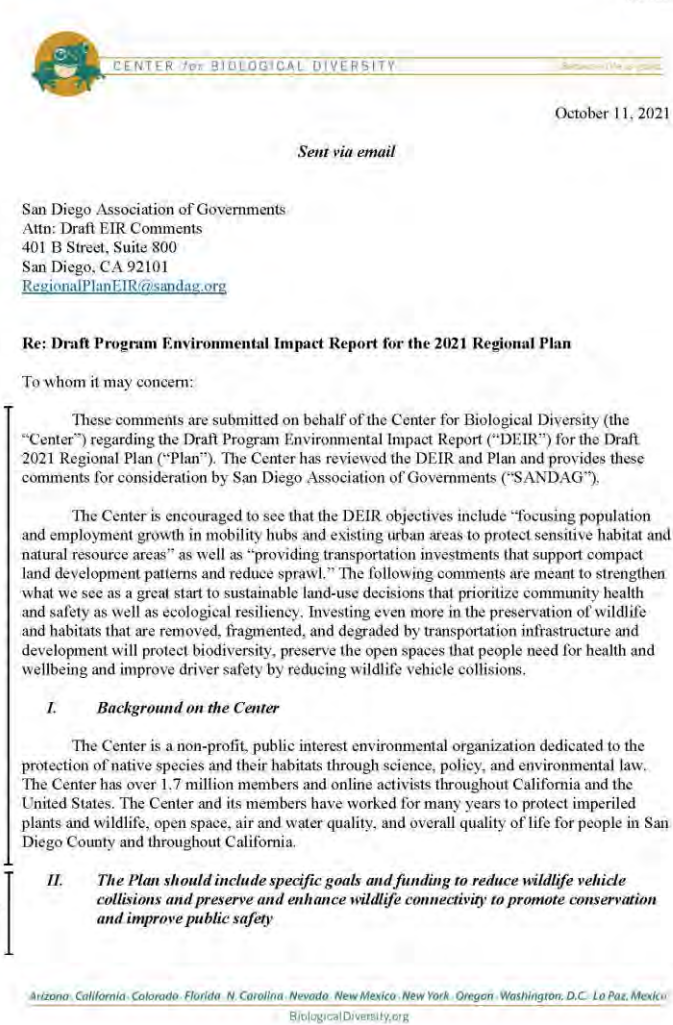
cc: Don Neu, City Planner  
Nathan Schmidt, Transportation Planning and Mobility Manager  
Jason Geldert, Engineering Manager  
Eric Lardy, Principal Planner  
Scott Donnell, Senior Planner  
Corey Funk, Associate Planner

Public Works Branch – Transportation Department  
1635 Faraday Avenue | Carlsbad, CA 92008 | 760-602-2766



**COMMENT LETTER 8: CENTER FOR BIOLOGICAL DIVERSITY**

Comment Letter 8



8-1

8-2

**RESPONSE TO COMMENT 8-1**

Thank you for the Center for Biological Diversity’s review of the Draft EIR and expressed support for the EIR objectives. The conservation of native species and their habitat is a key component of SANDAG’s Sustainable Communities Strategy. The land use pattern of the proposed Plan envisions greater compact development in areas served by high frequency, efficient transit. The result is less urban sprawl and fewer impacts on native habitat and species. Appendix AA, *Regional Habitat Conservation Vision*, of the proposed Plan describes the region’s efforts to develop and implement a system of open space for conservation of San Diego’s unique biodiversity. Detailed responses to the Center for Biological Diversity’s other comments can be found below.

**RESPONSE TO COMMENT 8-2**

Thank you for your comment and the valuable citations that document the effects of habitat fragmentation on biological resources. The commenter has requested “... SANDAG to add preservation of existing intact habitat and enhancement of wildlife connectivity at existing barriers, as an additional priority [of the Plan].”

The San Diego region has 30-year history of conservation planning for multiple species and their habitats, including the identification of an interconnected wildlife preserve system aimed at promoting connectivity and decrease the negative effects of habitat fragmentation. As documented in Appendix AA of the proposed Plan, SANDAG continues to be committed to funding regional conservation efforts that include wildlife corridors, and states that “the regional habitat conservation efforts have envisioned “hubs” of protected natural lands connected by wildlife movement corridors.” In order to conserve the region’s biodiversity, the EIR describes the proposed Plan’s intent to conserve unfragmented lands and cores and linkages consistent with adopted local NCCP Subarea Plans. The Plan encapsulated this intent within the Connect and Respect objectives of the Regional Vision (see Appendix AA).

To help meet the region’s habitat conservation goals, the proposed Plan identifies approximately \$3 billion for habitat-related efforts. This includes \$2,087 million for an enhanced habitat conservation,

management, and monitoring program (see Land Use and Habitat programs in Appendix B of the proposed Plan), a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (see Climate Adaptation and Resilience programs in Appendix B of the proposed Plan and mitigation measure GHG-5c in Section 4.8 of the EIR), and \$300 to \$500 million of land acquisition and restoration for habitat mitigation of transportation projects (incorporated in project costs presented in Appendix A of the proposed Plan). This funding is estimated to be sufficient to provide all the local funding needed to implement the habitat conservation plans as envisioned. Specific details would start to be developed immediately upon adoption as part of the near-term action items of the proposed Plan (Appendix B of the Plan).

At the project-level, as discussed in Section 4.4 of the EIR, projects that implement the proposed Plan will have to discuss impacts on the project on the conservation plans that include direct loss of habitat and species and indirect impacts such as promoting fragmentation and hindering wildlife movement. Furthermore, projects that bring high speed vehicles in proximity to wildlife life will have to address safety from collisions. This analysis would need to be included, as appropriate, into the subsequent (i.e., second tier) environmental review that will occur at the project level. Measures included in mitigation measure BIO-3 address design considerations to facilitate wildlife movement and connectivity on a project-specific level based on best available studies.

8-2 cont. The Center is encouraged to see that “protecting natural lands to absorb carbon and protect communities from the impacts of climate change” (Plan, Chapter 2, Page 35) is a priority in the Plan. However, **we urge SANDAG to add preservation of existing intact habitat and enhancement of wildlife connectivity at existing barriers, as an additional priority.**

Roads and development create barriers that lead to habitat loss and fragmentation, which harms native wildlife, plants, and people. As barriers to wildlife movement, poorly-planned development and roads can affect an animal’s behavior, movement patterns, reproductive success, and physiological state, which can lead to significant impacts on individual wildlife, populations, communities, landscapes, and ecosystem function (Brehme et al., 2013; Ceia-Hasse et al., 2018; Haddad et al., 2015; Marsh & Jaeger, 2015; Mitsch & Wilson, 1996; Trombulak & Frissell, 2000; van der Ree et al., 2011). For example, habitat fragmentation from roads and development has been shown to cause mortalities and harmful genetic isolation in mountain lions in southern California (Ernest et al., 2014; Riley et al., 2014; Vickers et al., 2015), increase local extinction risk in amphibians and reptiles (Brehme et al., 2018; Cushman, 2006), cause high levels of avoidance behavior and mortality in birds and insects (Benítez-López et al., 2010; Kantola et al., 2019; Loss et al., 2014), and alter pollinator behavior and degrade habitats (Aguilar et al., 2008; Goverde et al., 2002; Trombulak & Frissell, 2000). Habitat fragmentation also severely impacts plant communities. An 18-year study found that reconnected landscapes had nearly 14% more plant species compared to fragmented habitats, and that number is likely to continue to rise as time passes (Damschen et al., 2019).

8-3 Beyond direct impacts, edge effects of development in and adjacent to open space will likely impact key, wide-ranging predators, such as mountain lions and bobcats (Crooks, 2002; Delaney et al., 2010; J. S. Lee et al., 2012; Riley et al., 2006; Smith et al., 2015, 2017; Vickers et al., 2015; Wang et al., 2017), as well as smaller species with poor dispersal abilities, such as song birds, small mammals, and herpetofauna (Benítez-López et al., 2010; Cushman, 2006; Kociolek et al., 2011; Slabbekoorn & Ripmeester, 2008). Limiting movement and dispersal can affect species’ ability to find food, shelter, mates, and refugia after disturbances like fires or floods. Individuals can die off, populations can become isolated, sensitive species can become locally extinct, and important ecological processes like plant pollination and nutrient cycling can be lost. Negative edge effects from human activity, such as traffic, lighting, noise, domestic pets, pollutants, invasive weeds, and increased fire frequency, have been found to be biologically significant up to 300 meters (~1000 feet) away from anthropogenic features in terrestrial systems (Environmental Law Institute, 2003)

8-4 Furthermore, making roads more permeable for wildlife by prioritizing the construction of effective wildlife crossing infrastructure will help improve driver safety and save people money. From 2015 to 2018 more than 25,000 wildlife vehicle collisions with large mammals were reported in California, resulting in human deaths, injuries, and property damages estimated to be worth more than \$1 billion (Shilling et al., 2017, 2018, 2019). Alarming, many of these types of collisions go unreported. State Farm estimated more than 92,000 deer collision insurance claims during that same time frame (State Farm Insurance, 2016, 2018). And while car strikes can be immediately fatal for wildlife, many animals that are struck by vehicles may survive the collision but then slowly die from their injuries away from the road (T. S. Lee et al., 2021). Additional deaths from collisions include young that are orphaned and unable to survive

**RESPONSE TO COMMENT 8-3**

Thank you for the Center of Biological Diversity’s participation in the environmental review process. Further elaboration regarding your organization’s comments are addressed in subsequent responses below. SANDAG appreciates the summary of and citations for edge effects and potential effects of limiting wildlife movement.

**RESPONSE TO COMMENT 8-4**

SANDAG appreciates the summary and citations for potential effects on wildlife movement.

8-4 cont after their parent is killed. Such data should not be ignored in planning a regional transportation plan where lack of wildlife connectivity is causing harm to wildlife, ecosystems, and people.

In addition, connectivity between high quality habitat areas in heterogeneous landscapes is important to allow for range shifts and species migrations as climate changes (Cushman et al., 2013; Heller & Zavaleta, 2009; Krosby et al., 2018). Increasing variability and extremes in temperature, wind, and precipitation are all products of a warming climate, leaving species struggling to adapt. As a result, species' genes are changing, physiological and physical features such as body size are changing, ranges are shifting as species try to maintain a suitable climate space, and numerous species are expressing new breeding and migration behaviors (Scheffers et al., 2016). Reportedly, climate change is already impacting 82% of key ecological processes that form the foundation of healthy ecosystems (Scheffers et al., 2016). If climate change goes unabated, more than one third of all plant and animal species could become extinct in the next 50 years (Román-Palacios & Wiens, 2020). Wildlife connectivity is critical for biodiversity resilience and climate change adaptability. A permeable landscape that has multiple pathways or linkages between habitat patches allows a wide variety of species to adjust to shifts in resource availability (Mcrae et al., 2012; Olson & Burnett, 2013; Pinto & Keitt, 2008). Multiple connections help populations persist after extreme events worsened by climate change. During floods, landslides or wildfires, these pathways provide escape routes or refugia for animals seeking safety (Cushman et al., 2013; Mcrae et al., 2008). Prior to roads and development severely fragmenting and degrading habitats, a species could persist because individuals from neighboring populations would be able to recolonize an area that experiences a local extinction. But without adequate connectivity, recolonization and species persistence are improbable.

8-5 If the Plan truly aims to promote sustainable land-use, increase driver safety and mitigate impacts of climate change, then enhancing wildlife connectivity must be stated as a priority. **This should include funding that would go towards identifying roadkill hotspots; implementing wildlife crossing infrastructure** (e.g., upgrading existing culverts to make them more wildlife-friendly, installing crossings and directional fencing at roadkill hotspots, etc.) in those hotspots; **and protecting, managing, and restoring lands in perpetuity on both sides of the constructed wildlife crossings to facilitate wildlife movement.** Wildlife crossing structures have been shown to be a cost-effective means of reducing such collisions and facilitating wildlife movement. States that have invested in wildlife crossing infrastructure, like Utah, Colorado, and Wyoming, have seen 81-98.5% reductions in wildlife vehicle collisions on sections of highways where they have implemented wildlife crossings (Bissonette & Rosa, 2012; Kintsch et al., 2019, 2021; Sawyer et al., 2012; Kintsch et al., 2021). The savings over the long-term from the avoided wildlife vehicle collisions more than pay for the upfront costs to build the crossings (Center for Large Landscape Conservation, 2020). Priority implementation action #9 ("Expand regional programs on low-carbon transportation options, roadway safety and maintenance, and nature-based climate solutions") should include wildlife crossing infrastructure as a safety measure and the proposed Plan's \$441 billion going towards maintaining and optimizing the existing system should specifically allocate funding towards implementing wildlife crossing infrastructure.

**RESPONSE TO COMMENT 8-5**

This comment addresses the proposed Plan and is not related to the adequacy of the EIR. The comment asserts that the proposed Plan must enhance and fund wildlife connectivity. Appendix AA of the proposed Plan describes the status of the HCPs within the region and states SANDAG's commitment to funding regional conservation efforts that include wildlife corridors. For additional elaboration regarding habitat fragmentation and project-specific mitigation, please see response to comment CBD 8-2.

**IV. The DEIR fails to adequately describe, assess, and mitigate impacts to wildlife movement and habitat connectivity.**

8-6 The DEIR states that the MSCP cores and linkages maps (City of San Diego 1998) and the climate resilient wildlife movement models developed by San Diego State University (SDSU 2019), were used for the quantitative analysis of connectivity. Although these are important resources to identify areas for wildlife movement, there are additional resources that are additive and therefore should also be included when assessing the impact to wildlife connectivity in the area. For example, the UC Davis Road Ecology Center’s reports on wildlife vehicle collisions and roadkill hotspots also provide information regarding where wildlife are moving and being hit on roads (Shilling et al., 2017, 2018, 2019). And UC Davis and The Nature Conservancy researchers helped to define a connectivity “roadmap” for mountain lions across the region, and they identified where safe crossings can occur and where barrier effects are present (Vickers, 2020). These data should be considered when assessing the region’s wildlife connectivity and barriers to connectivity.

In addition, the DEIR states that the statewide habitat connectivity model and the SC Wildlands linkages models are “relatively coarse-scaled” (DEIR at 4.4-36) and therefore were excluded from the analysis. But both the SC Wildlands’ 2008 South Coast Missing Linkages Report and CDFW’s 2019 Areas of Conservation Emphasis data (which include terrestrial connectivity) are often used in such analyses; they provide more recent models compared to the 1998 MSCP cores and linkages maps by the City of San Diego and should be included here, or a more thorough explanation of why they are inappropriate to use here should be provided. Also, because San Diego County is located within the Pacific Flyway and is important for global connectivity for millions of birds that migrate along the West Coast, areas identified as Important Bird Areas (IBAs) by Audubon should also be included in the connectivity analysis. And there are likely other studies that provide more information regarding important wildlife connectivity throughout the region. The Plan and DEIR should provide the best available science when describing existing conditions and assessing potential impacts of the Plan. The DEIR fails to do this by only providing a fraction of the available information regarding wildlife movement and habitat connectivity.

8-7 The DEIR states that a total of 6,617 acres by 2025; 3,519 acres from 2026-2035; and 633 acres from 2036-2050 of mapped wildlife connectivity areas will be impacted by regional growth and transportation network improvements, but it does not provide the map of essential connectivity areas that would be impacted. This omission prevents the public from understanding where these development footprints overlap with connectivity areas or if the footprints are designed in a way to avoid and/or minimize impacts to wildlife connectivity. This information is essential to quantifying the impact and creating targeted mitigation measures. In addition, the number of acres that will be lost in connectivity areas due to growth could be much greater if other connectivity areas mentioned above and IBAs are included in the analysis.

8-8 The DEIR downplays and dismisses the impacts of the transportation projects on wildlife connectivity, stating that “transportation network improvements that would impact wildlife corridors are planned for existing highways, transit projects, or arterials that already act as wildlife barriers. Widening these transportation corridors would not necessarily cut off these

**RESPONSE TO COMMENT 8-6**

SANDAG appreciates the citations provided, including studies conducted by UC Davis Road Ecology Center, and the “roadmap” for mountain lions developed by UC Davis and The Nature Conservancy (Vickers 2020). Although some of the Shilling et al. studies were conducted in Northern California, they still provide valuable information for the design of wildlife crossings to avoid noise and light pollution, and to appropriately mitigate for impacts on wildlife movement. These citations have been included in mitigation measure BIO-3 as references to be consulted when developing project-specific wildlife crossing design.

The EIR uses best available data at the time the analysis was conducted. The Vickers 2020 dataset was not included in the county-wide wildlife movement model analyzed in this EIR because the data were not available yet at the time the model was produced (Jennings pers. comm.). The Vickers (2020) and Shilling (2019) data were used for local modeling (for example modeling conducted for SR 67), but a county-wide model using these datasets has not yet been developed. However, SANDAG has committed to funding regional conservation efforts that include wildlife corridors, and states that “the regional habitat conservation efforts have envisioned “hubs” of protected natural lands connected by wildlife movement corridors”(see Appendix A of the propose Plan). Please see also response to comment CBD 8-2 regarding habitat fragmentation.

SANDAG agrees that the South Coast Mission Linkages Report and CDFW Area of Conservation Emphasis data provide valuable information on wildlife corridors and linkages. EIR preparers reviewed and evaluated these and many more studies providing information on wildlife movement and connectivity in San Diego County on a programmatic level. However, the recent model prepared by SDSU provides more detailed and County-specific data on wildlife movement. The model was specifically prepared with the goal to provide climate change resiliency and adaptation. It incorporates the information from the referenced studies and builds upon them. Therefore, SANDAG did not evaluate the South Coast Wildlands and CDFW studies independently but rather used them in coordination with the SDSU

model. See also response to comment USFWS 38-12, which discusses the data used in the EIR for MHCP cores and linkages.

The Pacific Flyway is addressed in the EIR. It is described on page 4.4-39. Impacts are discussed on pages 4.4-98 and 4.4-106. Furthermore, the Audubon Society identifies Important Bird Areas (IBA) in San Diego County. All IBAs identified in the Plan footprint are either not developable (i.e., lakes, reservoirs, lagoons, and bays), or are already conserved through various designations (e.g., National Wildlife Refuges, State Preserves, City of San Diego Cornerstone Lands, etc.) and included in the Conserved Lands layers that were part of the GIS dataset analyzed in both Impact BIO-3 and Impact BIO-4 (see also Figure 4.4-16). A reference to the Audubon IBAs has been added to the text.

#### **RESPONSE TO COMMENT 8-7**

Figure 4.4-15 in the Final EIR has been updated to show the transportation network footprint impacts on wildlife connectivity areas. The model used for identification of wildlife corridors and linkages encompasses the most recent data available for San Diego County, including the Audubon IBAs (by way of the Conserved Lands layer), and therefore reflects a conservative assessment of impacts. In reality, once projects evaluate avoidance measures under project-specific CEQA and include wildlife corridor designs in the project design, the impacts on wildlife movement, corridors, and linkages are expected to be much less than reported in the EIR. A statement explaining the likely overestimation of impacts is included in the Impact BIO-3 direct impact section.

#### **RESPONSE TO COMMENT 8-8**

SANDAG acknowledges that widening of infrastructure would discourage wildlife movement (see the following statement on Draft EIR pages 4.4-99/100: “they may make existing crossings less attractive for use by wildlife species, and the greater width may lead to additional highway mortality for terrestrial and avian species that attempt to cross transportation corridors at grade.” Measures required under mitigation measure BIO-3 address design considerations to facilitate wildlife movement based on best available studies, including wildlife movement studies. In response to this comment, the following text has been added to measure BIO-3: Conduct wildlife movement studies and Before-After-Control-Impact-Studies (BACI) where data are lacking and consider balancing conservation and recreation (Mitrovich et al. 2020). Include

adaptive management and monitoring measures in the CEQA review, mitigation measures, and project design.

The participation of other project sponsors in the implementation of the EIR and mitigation measures is addressed in Section 4, *Environmental Impact Analysis Approach*. Specifically, the section identifies the following: “The EIR includes three broad types of mitigation measures: (1) plan- and policy-level mitigation measures assigned to SANDAG; (2) mitigation measures for transportation network improvements and programs, assigned to SANDAG and other transportation project sponsors; and (3) mitigation measures for development projects implementing regional growth and land use changes, which local jurisdictions implement.” Mitigation measures would be refined and implementation methods identified, as required by CEQA, the local jurisdictions, and Wildlife Agencies on a project-specific level. In addition, please see Master Response 2.

For more information regarding the use of “can and should” language regarding mitigation measures for other responsible agencies, please see Master Response 2.



8-8 cont. corridors because bridges that would be widened would likely be designed to allow for continued wildlife movement” (DEIR at Page 4.4-99). Such claims are unsubstantiated and dismiss how species move through landscapes. Widening transportation corridors can make a once feasible passage completely infeasible and the assumption that such widenings “would likely be designed to allow for continued wildlife movement” is not substantiated with the necessary information for the public to determine that this would indeed be true. While the DEIR states that SANDAG “shall implement project designs that provide for continued movement of wildlife,” it also says that “other transportation project sponsors can and should,” which suggests that not all network improvements will implement such measures.

SANDAG must also analyze and fully mitigate impacts of the Plan on local mountain lions in the Santa Ana Mountains (SAM) and the Eastern Peninsular Range (EPR) because they are provisionally listed under the California Endangered Species Act (“CESA”). Under CESA, SANDAG may not approve projects (including the Plan) that could jeopardize the continued existence of protected populations or result in destruction of essential habitat (Cal. Fish & Game Code § 2053(a) and ABAG must require that appropriate mitigation measures be implemented for projects that could destroy mountain lion habitat or impair connectivity (Cal. Fish & Game Code § 2054). The Santa Ana Mountains puma population is of particular concern. According to the 2019 CESA petition (Yap et al., 2019):

8-9 The SAM mountain lion population has been found to have the lowest genetic diversity of all populations in California, with levels nearly as low as the endangered Florida panther (Benson et al., 2019; Ernest et al., 2014; Gustafson et al., 2017, 2018). This population is also estimated to have a low effective population size ( $N_e = 5.1$  to  $15.6$ ) and high levels of relatedness and inbreeding (Ernest et al. 2014; Gustafson et al. 2018; Benson et al. 2019). The SAM population was found to be a genetic sink population, with limited gene flow with the EPR population (Gustafson et al. 2018). In a 16-year study (2001-2016) seven migrants (out of 146 sampled animals), were detected via genetics and GPS collar tracking to have crossed the I-15 between the EPR and SAM (three males from the EPR to SAM, four males from the SAM to the EPR); only one migrant is known to have reproduced (Gustafson et al. 2017). Low genetic diversity and effective population size in the SAM are indicative of a genetic bottleneck that is estimated to have occurred 40-80 years ago, around the time when urban development and multi-lane highway construction boomed in Southern California (Ernest et al. 2014; Gustafson et al. 2018). This population was also found to be largely disconnected from all the other California populations, along with the EPR population.

A recent population viability analysis found that if the population remains isolated with little or no immigration (similar to what is currently being observed in the area), the population could experience further genetic erosion, with 28-49% loss of predicted heterozygosity within 50 years (Benson et al. 2019). When considering just demographic processes with little or no immigration and no inbreeding depression, the population was predicted to have a 16-21% chance of extinction within 50 years. However, to avoid inbreeding depression in wild

**RESPONSE TO COMMENT 8-9**

SANDAG appreciates your concern regarding the peril of the Santa Ana Mountains and Eastern Peninsula Range mountain lion population.

Since 2012 SANDAG has funded work totaling \$989,384 by Winston Vickers and his team at UC Davis Wildlife Health Center to research mountain lions in the San Diego Region. The conclusions of these studies showed: (1) low annual survival rates for mountain lion populations both east and west of I-15, primarily due to interactions with humans – collisions with vehicles and mortalities secondary to depredation permits being the most prominent causes of death, and (2) connectivity between conserved habitat areas is severely compromised, especially between San Diego, Orange, and Riverside (Vickers 2020). The two major connections into San Diego County are through Orange County into Camp Pendleton and then through San Luis Rey River. The other contention is outside of San Diego County located in Riverside County and connects Camp Pendleton/Fallbrook to lands east of I-15 and Palomar Mountain. The projects in the Plan are outside these identified connections and, therefore, would not further impede existing movements of mountain lion in these two corridors.

This work is being done as part of SANDAG’s commitment to funding regional conservation efforts under its TransNet-funded Environmental Mitigation Program (EMP), which is referenced in the EIR (pg. 4.4-53), together with its implementing entity, the San Diego Monitoring and Management Program (SDMMP). The SDMMP’s charter is “to assist with the alignment of regional efforts to implement activities identified in the Management Strategic Plan” (MSP, SDMMP 2017). The MSP identifies priority species, and has developed and is currently developing, best management practices (BMPs) and protocols for sensitive plants and animals, wildlife movement, fire management, and grazing management” (EIR page 4.4-54). The MSP identifies the MSCP-covered mountain lion as a high priority species (SL Category) and has conducted and is currently conducting studies identifying connectivity and genetics of mountain lions in San Diego County. These studies and other best available information will be considered on the project-specific level as identified in mitigation measure BIO-3.

Lastly, please note that Fish and Game Code Sections 2053(a) and 2054 are statements of legislative intent.

8-9  
cont.

populations, loss in heterozygosity should be less than 5-10% over 100-200 years (Benson et al., 2016; Soule et al., 1986), which suggests that inbreeding depression in the SAM population is a strong possibility. In addition, evidence of potential inbreeding depression has been observed in the population (e.g., kinked tails coupled with low genetic diversity, Figure 2, Ernest et al. 2014). When inbreeding depression was considered in the population viability analysis, population growth will likely decline and chances of extinction within 50 years is predicted to be 100%, with a median time to extinction of 11.7 years (Benson et al. 2019).

To improve the outlook for local mountain lions and prevent their extirpation, transportation and land-use planning in the SANDAG region must proactively account for puma movement and behavioral needs.

8-10

The DEIR's proposed mitigation measures are vague and insufficient to mitigate impacts to special-status species and sensitive habitats, designated critical habitat, and wildlife movement and habitat connectivity. For example, BIO-1b states that SANDAG shall "design compensatory mitigation to result in the conservation, establishment, or creation of self-sustaining sensitive natural and native communities, replacing the lost habitat and/or habitat value as required to offset those lost from project implementation" (DEIR, Page 4.4-75). However, there is no detail on how this will be measured assessed or maintained over time. Additionally, mitigation measure BIO-2 calls for the "establishment of appropriate habitat mitigation ratios," but it does set a minimum threshold. Avoidance of impacts to sensitive habitats and designated critical habitat should be prioritized, after which in-kind mitigation should be a minimum of 3:1 given that critical habitat is designated for threatened and endangered species that are on a trajectory towards extinction without protective action and are already struggling to survive in the long-term, and 5:1 for off-site restoration or habitat creation with continued monitoring, adaptive management strategies, and well-defined success criteria, to be funded in perpetuity (not just for five years).

The DEIR lacks sufficient mitigation for wildlife connectivity as well. **It should require project proponents to implement wildlife connectivity into the design and budget of the projects when planning starts**, being sure to consider the local, regional, and global context of landscape connectivity for a given project in a given area. Opportunities to upgrade existing culverts or implement directional fencing to guide animals to existing culverts or underpasses, as outlined in BIO-3 Mitigation Measures, should be actively sought when conducting maintenance, expansion, or enhancement projects on existing roads. Additionally, acquiring habitat on both sides of wildlife crossings should also be prioritized. And the different needs of the diverse species should be taken into account when designing crossings for wildlife passage. For example, mountain lions have been documented using culverts that are about 4 meters (~13 feet) in diameter (Clevenger & Waltho, 2005; Kintsch & Cramer, 2011; Riley et al., 2018), while smaller animals, including small mammals, reptiles, and amphibians, might require smaller passageways to actually use them. In addition, smaller species with poor dispersal abilities would require more frequent intervals of crossings to increase their chances of finding a crossing compared to more mobile animals, like mountain lions or deer. And for some amphibian and reptile species, such as California red-legged frogs and western pond turtles, undercrossings could include elevated roads or tunnels with grated tops so that the light and moisture inside the

**RESPONSE TO COMMENT 8-10**

Mitigation ratios cannot be identified on a programmatic basis due to the widely differing circumstances of second-tier transportation and land use projects. The appropriate mitigation ratios will be calculated on a project-specific level based on regulatory agency requirements, and will be applied consistent with local requirements and ordinances. Mitigation measure BIO-3 requires incorporation of wildlife connectivity into project design on a project-specific level and identifies ways to do so (see response to comment CDB 8-12). Mitigation measure BIO-1b states that using approved mitigation banks is the preferable alternative to provide compensatory mitigation. Approved mitigation banks, through the approval process with the Wildlife Agencies, are required to monitor, manage and maintain in perpetuity the biological resources for which mitigation credits were approved by the Wildlife Agencies. The Wildlife Agencies monitor the mitigation banks' commitments on an annual basis by way of annual reports prepared by the mitigation banks' management entity; all management entities managing mitigation banks must also be approved by the Wildlife Agencies. Furthermore, mitigation measure BIO-1b also identifies "requirement for and financing of long-term conservation and management requirements of the mitigation projects." Mitigation measures BIO1-c and BIO-1d provide detail on the compensatory mitigation requirements in the form of native habitat restoration planning and design, and the requirement for long-term management and monitoring in perpetuity to assure that all mitigation continues to function over time. Text was added to mitigation measure BIO-1a to require early coordination with the Wildlife Agencies and respective local jurisdictions to design alignments (see also response to comment CDFW 9-8).

8-10  
cont. crossings are similar to that of the ambient environment (Brehme & Fisher, 2020; Langton & Clevenger, 2021).

Mitigation Measure BIO-3 should include long-term monitoring of the crossing structures to help understand if the crossings are effective and/or how to improve upon them so that animals use the crossings and roads are safer for wildlife and people. And while Mitigation Measure BIO-3 includes maintenance of the crossing infrastructure, such maintenance should include adaptive management so that lessons learned from the monitoring can be applied to improve functionality of the crossings. Protecting, managing, and restoring lands in perpetuity on both sides of the constructed wildlife crossings should also be included to facilitate wildlife movement. Mitigation Measure BIO-3 should also include measures to reduce impacts of light and noise in connectivity areas and at crossing infrastructure both during construction and operation of projects. Some examples of noise and light mitigation that are not already provided include:

8-11

- Use high pressure sodium and/or cut-off fixtures instead of typical mercury vapor fixtures for outdoor lighting.
- Design exterior lighting to confine illumination to the project site.
- Provide structural and/or vegetative screening from light-sensitive uses.
- Use non-reflective glass or glass treated with a non-reflective coating for all exterior windows and glass used on building surfaces.
- Architectural lighting shall be directed onto the building surfaces and have low reflectivity to minimize glare and limit light onto adjacent properties.
- Install temporary noise barriers during construction
- Include permanent noise barriers and sound-attenuating features as part of the project design. Barriers could be in the form of outdoor barriers, sound walls, buildings, or earth berms to attenuate noise at adjacent sensitive uses.
- Ensure that construction equipment is properly maintained per manufacturers' specifications and fitted with the best available noise suppression devices (e.g., improved mufflers, equipment redesign, use of intake silencers, ducts, engine enclosures, and acoustically attenuating shields or shrouds silencers, wraps). All intake and exhaust ports on power equipment shall be muffled or shielded.
- Use hydraulically or electrically powered tools (e.g., jack hammers, pavement breakers, and rock drills) for project construction to avoid noise associated with compressed air exhaust from pneumatically powered tools.
- Use rubberized asphalt or "quiet pavement" to reduce road noise for new roadway segments, roadways in which widening or other modifications require re-pavement, or normal reconstruction of roadways where re-pavement is planned.
- Use equipment and trucks with the best available noise control techniques (e.g., improved mufflers, equipment redesign, use of intake silencers, ducts, engine enclosures, and acoustically attenuating shields or shrouds, wherever feasible) for project construction.
- Use techniques such as grade separation, buffer zones, landscaped berms, dense plantings, sound walls, reduced-noise paving materials, and traffic calming measures.

## RESPONSE TO COMMENT 8-11

Mitigation measure BIO-3 provides programmatic mitigation measures to reduce indirect impacts on wildlife movement corridors. Monitoring and adaptive management was added to the text (see response to comment CBD 8-8). Avoidance, minimization, and mitigation of indirect impacts on wildlife, including mitigation for noise and light impacts, will be addressed at the project-specific CEQA level. These include specific requirements, including prohibiting night-time trail use, use of shielded and dimmed lighting and non-reflective surfaces near wildlife corridors, and installing physical barriers to limit encroachment by humans and noise pollution on wildlife corridors.

In addition, please see response to comment USFWS 38-7, which further describes how the EIR addresses impacts on wildlife movement corridors.

8-11 In addition, Mitigation Measure BIO-3 should include banning the use of anticoagulant rodenticides, at least in areas near open space and identified connectivity areas. Secondary poisoning has been documented in many non-target animals, especially predators (e.g., coyotes (Riley et al., 2003), bobcats (Riley et al., 2007; L E K Serieys et al., 2015; Laurel E.K. Serieys et al., 2021), San Joaquin kit fox (McMillin et al., 2008), California fishers (Gabriel et al., 2012), raptors (Lima & Salmon, 2010), and many more). And a recent study found that rodenticides contributed to reduced functional connectivity in an already constrained landscape (Laurel E.K. Serieys et al., 2021). Therefore, to reduce edge effects of roads and development on wildlife and wildlife movement, the use of anticoagulant rodenticides should be restricted.

The Center appreciates SANDAG's efforts and vision towards wildlife-friendly growth, but more can be done to protect biodiversity and ensure public safety. Here the Center aims to provide just a few examples of how the mitigation measures provided in the DEIR could be more robust and effective at minimizing impacts to sensitive and special-status species, designated critical habitat, and wildlife connectivity. But these recommendations are not comprehensive, and further assessments and analyses should be conducted by SANDAG to improve the Plan and the DEIR to adequately disclose, assess, and mitigate impacts to wildlife connectivity due to the proposed Plan.

#### 8-12 E. Conclusion

Thank you for the opportunity to submit comments on the DEIR and the 2021 Regional Plan. We look forward to working with SANDAG to foster land use policy and growth patterns that promote the preservation and enhancement of wildlife movement and habitat connectivity, facilitate public health and safety, and move towards the State's biodiversity conservation and climate change goals. Please add the Center to your notice list for all future updates to the Plan and do not hesitate to contact the Center with any questions at the emails listed below.

Sincerely,



Tiffany Yap, DEnv/PhD  
Senior Scientist, Wildlife Connectivity  
Advocate  
1212 Broadway, Suite #800  
Oakland, CA 94612  
[tyap@biologicaldiversity.org](mailto:tyap@biologicaldiversity.org)



Elizabeth Reid-Wainscoat,  
Campaigner, Urban Wildlands  
660 S. Figueroa Street #1000  
Los Angeles, CA 90017  
[ereidwainscoat@biologicaldiversity.org](mailto:ereidwainscoat@biologicaldiversity.org)

### RESPONSE TO COMMENT 8-12

lease see Chapter 4, *Environmental Impact Analysis Approach*, for more discussion regarding SANDAG's approach to proposed mitigation measures. In addition, specific text has been added to mitigation measure BIO-3, including the following:

Conduct wildlife movement studies and Before-After-Control-Impact-Studies (BACI) where data are lacking, identify corridor widths and wildlife crossing structures, and consider balancing conservation and recreation (Mitrovich et al. 2020) in project design. Include adaptive management and monitoring measures in the CEQA review, mitigation measures and project design.

- Where feasible, site linear projects, including pedestrian trails, away from wildlife corridors and conserved lands or NCCP lands.
- Where feasible, prohibit night-time trail use, enforce seasonal trail closure, and plan access points and infrastructure carefully to minimize the effects on biological resources and wildlife corridors.
- As feasible, within 200 feet of a wildlife corridor, use non-reflective glass or glass treated with non-reflective coating for all exterior windows and building surfaces.
- Incorporate dimmed, shielded and directed lighting in areas near corridors that only illuminate the project site; consider high pressure sodium or cut-off fixtures as feasible, and provide vegetative screening to reduce light pollution on corridors.
- Include permanent noise barriers and sound-attenuating features as part of the project design, and incorporate temporary noise barriers and noise-reduction devices on equipment during construction; require the use of hydraulically or electrically powered tools, as feasible. Barriers could be in the form of outdoor barriers, sound walls, buildings, or earth berms to attenuate noise at adjacent sensitive uses.
- Install physical barriers (e.g., wildlife fencing) that prevent human and/or domestic predator entry into the corridor and, if appropriate, limit the amount of noise and lighting that enters the corridor. Use techniques such as grade separation, buffer zones, landscaped berms.

- dense plantings, sound walls, reduced-noise paving materials (i.e. rubberized asphalt), and traffic calming measures.
- Minimize the number of road crossings through identified wildlife corridors.
    - Incorporate the appropriate wildlife crossing infrastructure into project design. Wildlife crossing infrastructure shall be designed following the latest scientific information, and should include upgrading existing culverts to facilitate functional wildlife movement, installing crossing and directional fencing at roadkill hotspots, install wildlife bridges or undercrossing, and manage in perpetuity both sides of the wildlife crossings. Construct or retrofit with features such as open span bridges instead of closed culverts to allow for wildlife movement under linear transportation corridors.
    - If the construction of or retrofitting with wildlife bridges is infeasible, incorporate undercrossings and/or other crossing structures that use scientifically accepted openness ratios to allow for continued movement of wildlife where transportation facilities create barriers to wildlife movement and use of nursery sites. Evaluate size-class-specific crossing structures and movement enhancement features (e.g. habitat refugia within structure, soft bottom undercrossings) for each species to ensure that crossings are functional for movement. Additionally, within aquatic habitat impacting fish corridors for species such as southern steelhead, create passable aquatic barriers for migratory fish species in order to provide fish access to spawning and rearing habitats.
    - Maintain undercrossings and/or other crossing structures as needed to ensure wildlife movement. Prepare a fencing and wildlife crossing structure maintenance plan for projects with edge effects to maintain permeability for wildlife across corridors.
    - Install directional fencing, where appropriate, to reduce vehicle mortality and guide wildlife to proposed bridges, undercrossings, and/or other crossing structures. Where fencing stops, extend the fence and angle it away from the roadways to deter wildlife from being funneled to roadways. Because it is not possible to install a continuous fence, use one-way gates or jump-outs so animals that do get around fence end runs can safely exit roadways.

Furthermore, additional language was added to ban anticoagulant rodenticides as follows:

Pursuant to the California Ecosystems Protection Act (AB 1788), ban the use of anticoagulant rodenticides near open space, conserved lands and areas identified as core, linkages, wildlife corridors or other connectivity areas. The use of anticoagulant rodenticides causes secondary poisoning in predators and may contribute to reduced functional connectivity in an already constrained landscape.

The EIR prepared for the proposed Plan is a first-tier Program EIR. Second-tier projects that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. The lead agency may identify additional mitigation measures as applicable for implementation at that time.

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## RESPONSE TO COMMENT 8-13

SANDAG appreciates the depth of resources provided for consideration and they have been reviewed accordingly. No responses to the attachments specifically have been included because they do not contain comments specific to the EIR and/or proposed Plan. No further response is required.



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**COMMENT LETTER 9: CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE**

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Comment Letter 9



State of California – Natural Resources Agency  
 DEPARTMENT OF FISH AND WILDLIFE  
 South Coast Region  
 3883 Ruffin Road  
 San Diego, CA 92123  
 (858) 467-4201  
[www.wildlife.ca.gov](http://www.wildlife.ca.gov)

GAVIN NEWSOM, Governor  
 CHARLTON H. BONHAM, Director



October 11, 2021

Kirsten Uchitel, Associate Planner  
 SANDAG  
 401 B Street, Suite 800  
 San Diego, CA 92101  
[Kirsten.Uchitel@sandag.org](mailto:Kirsten.Uchitel@sandag.org)

**Subject: San Diego Forward: The 2021 Regional Plan (PLAN); Draft Environmental Report (DEIR); SCH #2010041060**

Dear Ms. Uchitel:

The California Department of Fish and Wildlife (CDFW) has reviewed the San Diego Association of Governments' (SANDAG) DEIR for the Plan pursuant the California Environmental Quality Act (CEQA) and CEQA Guidelines.<sup>1</sup>

Thank you for the opportunity to provide comments and recommendations regarding those activities involved in the Project that may affect California fish and wildlife. Likewise, we appreciate the opportunity to provide comments regarding those aspects of the Project that CDFW, by law, may be required to carry out or approve through the exercise of its own regulatory authority under the Fish and Game Code.

**CDFW ROLE**

9-1 CDFW is California's **Trustee Agency** for fish and wildlife resources and holds those resources in trust by statute for all the people of the state. (Fish & G. Code, §§ 711.7, subd. (a) & 1802; Pub. Resources Code, § 21070; CEQA Guidelines § 15386, subd. (a).) CDFW, in its trustee capacity, has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species. (*Id.*, § 1802.) Similarly, for purposes of CEQA, CDFW is charged by law to provide, as available, biological expertise during public agency environmental review efforts, focusing specifically on projects and related activities that have the potential to adversely affect fish and wildlife resources.

CDFW is also submitting comments as a **Responsible Agency** under CEQA. (Pub. Resources Code, § 21069; CEQA Guidelines, § 15381.) CDFW may also need to exercise regulatory authority as provided by the Fish and Game Code. As proposed, for example, projects tiering off the Plan may be subject to CDFW's lake and streambed alteration regulatory authority. (Fish & G. Code, § 1600 *et seq.*) Likewise, to the extent implementation of projects as proposed under the Plan may result in "take" as defined by State law of any species protected under the California Endangered Species Act (CESA) (Fish & G. Code, § 2050 *et seq.*), the project proponent may seek related take authorization as provided by the Fish and Game Code.

<sup>1</sup> CEQA is codified in the California Public Resources Code in section 21000 *et seq.* The "CEQA Guidelines" are found in Title 14 of the California Code of Regulations, commencing with section 15000.

**RESPONSE TO COMMENT 9-1**

Thank you for CDFW's participation in the environmental review process and the identification of your organization's role and objectives. Further elaboration regarding your organization's comments is addressed in the responses below.

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CDFW also administers the Natural Community Conservation Planning (NCCP) program. The area encompassed by the Plan is located within planning areas for several NCCP plans within San Diego County (County), including the adopted Multiple Species Conservation Program (MSCP) and Multiple Habitat Conservation Program (MHCP), as well as the draft North County (NC) MSCP and East County (EC) MSCP.

**PROJECT DESCRIPTION SUMMARY**

**Proponent:** San Diego Association of Governments (SANDAG)

**Objective:** The Plan is an update to San Diego Forward: The 2015 Regional Plan adopted in October 2015, and the 2019 Federal Regional Transportation Plan, adopted in October 2019. The DEIR analyzes the significant environmental impacts of the proposed 2021 Plan, which focuses on developing an integrated planning strategy for achieving sustainability in the areas of land use decisions, housing development, and planned transportation for the San Diego region through 2050. The planning strategies also focus on coordinating and managing the region's transportation networks, services and program, along with emphasizing the role of public transit in the process. Regional transportation challenges addressed in the Plan include economic and social inequities, climate change, public health, and safety. The Plan creates an integrated transportation system throughout the 11 Major Travel Corridors of the San Diego region, specifically: South Bay to Sorrento; Central Mobility Hub; State Route 125 (SR 125); Interstate 15 (I-15); Interstate 5 (I-5) North Coast Corridor; State Route 94 (SR 94); Interstate 8 (I-8), Coast, Canyons, and Trails; State Route 56 (SR 56); San Vicente; and North County.

The DEIR functions as a Programmatic EIR under CEQA Guidelines Section 15168 for streamlining future projects. The DEIR provides a foundation for second-tier CEQA documents for subsequent projects, but does not analyze the project-specific impacts of individual projects.

The planning horizon of the proposed Plan is 2050. The programmatic and long-term nature of the proposed Plan necessitates a general and at times qualitative approach to the evaluation of impacts. The DEIR analyzes impacts for the two main physical components of the proposed Plan, as well as the combined impacts of these components: regional growth and land use change, and transportation network improvements and programs. SANDAG is required to update the Plan every 4 years, in collaboration with the 18 cities and the County, along with regional, state, and federal partners.

**Location:** The Plan encompasses the entirety of San Diego County, which is more than 4,200 square miles in area. Most of the urban development lies in the western portion of San Diego County near the coast. Development inland in the eastern portion of the region is less dense and has a more rural character. The boundaries of the Plan include the cities of Carlsbad, Chula Vista, Coronado, Del Mar, El Cajon, Encinitas, Escondido, Imperial Beach, La Mesa, Lemon Grove, National City, Oceanside, Poway, San Diego, San Marcos, Santee, Solana Beach, Vista, and unincorporated areas within the County. Over half of the total land area in the region is not available for public development, including public lands, dedicated parks and open space, lands constrained for environmental reasons, and military use.

**Biological Setting:** The DEIR identifies 17 vegetation types in three categories in the San Diego Region: Wetlands and Riparian (Beach/Coastal Dunes/Saltpan/Mudflats, Marsh, Meadows and Seeps, Open Water and Streams, Riparian Forest/Woodland, Riparian Scrub, Vernal Pools), Uplands (Chaparral, Coastal Scrub, Desert Dunes, Desert Scrub, Oak Woodlands,

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Forest/Woodland, Grasslands), and Other Cover Types (Agriculture, Disturbed Habitat, Urban/Developed). As indicated in the DEIR, 34 federally or state-listed or candidate plant species and approximately 244 additional special-status plant species have known distributions within the County. Twenty-nine (29) federally and/or state-listed or candidate animal species have potential to be found within the County, as year-round residents or as migrants. An additional 138 special-status wildlife species have known distributions within the County.

Wildlife movement occurs along landscape features (e.g., wildlife corridors, habitat linkages) within the boundaries of the Plan. The various County NCCP plans, both adopted and still in draft, identify landscape-level biological linkages that serve to connect large tracts of core habitat. These linkages allow species movement over time between habitat patches that would otherwise be disconnected. Wildlife corridors contribute to population viability by assuring genetic exchange between populations, providing access to adjacent habitat areas for foraging and mating, allowing for a greater carrying capacity, and providing routes for colonization of habitat lands following local population extinctions or habitat recovery from ecological catastrophes, such as wildfires. Corridors also allow species to adapt to climate change because many habitats could lose their original value as the climate changes and force species range shifts into more hospitable areas or climates. The DEIR focuses on the qualitative and quantitative analysis of landscape level regional wildlife movement and habitat linkages rather than specific local corridors (e.g., small canyons, ephemeral drainages); the latter would be evaluated individually during project-level CEQA review.

9-1  
 cont.

The Biological Resources section of the DEIR projects significant and unavoidable impacts in 2025, 2035, and 2050 to natural resources from projects tiering from the Plan.

BIO-1 projects significant and unavoidable impacts to sensitive natural communities identified in local or regional plans, policies, regulations, or by CDFW or USFWS and state or federally regulated waters and wetlands through direct removal, filling, hydrological interruption, or other means. BIO-1 mitigation measures include: design, minimization, and avoidance measures for Sensitive Natural Vegetation Communities and Regulated Aquatic Resources; provision of compensatory mitigation; preparation of a Habitat Restoration Plan; preparation of Habitat/Long-Term Management Plans; and implementation of Best Management Practices (BMPs) to avoid indirect impacts.

BIO-2 projects significant and unavoidable direct and indirect impacts to certain species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or listed by CDFW or USFWS, including their federally designated critical habitat, or species that are considered sensitive in CEQA Guidelines Section 15380. BIO-2 mitigation measures include: design, minimization, and avoidance measures for Special Status animal species; provision of compensatory mitigation for Special Status plant and animal species; preparation of a Habitat Restoration Plan; preparation of Habitat/Long-Term Management Plans; and implementation of Best Management Practices (BMPs) to avoid indirect impacts.

BIO-3 projects significant and unavoidable impacts to the movement of native resident or migratory fish and wildlife species, to established native resident or migratory wildlife corridors, and to the use of native wildlife nursery sites. Mitigation would involve facilitation of wildlife movement.

BIO-4 projects that no conflicts with any approved HCPs, NCCPs, other conservation plans, and local biological protection policies and ordinances would occur. The DEIR states that



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- 9-1 cont. encroachment into hardline preserve areas would not conflict with HCPs because biologically equivalent or superior compensation of habitat or project redesign would be required when there is encroachment into hardline preserve areas. Thus, BIO-4 projects less than significant impacts. The draft NC and EC MSCPs were not included in this analysis.
- 9-2 CDFW's primary concerns with respect to climate change in San Diego County are the effects on biodiversity, special status plant and wildlife species, natural vegetation communities, and connections which maintain viable movement corridors between blocks of conserved habitat. Because climate change may impact species directly or indirectly by altering the distribution of vegetation types, promoting non-native species, duration and severity of drought, and increased frequency or magnitude of fires, CDFW considers the use of regional scale, multiple species conservation plans to be a valuable tool to guard against the effects of climate change.
- Timeline: The 2021 RP projects impacts forward to 2050. SANDAG is required to update the RP every 4 years.
- COMMENTS AND RECOMMENDATIONS**
- 9-3 It is the policy of the Department to promote and foster the development of planning strategies at the ecosystem level through active participation in local development of regional NCCPs, which often include innovative multiple species habitat conservation planning efforts (e.g., MSCP). The success of these plans is reliant on maintaining core biological resource areas and habitat linkages that are essential to the long-term biological viability of associated flora and fauna. Many of those projects defined within the Plan extend through diverse and biologically valuable habitats, consequently the need for comprehensive planning and creative designs solutions will be essential to ensure goals and objectives articulated in current and draft NCCP/HCP efforts are not undermined. CDFW believes the Plan provides a unique opportunity to develop and refine the SANDAG policies and strategies that could lead to more effective implementation of resource conservation and species protection. This includes compliance with State and Federal endangered species acts, approved NCCP/HCPs (e.g., County of San Diego's and City of San Diego's approved MSCP and several others) and the in-process NC and EC MSCPs. Our comments below are intended to complement existing work to date and provide guidance to reduce the potential for any subsequent conflict that could occur between existing and/or future plans, and other regulations for species protection (e.g., MSCP/MHCP, Lake and Streambed Alteration Agreements under Fish and Game Code §1600 et seq., Fish and Game Code §3500, et seq., etc.) that have received, or are anticipated to receive, State and Federal permits.
- CDFW offers the comments and recommendations below to assist SANDAG in adequately identifying and/or mitigating the Plan's significant, or potentially significant, direct and indirect impacts on fish and wildlife (biological) resources. Recommendations may also be included to improve the document.
- 9-4 I. Mitigation Measure or Alternative and Related Impact Shortcoming
- COMMENT #1:** The DEIR does not analyze potential conflicts with draft MSCPs.
- Issue:** The Biological Resources section of the DEIR states that conflicts with unapproved or unadopted plans do not require analysis under CEQA (CEQA Guidelines Section 15125(d)(e)). The NC and EC MSCP plans have not yet been implemented; however, in March 2021, the County of San Diego reinstated the Planning Agreements with the USFWS and CDFW for both draft plans. The County has completed the NC MSCP conservation design and identified

**RESPONSE TO COMMENT 9-2**

SANDAG appreciates CDFW's concerns with respect to climate change and its effects on the region's biodiversity. SANDAG has included a climate Adaptation and Resilience Program in the proposed Plan. In addition, please see Appendix C of the EIR, *Climate Change Projections, Impacts, and Adaptation*, which provides the framework for the exacerbation of climate change effects analyzed in the environmental impact analysis sections of the EIR's Chapter 4.

**RESPONSE TO COMMENT 9-3**

SANDAG appreciates CDFW's intentions to complement existing work and provide guidance to reduce the potential for conflict between existing and future plans and regulations for species protections.

**RESPONSE TO COMMENT 9-4**

This comment expresses concern that the Draft EIR does not analyze potential conflicts with draft MSCPs. Under CEQA and the CEQA Guidelines, only conflicts with adopted HCPs are considered potentially significant. See CEQA Guidelines Appendix G question IVe; see also CEQA Guidelines Section 15125(d)(e)) and *Chaparral Greens v. City of Chula Vista* (1996) 50 Cal.App.4th 1134.

Regarding concern about continuing and funding the development of NCCP/HCP planning efforts, the transportation network and the land use pattern proposed in the SCS does not impact the ability of the local jurisdictions to seek a regional funding source, and, therefore, there is no impact under CEQA and no required mitigation. However, the final Plan has included a commitment to fund habitat conservation, management, and monitoring of the HCPs and regional preserve system under a new funding allocation that when combined with the nature-based climate solutions program and habitat mitigation for transportation projects would total \$3 billion, as described in Appendix A of the proposed Plan. Furthermore, SANDAG has committed to monitor the implementation of the SCS on a two-year cycle pursuant to AB 1730 (Gonzalez 2019).

Please refer to Master Response 1 for additional discussion regarding including a regional habitat conservation fund.

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priority areas for conservation that are being considered in the CEQA analysis of development projects within the NC MSCP planning area. While a planning effort for the eastern portions of the San Diego region was considered by the County of San Diego in 2008, the EC MSCP planning efforts have slowed. However, preliminary conservation design was completed for this area and identified focused areas for conservation that are considered during CEQA analysis as described above for the North County.

**Specific impact:**

**Why impact would occur:** Lack of analysis of future conflicts with the draft NC and EC MSCP plans may inhibit forward planning for preservation, acquisition, management and monitoring of open space and biological resources and funding opportunities for support of these conservation actions.

9-4  
 cont.

**Evidence impact would be significant:** The *TransNet* Extension Ordinance and Expenditure Plan, approved countywide by voters in November 2004, includes an Environmental Mitigation Program (EMP) which is a funding allocation category for the costs to mitigate habitat impacts for regional transportation projects. The EMP is a unique component of the *TransNet* Extension in that it goes beyond traditional mitigation for transportation projects by including a funding allocation for habitat acquisition, management, and monitoring activities as needed to help implement the MSCP and MHCP, including subarea plans issued under these subregional planning efforts. This funding allocation is tied to mitigation requirements and the environmental clearance approval process for proposed transportation projects. Additionally, SANDAG has been discussing funding needs for planning and implementation of regional conservation efforts throughout San Diego County, including the monitoring and management of regional preserves. CDFW strongly supports completion of NCCP/HCP planning efforts, and believes that development of a regional funding source to support implementation of these plans, should be seen as a critical component of the San Diego Forward program.

**Recommended Potentially Feasible Mitigation Measure(s) (Regarding Mitigation Measure or Alternative and Related Impact Shortcoming)**

**Mitigation Measure #1:**

9-5

**To reduce impacts to less than significant:** The proposed Plan covers areas that are critical to the assembly of the County's Multiple Species Conservation Program (MSCP), including NC and EC plans and establishment of Preserve areas. We recommend the DEIR analyze the effects of the proposed Plan on the NC and EC MSCP plans, Preserve assembly, and full implementation of the plans. Any effect (direct or indirect) of the Plan on these draft NCCPs should be evaluated (and mitigated, if necessary). SANDAG staff should coordinate with County staff as well as the U.S. Fish and Wildlife Service and CDFW (jointly, the Wildlife Agencies) to best determine how to evaluate these draft NCCPs in the Plan and DEIR.

**Additional Recommendations**

**Recommendation #1: Regional Wildlife Movement Corridor Map**

9-6

The Regional Wildlife Movement Corridor Map (Figure 4.4-15, page 361 of the DEIR) as well as corresponding text on page 362 should be expanded to include certain omitted linkages prior to publication of the final EIR. Connectivity throughout the subregional MHCP should be included; for example, connections through Oceanside for coastal California gnatcatcher

**RESPONSE TO COMMENT 9-5**

This comment recommends that the Draft EIR analyze the impact of the proposed Plan on the unadopted, draft versions of the North County and East County MSCP plans. Please see response to comment CDFW 9-4 above and USFWS 38-4.

**RESPONSE TO COMMENT 9-6**

In response to this comment, the MHCP core and linkage areas (BCLA) have been added to Figure 4.4-15. The MHCP core and linkages mapping includes the gnatcatcher stepping stones, based on an analysis specifically conducted for the City of Oceanside to inform the preserve design for the MHCP (Bailey and Mock 1998). Under the discussion of the MHCP, the gnatcatcher stepping stones are discussed; text has been added to clarify that the stepping stone concept was included in the MHCP core and linkage map.

The comment asserts that the linkage along I-15 through North County is not referenced in the text. Mention of the I-15 linkage (Santa Ana – Palomar) is included in the text on pages 4.4-103 and 4.4-115. The I-15 linkage is also included on Figure 4.4-16 as part of the model prepared by Jennings (2020). No GIS data currently exist on the Jacumba-Sierra Juarez linkage to Mexico, but the Jennings (2020) model that is analyzed in the EIR includes the US-side of the linkage. With respect to the Santa Ana–Palomar and Jacumba-Sierra Juarez linkage, please see response to comment USFWS 38-12.

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9-6 cont. (Poliophtia californica californica) should be added to the map. The map is also missing the linkage along the I-15 through North County and there is no reference to it in the text. Additionally, it is not clear if MHPA areas on the map shown near the Border include the north/south connectivity with Mexico near Jacumba for Peninsular Bighorn Sheep (Ovis canadensis nelsoni) and whether this is included in the areas referenced in the text on page 362 under the Las Californias Binational Conservation Initiative section. Last, the DEIR should recognize that additional areas for wildlife movement may be subsequently identified through future studies and/or become necessary as a result of future urbanization/development in the County. Thus projects which tier off the final EIR may need to address wildlife corridor issues beyond just the corridors identified in the DEIR.

**Recommendation #2: Los Angeles–San Diego–San Luis Obispo (LOSSAN) Commuter Rail Corridor Alignment**

9-7 Past impacts to coastal resources by rail projects have been significant, and improvements proposed by the Plan are important elements which address removal of serious impediments to restoration of coastal wetlands, as well as removing rail elements from other sensitive habitats. The DEIR discusses major rail-related transportation network improvements, including continued double-tracking at certain locations on the LOSSAN rail corridor and construction of the Del Mar Tunnel. SANDAG has been considering alternatives that would direct the railroad inland and out of Los Peñasquitos Lagoon. However, Figures 2-32, 2-33, and 2-34 in the DEIR show the alignment of the LOSSAN corridor along the coast. We encourage SANDAG to include the proposed realignments in the DEIR maps and clarify which alignment is included in the quantification of impacts.

**Recommendation #3: 2. New commuter and light rail alignments proposed through the City of San Diego**

9-8 CDFW recommends SANDAG conduct early coordination with the Wildlife Agencies and the City of San Diego to design alignments that avoid sensitive resources and preserved lands.

**Recommendation #4: 3. Proposed upgrade of SPRINTER Rail segments to double tracks**

9-9 The North County Transit District's (NCTD) east-west SPRINTER hybrid rail spans 22 miles and connects Oceanside, Vista, San Marcos, and Escondido, serving 15 stations along the Highway 78 corridor. The addition of a second rail to existing SPRINTER tracks could potentially impact riparian corridors in the cities of Oceanside and Vista. CDFW recommends SANDAG conduct early coordination with the Wildlife Agencies and the cities of Oceanside and Vista to minimize impacts to sensitive resources as feasible.

**ENVIRONMENTAL DATA**

9-10 CEQA requires that information developed in environmental impact reports and negative declarations be incorporated into a data base which may be used to make subsequent or supplemental environmental determinations. (Pub. Resources Code, § 21003, subd. (e).) Accordingly, please report any special status species and natural communities detected during Project surveys to the California Natural Diversity Database (CNDDDB). The CNDDDB field survey form can be found at the following link: [http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/CNDDDB\\_FieldSurveyForm.pdf](http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/CNDDDB_FieldSurveyForm.pdf). The completed form can be mailed electronically to CNDDDB at the following email address: [CNDDDB@wildlife.ca.gov](mailto:CNDDDB@wildlife.ca.gov). The types of information reported to CNDDDB can be found at the following link: [http://www.dfg.ca.gov/biogeodata/cnddb/plants\\_and\\_animals.asp](http://www.dfg.ca.gov/biogeodata/cnddb/plants_and_animals.asp).

**RESPONSE TO COMMENT 9-7**

The EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the plan include site-specific transportation network improvements and development projects. Specific projects under the proposed Plan, including the potential LOSSAN double-tracking alignments and the Del Mar Tunnel would be subject to project-specific environmental review, and the alignment, alternatives, and biological resources analysis will be included in the project-specific environmental review.

**RESPONSE TO COMMENT 9-8**

SANDAG appreciates your input and suggestion. Early coordination with the Wildlife Agencies and the City of San Diego to design alignments that avoid sensitive resources and preserved lands would occur on the project-specific level once a project has been further designed. In response to this comment, the following revision was made to mitigation measure BIO-1a, first bullet point:

- Conduct early coordination with the Wildlife Agencies and the respective local jurisdictions to design alignments that avoid sensitive resources and preserved lands.

**RESPONSE TO COMMENT 9-9**

This comment suggests that SANDAG coordinate with the Wildlife Agencies and cities of Oceanside and Vista to minimize impacts on riparian corridors from the addition of a second rail to the SPRINTER tracks. Language has been added to measure Bio-1a as included under Comment CDFW 9-8.

**RESPONSE TO COMMENT 9-10**

Reporting of special-status species to the CNDDDB would occur for each specific project on a project-specific analysis level. In response to this comment, the following revision was made to mitigation measure BIO-1a, last bullet point:

- Require biological monitoring and regular inspections for construction in the vicinity of and adjacent to sensitive habitats to avoid impacts on these habitats. Report any special-status species and natural communities detected during project surveys to the CNDDDB.

Thank you for your comment, SANDAG appreciates your input.

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SANDAG  
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**FILING FEES**

The Project, as proposed, would have an impact on fish and/or wildlife, and assessment of filing fees is necessary. Fees are payable upon filing of the Notice of Determination by the Lead Agency and serve to help defray the cost of environmental review by CDFW. Payment of the fee is required in order for the underlying project approval to be operative, vested, and final. (Cal. Code Regs, tit. 14, § 753.5; Fish & G. Code, § 711.4; Pub. Resources Code, § 21089.)

9-10


**CONCLUSION**

CDFW appreciates the opportunity to comment on the DEIR to assist SANDAG in identifying and mitigating Project impacts on biological resources.

Questions regarding this letter or further coordination should be directed to Meredith Osborne, Environmental Scientist, at [Meredith.Osborne@wildlife.ca.gov](mailto:Meredith.Osborne@wildlife.ca.gov).

Sincerely,

DocuSigned by



071084520375408

David Mayer  
Environmental Program Manager I  
South Coast Region

cc: CDFW

David Mayer, San Diego – [David.Mayer@wildlife.ca.gov](mailto:David.Mayer@wildlife.ca.gov)  
Jennifer Turner, San Diego – [Jennifer.Turner@wildlife.ca.gov](mailto:Jennifer.Turner@wildlife.ca.gov)  
Meredith Osborne, San Diego – [Meredith.Osborne@wildlife.ca.gov](mailto:Meredith.Osborne@wildlife.ca.gov)  
Cindy Hailey, San Diego – [Cindy.Hailey@wildlife.ca.gov](mailto:Cindy.Hailey@wildlife.ca.gov)  
State Clearinghouse, Office of Planning and Research – [State.Clearinghouse@opr.ca.gov](mailto:State.Clearinghouse@opr.ca.gov)  
Susan Wynn, USFWS – [Susan.Wynn@fws.gov](mailto:Susan.Wynn@fws.gov)

Attachments

- A. CDFW Comments and Recommendations

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Attachment A: CDFW Comments and Recommendations

	Recommendations/Mitigation Measures	Timing	Responsible Party
9-11	Mitigation Measure #1 The DEIR should analyze the effects of the proposed Regional Plan on the draft NC and EC MSCPs, Preserve assembly, and full implementation of the Plan on these draft NCCPs should be evaluated (and mitigated, if necessary). SANDAG staff should coordinate with County staff and the Wildlife Agencies to best determine how to evaluate the NC MSCP and the EC MSCP in the Plan and DEIR.	Prior to release of the final EIR	SANDAG
9-12	Recommendation #1 The Regional Wildlife Movement Corridor Map (Figure 4.4-15, page 361 of the DEIR) as well as corresponding text on page 362 should be expanded to include all omitted linkages, including MHCP connectivity, I-15 linkage through North County, and North/south connectivity with Mexico near Jacumba for Peninsular Bighorn Sheep.	Prior to release of the final EIR	SANDAG
9-13	Recommendation #2 CDFW recommends SANDAG to include proposed realignments of the LOSSAN corridor away from the coast and Los Peñasquitos Lagoon in the DEIR and maps and clarify which alignment is included in the quantification of impacts.	Prior to release of the final EIR	SANDAG
9-14	Recommendation #3 CDFW recommends SANDAG conduct early coordination with the Wildlife Agencies and the City of San Diego to design alignments within the City of San Diego that avoid sensitive resources and preserved lands.	Prior to construction	SANDAG
9-15	Recommendation #4 CDFW recommends SANDAG conduct early coordination with the Wildlife Agencies and the cities of Oceanside and Vista to minimize impacts from addition of a second rail to existing SPRINTER rails to sensitive resources as feasible.	Prior to construction	SANDAG

**RESPONSE TO COMMENT 9-11**

Please see response to comment CDFW 9-4.

**RESPONSE TO COMMENT 9-12**

Please see response to comment CDFW 9-6.

**RESPONSE TO COMMENT 9-13**

Please see response to comment CDFW 9-7.

**RESPONSE TO COMMENT 9-14**

Please see response to comment CDFW 9-8.

**RESPONSE TO COMMENT 9-15**

Please see response to comment CDFW 9-8.



**COMMENT LETTER 10: CALIFORNIA COASTAL COMMISSION**

Comment Letter 10

STATE OF CALIFORNIA - NATURAL RESOURCES AGENCY

GAVIN NEWSOM, Governor

**CALIFORNIA COASTAL COMMISSION**

SOUTH CENTRAL COAST DISTRICT OFFICE  
89 SOUTH CALIFORNIA STREET, SUITE 200  
VENTURA, CA 93001-2801  
VOICE (805) 588-1800  
FAX (805) 641-1732



October 11, 2021

San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92101

**RE: Draft Environmental Impact Report for San Diego Forward – the 2021 Regional Plan**

To Whom It May Concern:

10-1 Thank you for the opportunity to provide comments on the Draft Environmental Impact Report (DEIR) for San Diego Forward, the update of San Diego Association of Governments' (SANDAG) Regional Transportation Plan (RTP). The project is an update of SANDAG's existing RTP which aims to improve the balance between land use and transportation systems, including identifying future land use patterns for the region and policies, programs, actions, and a plan of projects intended to meet regional transportation needs and policy goals.

10-2 Given the California Coastal Commission's mandate to protect coastal resources through planning and regulation of the use of land and water within the Coastal Zone, we request that the Final EIR analyze consistency of the RTP with relevant certified Local Coastal Programs (LCPs), sea level rise (SLR), and possible impacts to coastal resources such as public access. Commission staff would note that these comments are in line with comments provided by staff on previous Notices of Preparation and EIRs for SANDAG RTP updates (e.g., Commission staff comments on the Draft 2021 Regional Plan, submitted August 6, 2021).

10-3 1) **Sea Level Rise.** Coastal Act Section 30253 requires that new development minimize risks to life and property from hazards and to assure stability and structural integrity without the use of a shoreline protective device. Thus, a principal concern of the Coastal Commission is ensuring that new coastal infrastructure, including transportation, housing and jobs investments, is designed to avoid or adapt to the effects of sea level rise for the expected life of the infrastructure, as described in the Commission's Sea Level Rise (SLR) policy guidance<sup>1</sup> as well as through recent Commission actions on key infrastructure projects throughout California. The Commission's Guidance references best available science, including SLR projection tables, from the Ocean Protection Council's (OPC) SLR Guidance (2018).<sup>2</sup> Understanding the potential impacts of climate change and sea level rise is critically important when conducting long-range planning efforts to ensure that housing, jobs,

<sup>1</sup> <https://www.coastal.ca.gov/climate/slrguidance.html>

<sup>2</sup> [https://opc.ca.gov/webmaster/ftp/pdf/agenda\\_items/20180314/Item3\\_Exhibit-A\\_OPC\\_SLR\\_Guidance-rt3.pdf](https://opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rt3.pdf)

**RESPONSE TO COMMENT 10-1**

Thank you for your comments and consideration of the proposed Plan.

**RESPONSE TO COMMENT 10-2**

Consistency of the proposed Plan with relevant Local Coastal Programs was analyzed in Section 4.11, *Land Use*, of the Draft EIR. In addition, sea level rise, including exacerbation of climate change effects, and potential impacts on coastal resources are also addressed throughout the document, including in Section 4.1, *Aesthetics and Visual Resources*; Section 4.4, *Biological Resources*, Section 4.7, *Geology and Soils*, Section 4.10, *Hydrology and Water Quality*, as well as Section 4.11. For more information related to sea level rise, please see responses to comments CCC 10-3 and 10-4, below.

**RESPONSE TO COMMENT 10-3**

It is SANDAG's understanding that the H++ sea level rise scenario is generally used for projects with a lifespan beyond 2050 that have high consequences if damaged (for example, major airports or hazardous waste sites) and little to no adaptive capacity. The EIR did not include the H++ scenario in the climate change appendix due to its unknown probability and the fact that it is more relevant in the second half of the century. Because the EIR time horizon only goes out to 2050, SANDAG did not think the H++ scenario was appropriate to include.

The H++ scenario was not further analyzed due to the evolving nature of the science and the significant uncertainty associated with that scenario. In 2019, new science was published that reduces the likelihood of the H++ scenario (Edwards, T.L., M.A. Brandon, G. Durand, N.R. Edwards, N.R. Gолledge, P.B. Holden, I.J. Nias, A.J. Payne, C. Ritz, and A. Wernecke. 2019. Revisiting Antarctic Ice Loss Due to Marine Ice-Cliff Instability. *Nature* 566:58–64, doi:10.1038/s41586-019-0901-4).

10-3 cont. and transportation infrastructure are not located in areas that will be at risk from coastal hazards.

Given the proximity of essential regional infrastructure to the coast of San Diego County, particularly highways and railways, the RTP should carefully evaluate the vulnerability of existing and proposed transportation infrastructure and housing/jobs investments to the effects of sea level rise and associated hazards for the expected life of those investments. Potential impacts should include modeling of both tidal and fluvial flooding across the range of projected increases in global mean sea level (including under the medium-high and extreme risk aversion scenarios) as applied to the local area (e.g., San Diego County's open coast), combined with potential impacts from storm surge, wave run-up, and coastal erosion. While Commission staff appreciate the incorporation of SLR impacts on natural resources throughout the DEIR, the report references only the 'most-likely' scenario predicted in OPC's SLR Guidance (2018). OPC, however, recommends using the H++ scenario to plan for SLR, which references 2.7 ft. of SLR by 2050 and 10.2 ft. of SLR by 2100, as opposed to the 1.2 ft. and 4.6 ft. of SLR referenced in the DEIR. Therefore, Commission staff request that the impacts to infrastructure under an H++ scenario be analyzed alongside the most-likely scenario.

10-4 If the RTP recommends infrastructure improvements that are likely to be temporarily flooded or perpetually inundated in the next 75 to 100 years, then the RTP and the DEIR for the plan update should describe and analyze potential adaptation measures that would minimize adverse impacts to coastal resources and enhance public access to the coast. For example, if the proposed infrastructure investments are proposed to be protected from coastal hazards with shoreline armoring devices, such as seawalls and revetments, which adversely affect public access because they block access to the beach and result in the loss of public recreational areas, then the DEIR should analyze a) alternative infrastructure projects that would minimize the need for shoreline armoring, b) alternative adaptation strategies for protecting the proposed infrastructure from coastal hazards, and/or c) include options for relocation of existing or proposed infrastructure segments away from hazardous conditions.

10-5 2) **Selection of Project Alternative.** Commission staff would like to express their preference for Project Alternative 3, specifically because it is the only alternative that advances a free public transit policy by 2035. However, the Coastal Act was recently amended to add Environmental Justice as a policy to be analyzed in our regulatory work, and to add a designated Environmental Justice commissioner on the Coastal Commission. Accordingly, although we applaud the Regional Plan's focus on equity and recognize the need to generate revenue for implementation, Commission staff urge SANDAG conduct a thorough equity analysis to demonstrate that the free transit policy will be significant enough to offset the mobility impacts (specifically with respect to coastal access) to disadvantaged communities caused by proposed dynamic pricing on roadways and parking, consistent with Coastal Act Sections 30013, 30210, 30212, and 30252.

10-6 Please note that the comments provided herein are preliminary in nature and Coastal Commission staff may have additional comments as the project develops. Coastal Commission staff requests notification of any future activity associated with this project or

**RESPONSE TO COMMENT 10-4**

The effects of sea level rise on each individual environmental topic studied in the EIR is included in Sections 4.1 through 4.19 as well as in Appendix C of the EIR. In addition, Table C-2 in Appendix C of the EIR identifies all of the EIR resource topic sections that incorporate the effects of climate change-caused sea level rise. Appendix C also provides a description of scientific studies related to sea level rise in California and the San Diego region, including the California Coastal Commission's Sea Level Rise Policy Guidance and 2017 Draft Residential Adaptation Policy Guidance documents. As acknowledged in the EIR, particularly in Section 4.10, *Hydrology and Water Quality*, project footprints that lie in low elevations directly adjacent to the coast and within 100-year flood hazard areas would be susceptible to flooding and the effects of sea level rise. Tables 4.10-10 through 4.10-12 in the EIR show transportation network improvements in the 100-year floodplain. Design practices employed in accordance with the local HMP; Caltrans standards; and other related regulations and programs, including FHWA, FTA, and Caltrans policies on adapting to climate change, sea-level rise, and flooding, would be required. Compliance with applicable regulatory requirements and implementation of design measures, safety ordinances, and water quality requirements described above and in Section 4.10.2 would ensure that regional growth and land use changes as well as transportation network improvements would minimize impacts related to flooding. In addition, proposed improvements within coastal zones will undergo separate CEQA analysis, at which time, additional potential adaptation measures may be developed in conjunction with applicable resource agencies, including the California Coastal Commission.

Furthermore, the EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan, including infrastructure investments within the coastal zone, would be subject to project-specific environmental review. During project-specific environmental review, alternatives to specific infrastructure projects would be identified to minimize the significant impacts of the project, including any potential need for shoreline



armoring, alternative adaptation strategies to protect the project from coastal hazards, and/or alternate locations.

**RESPONSE TO COMMENT 10-5**

SANDAG acknowledges the Coastal Commission's support for Project Alternative 3 and the free public transit policy. The proposed Plan provides a framework for meeting its stated goals with coordinated land use and transportation planning strategies. Implementation actions related to projects, policies, and programs will confirm SANDAG's commitment to fully realizing the strategies in the proposed Plan. As described in Chapter 2.0, *Project Description*, of the EIR, as an implementation action SANDAG will evaluate the transition to free public transit and develop a Value Pricing and Fee Implementation Strategy. As part of the implementation process, SANDAG will be conducting ongoing analyses to assess mobility and transit improvements, including those related to improving access for disadvantaged communities. For example, SANDAG is currently working with the Social Equity Working Group to develop near-term solutions to address transit service improvements, amenities, and subsidized transit fares. Appendix U, *Cost Estimation Methodology*, Table U.2, in the proposed Plan, captures the transit fare subsidies to riders throughout FY2026–FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U of the proposed Plan.

**RESPONSE TO COMMENT 10-6**

It is noted that the comments provided are preliminary and that they do not represent the opinion of the Coastal Commission itself but rather Coastal Commission staff. Thank you for your comments and consideration of the proposed Plan.

10-6  
cont.

related projects. Additionally, the comments contained herein are those of Coastal Commission staff only and should not be construed as representing the opinion of the Coastal Commission itself. Thank you for the opportunity to comment on the DEIR.

Sincerely,

Trevor Hill  
Transportation Program Analyst

Cc:  
Tami Grove, Statewide Development and Transportation Program Manager, CCC  
Shannon Fiala, Southern California Transportation Program Manager, CCC  
Karl Schwing, District Director, San Diego Coast District, CCC  
Diana Lily, District Manager, San Diego Coast District, CCC  
Deborah Lee, District Manager, San Diego Coast District, CCC  
Kanani Leslie, Coastal Program Manager, San Diego Coast District, CCC

**COMMENT LETTER 11: CITY OF CORONADO**

Comment Letter 11



1825 STRAND WAY · CORONADO, CA 92118 · TEL (619) 522-7335 · FAX (619) 522-7846

October 6, 2021

**Subject:** Comments on the Draft EIR for the San Diego Forward: 2021 Regional Plan

Dear SANDAG staff:

Thank you for the opportunity to review the Draft Environmental Impact Report (EIR) for the San Diego Forward: 2021 Regional Plan (Regional Plan). While the City of Coronado (City) is generally supportive of the 2021 Regional Plan, there are several areas of concern, including the inclusion of a mobility hub in the Orange Avenue Business District / Village area, and the potential consequences of such designation including further increases in housing, and the assumption of new mixed use areas in the City. These main concerns were summarized in the City's July 21, 2021 letter (Attachment) and remain unresolved.

The Regional Plan introduces the concept of a Mobility Hub, which would call for facilities for "Flexible Fleets" and "Transit Leaps," such as ride hailing zones, electric vehicle charging stations, micro-mobility parking areas, parcel delivery lockers, and sidewalk delivery bots and the use of drone technology. These facilities, as well as mixed use or residential uses which are also anticipated in the Regional Plan, are currently not allowed uses within the Commercial zone of Coronado. Implementation of these would require significant time and resources to update the City's General Plan, Zoning Ordinance, and Local Coastal Program.

Objective No. 1. of the Regional Plan, found on page ES.1 of the EIR, calls to "[f]ocus population and employment growth in mobility hubs and existing urban areas to protect sensitive habitat and natural resource areas." This is of great concern for the City of Coronado as it has approximately 24,000 residents and a compact, fully developed village area covering about two square miles surrounded by the San Diego Bay and the Pacific Ocean. The City is highly constrained and has limited additional development capacity due to the multiple other jurisdictions that control land within Coronado, as well as the Naval Air Station North Island Airport Land Use Compatibility Plan (NASNI ALUCP) overlay. Designating a mobility hub in Coronado will undoubtedly lead to expectations of future growth in Coronado, contrary to the statement on page 4.14-16 that SANDAG has no control over the amount or exact location of growth in implementing the Regional Plan. By designating an area as a mobility hub, SANDAG is dictating where future growth would occur.

11-1

11/9/21

**RESPONSE TO COMMENT 11-1**

Not all Mobility Hub areas are created equal. Coastal Mobility Hubs are envisioned to rely upon some transit services supported by an array of on-demand Flexible Fleets to help people complete short trips in and around the hub without needing to rely on a car. The suite of Flexible Fleets and supporting Mobility Hub amenities as included in the Final EIR can be tailored to meet the needs of people traveling to and within Coronado. SANDAG staff will continue to coordinate with Coronado on planning for appropriate Mobility Hub services, amenities, and supporting technology for this community.

Consistency of the proposed Plan with relevant general plans and LCPs is analyzed in Section 4.11, *Land Use*, of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions' general plans, LCPs, or other local planning documents. Consistency of individual second-tier projects with these policies would be considered during project-specific CEQA reviews.

Government Code Section 65080(b)(2)(B) provides that an SCS "use most recent planning assumptions considering local general plans and other factors." It also requires that the SCS "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board." The SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the proposed Plan. As the comment notes, the SCS land use pattern focuses growth and development in the Mobility Hub areas.

Coronado is a major destination due to the presence of one of the region's top military bases. Additionally, people commuting to hospitality, retail, and dining jobs is a daily occurrence, and the community serves as one of the region's top tourism destinations for visitors from both outside and within San Diego County. These trip-

inducing factors contribute to the area's high propensity for regional Mobility Hub designation.

The 6<sup>th</sup> Cycle RHNA Plan, adopted by the Board of Directors and approved by the California Department of Housing and Community Development, includes a methodology that allocates housing throughout the region near jobs and transit. Consistent with State law, the RHNA process occurs about every 8 years. During the next RHNA process, the Board of Directors will again consider a methodology for allocating housing throughout the region, which may be different from the 6th Cycle methodology. The SCS land use pattern assumes mixed-use development to accommodate future growth and development in the Mobility Hub areas. While this is a strategy to increase housing affordability and reduce VMT, land use authority is reserved for local jurisdictions, and implementation of the land use pattern is to be refined through coordinated planning with the jurisdiction(s).

With respect to Figures 2-35 and 2-14, each shows generalized Mobility Hub boundaries for planning purposes and is not intended to be binding or precise. Mobility hub boundaries are subject to refinement in close coordination/planning with the affected jurisdiction(s). While Naval Air Station North Island is not located within the Mobility Hub area identified in Figures 2-35 and 2-14, it is a major regional employer. As described above, this is one of many trip-inducing factors contributing to the area's high propensity for regional Mobility Hub designation.

11-1  
cont.

The City of Coronado is concerned that a mobility hub within its jurisdiction would lead to a higher assigned Regional Housing Need Allocations (RHNA) from SANDAG in future Housing Element Update cycles. For the 6<sup>th</sup> Housing Element Update cycle, SANDAG based each jurisdiction's RHNA solely on the number of jobs and transit stops within the jurisdiction and included adjacent military jobs that had previously never been assigned to individual cities, resulting in a 1,800% increase in RHNA between the 5<sup>th</sup> and 6<sup>th</sup> Cycles. With the plan objective to focus on population and job growth within mobility hubs, the City believes the designation of a mobility hub in Coronado will lead to significant future impacts, including increases in the RHNA assigned to the City by SANDAG to which the City is vehemently opposed. Additionally, the City would oppose Alternative 3 outlined in the EIR, which would focus all growth within mobility hubs, for the same reasons.

When reviewing figures 2-35 and 2-14 that show proposed mobility hub locations as well as employment density for 2025 it does not appear that the significant employer/jobs are located within Coronado where the mobility hub is proposed, but rather on Naval Air Station North Island (NASNI). The Coronado village area is not a significant job center for the region, is constrained by existing development and the NASNI ALCUP, and has a general lack of vacant sites.

11-2

Additional intensified future growth could lead to many issues and create impacts within Coronado such as on the City's infrastructure, including sewer services, recreation facilities, and parks. Additionally, Coronado has just two access points into and out of the city: the San Diego-Coronado Bay Bridge and SR-75 Silver Strand, which is a Designated Scenic Highway as well as a STRAHNET Connector that is part of the National Strategic Highway Corridor Network for defense purposes. It is not prudent to place additional future growth on a constrained community that lacks adequate roadways that do not have feasible expansion opportunities and are designated as a strategic highway for defense purposes. Coronado requests that SANDAG conduct further analysis on potential impacts to the San Diego – Coronado Bay Bridge as well as the Silver Strand State Highway as a result of the Regional Plan.

The City also has the following comments:

11-3

- Page 4.18-2, related to water supply, includes a discussion on the various ways that water is provided to the region and states that "Coronado and Imperial Beach are not within SDCWA's service area" which is true. However, the EIR fails to analyze the water supply and demand for both Coronado and Imperial Beach, both of which are served by California American Water, and the potential impacts the Regional Plan would have on this water source.

11-4

- Table 4.8-5, found on page 4.8-18 of the Regional Plan, includes the status of each jurisdiction's efforts related to Climate Action Plans (CAP). The City of Coronado asks that a footnote be added to the table for Coronado, similar to footnote 2 for the City of Vista, noting that the City of Coronado published a public draft of a CAP update in 2021 that has not yet been adopted. On September 7, 2021, the City Council authorized the release of a public review draft CAP.

11-5

- Figure 2-27 on page 2-46 shows the 2025 regional bike network but omits a portion of the existing Bayshore Bikeway along Glorietta Boulevard. The Bayshore

**RESPONSE TO COMMENT 11-2**

he degree of specificity required in an EIR corresponds to the degree of specificity involved in the underlying activity (CEQA Guidelines Section 15146). As a programmatic document encompassing the entire region, the proposed Plan and its EIR do not analyze project-specific impacts on City sewer services, recreation facilities, and parks. These would be analyzed at the development project level. This comment also inaccurately suggests that future growth necessitates roadway expansion to increase capacity. SB 743 directed OPR to identify appropriate criteria for the evaluation of transportation impacts in CEQA Guidelines amendments, and provided that once these amendments are adopted, automobile delay, as measured by "level of service" and other similar metrics, no longer constitutes a significant environmental effect under CEQA. OPR selected VMT as the preferred transportation impact metric and applied its discretion to require its use statewide for land use projects and to recommend its use for transportation projects. Transportation impacts for future development projects would be evaluated at the project level consistent with SB 743 and the CEQA Guidelines.

In the proposed Plan, Transit Leap includes a new Rapid bus service from Coronado to Downtown San Diego (Rapid 910) via the San Diego-Coronado Bay Bridge and San Diego-Coronado-Military ferry service that will provide alternatives to driving alone.

**RESPONSE TO COMMENT 11-3**

Coronado and Imperial Beach are not within the SDCWA service area. They are served by California American Water. However, as is detailed in California American Water's Typical Water Quality Summary (<https://www.amwater.com/caaw/water-quality/water-quality-reports/coronado>), "The Coronado water system is served entirely by treated surface water purchased from the City of San Diego. The City of San Diego obtains its raw surface water supplies from local reservoirs and the San Diego County Water Authority. The San Diego County Water Authority obtains its supply from the Metropolitan Water District of Southern California (MWD) and transfers from other water agencies." The regional water supply discussed in the EIR includes all water obtained from MWD or other sources and imported into the County by the SDCWA. It also includes any surface water captured in reservoirs owned by the City of San Diego. The water supplies purchased by the cities of Coronado and Imperial Beach, therefore, are included in the

regional supplies discussed in the EIR. The conclusions regarding the adequacy of regional supplies would apply to the water supplies of these two cities. Wording in the EIR has been changed to clarify that, while the two cities are not within the SDCWA service area, their water supply, obtained via the City of San Diego, is part of the regional supply included in the analysis.

#### **RESPONSE TO COMMENT 11-4**

This comment notes that the City Council authorized the release of a public draft CAP on September 7, 2021, and requests that this information be included in Table 4-8.5 of the Draft EIR (page 4.8-18).

The Draft EIR was published for public review on August 27, 2021, before the City's public draft CAP was authorized for release. In response to this request, SANDAG has revised Table 4.8-5 in the Final EIR to include a footnote explaining that the City has published a public draft CAP and does not have an adopted CAP.

**Table 4.8-5**  
**Summary of Local Plans to Reduce GHG Emissions (as of**  
**November~~June~~ 2021)**

<b>Jurisdiction</b>	<b>Document Title</b>	<b>Adopted (year)</b>	<b>New Plan or Update In Progress?</b>	<b>CEQA Qualified Plan?<sup>1</sup></b>
Carlsbad	Climate Action Plan	2020	No	Yes
Chula Vista	Climate Action Plan	2017	No	No
Coronado	Climate Action Plan	n/a	Yes <sup>2</sup>	n/a
Del Mar	Climate Action Plan	2016	No	No
El Cajon	El Cajon Sustainability Initiative: Policies to Reduce Greenhouse Gas Emissions	2020	No	No
Encinitas	Climate Action Plan	2020	No	Yes
Escondido	Climate Action Plan	2021	No	Yes
Imperial Beach	Resilient Imperial Beach: Climate Action Plan	2019	No	No
La Mesa	Climate Action Plan	2018	No	Yes

Lemon Grove	Climate Action Plan	2020	No	No
National City	Climate Action Plan	2011	No	Yes
Oceanside	Climate Action Plan	2019	No	No
Poway	None	n/a	No	n/a
San Diego (City)	Climate Action Plan	2015	Yes	Yes
San Diego (County)	Climate Action Plan	n/a	Yes	n/a
San Diego (Port)	Climate Action Plan	2013	No	Yes
San Diego County Regional Airport Authority	Sustainability Management Program	2020	No	No
San Marcos	Climate Action Plan	2020	No	Yes
Santee	Sustainable Santee Plan	2019	No	Yes
Solana Beach	Climate Action Plan	2017	No	No
Vista	Climate Action Plan	2012	Yes <sup>32</sup>	Yes

Sources: City of Carlsbad 2020, City of Chula Vista 2017, City of Coronado 2021, City of Del Mar 2016, City of El Cajon 2020, City of Encinitas 2020, City of Escondido 2021, City of Imperial Beach 2019, City of La Mesa 2018, City of Lemon Grove 2020, National City 2011, City of Oceanside 2019, City of Poway 2009, City of San Diego 2015, Port of San Diego 2013, San Diego County Regional Airport Authority 2020, City of San Marcos 2020, City of Santee 2019, City of Solana Beach 2017, and City of Vista 2021.

<sup>1</sup> CEQA Qualified Plan = a plan for the reduction of GHG emissions that includes the elements listed in CEQA Guidelines Section 15183.5(b)(1) (as determined by the agency adopting the plan).

<sup>2</sup> The City of Coronado authorized the release of a public draft Climate Action Plan (CAP) on September 7, 2021.

<sup>32</sup> The City of Vista published a public draft of a CAP update in 2021 that has not been adopted as of August 6, 2021.

**RESPONSE TO COMMENT 11-5**

For a more detailed response related to this comment, please refer to response L83 in Appendix P.2.



11-5 cont. Bikeway within Coronado is accurately depicted in the figure for the 2035 and 2050 regional bike networks. Coronado asks that Figure 2-27 be updated to reflect the current Bayshore Bikeway.

11-6


- Figure 4.11-1 on page 4.11-2 shows the 2016 Land Use Map for the region. When looking at residential designations in Coronado it appears as mostly single family residential, but lacks much of the existing multi-family residential zoned properties generally between Fourth and Tenth Streets and should be updated to reflect these conditions.

11-7

As stated earlier, Coronado appreciates SANDAG's ambitious plan to improve the San Diego region's mobility options, reduce greenhouse gas emissions, address traffic congestion, advance technology related to transportation services, and improve regional transportation infrastructure. Coronado, however, is concerned with the potential growth intensification the Regional Plan would have on this small, compact community with constrained and burdened transportation corridors and infrastructure. Coronado requests that the Regional Plan remove the mobility hub identified in Coronado and address the other comments in this letter.

Once again, thank you for the opportunity to comment on the 2021 Regional Plan. We look forward to seeing an amended plan in the future.

Respectfully submitted,



Tina Friend  
City Manager

Cc: City Councilmembers for the City of Coronado

**RESPONSE TO COMMENT 11-6**

The 2016 land use map was used by SANDAG as detailed in Appendix F of the proposed Plan, and considered local general plans. For consistency purposes with the rest of the County, no change has been made. However, it should be noted that ultimate land use authority is reserved for local jurisdictions, including the City of Coronado. The cities and the county are best positioned to effectively implement the objectives outlined in the proposed Plan as those jurisdictions understand the unique needs of their communities and geographies. As such, it is within the City of Coronado's authority to determine whether zoning in this area is single-family or multi-family.

**RESPONSE TO COMMENT 11-7**

This comment addresses the proposed Plan and does not relate to the adequacy of the Draft EIR.

Coronado is a major destination due to the presence of one of the region's top military bases. Additionally, people commuting to hospitality, retail, and dining jobs is a daily occurrence, and the community serves as one of the region's top tourism destinations for visitors from both outside and within San Diego County. These trip-inducing factors contribute to the area's high propensity for regional Mobility Hub designation.

Not all Mobility Hub areas are created equal. Coastal Mobility Hubs are envisioned to rely upon some transit services supported by an array of on-demand Flexible Fleets to help people complete short trips in and around the hub without needing to rely on a car. The suite of Flexible Fleets and supporting Mobility Hub amenities as included in the proposed Final EIR can be tailored to meet the needs of people traveling to and within Coronado. SANDAG staff will continue to coordinate with Coronado on planning for appropriate Mobility Hub services, amenities, and supporting technology for this community. Mobility hub boundaries are also subject to refinement in close coordination/planning with the affected jurisdiction(s).

**COMMENT LETTER 12: COUNTY OF SAN DIEGO**



October 11, 2021

Kirsten Uchitel  
 Associate Planner  
 SANDAG  
 401 B Street, Suite 800  
 San Diego, CA 92101

Sent via email to: [RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)

**RE: REQUEST FOR COMMENTS ON THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT REPORT FOR SAN DIEGO FORWARD: THE 2021 REGIONAL PLAN FOR SANDAG**

Dear Ms. Uchitel,

12-1 The County of San Diego (County) staff reviewed SANDAG's Draft Programmatic Environmental Impact Report (Draft PEIR) for "San Diego Forward: The 2021 Regional Plan," dated August 2021. County staff provided detailed comments regarding the 2021 Regional Plan (Proposed Plan) in a letter previously submitted to SANDAG. The letter, dated August 6, 2021 (Attachment A), outlined opportunities within the Proposed Plan for which County staff requested further clarification, exploration, and consideration. County staff would like to continue discussions with SANDAG on how these opportunities align with the objectives of the proposed plan and the Draft PEIR.

To ensure that potential opportunities within the unincorporated area are not precluded in the future, County staff requests that SANDAG consider the comments below on the Draft PEIR and that any necessary refinements be reflected in Chapter 2, Project Description, and analyzed in the appropriate sections of the Final PEIR. County staff appreciates the opportunity to review the Draft PEIR for the Proposed Plan and offers the following comments for your consideration:

**GENERAL**

- 12-2
1. The Draft PEIR (Table 2-5) notes that 56% (1,855,597 out of 3,309,510 total people) of San Diego County residents are currently located outside of a Mobility Hub Network, including 512,597 people in the unincorporated area. With the significant investment described in the Proposed Plan, County staff would like to ensure that it is fairly and equitably distributed for the benefit of all County residents, including rural residents living in unincorporated communities.

**RESPONSE TO COMMENT 12-1**

SANDAG appreciates the County of San Diego's feedback on the proposed Plan and your participation in the environmental review process. Please refer to subsequent responses to your comments below for detailed responses. Refinements have been made to the Final EIR as applicable.

Responses to comments on the County's comments on the proposed Plan can be found under ID 968 in Appendix P.2. Please note that comments 12-1 through 12-7 apply to the proposed Plan, not to the adequacy of the Draft EIR.

**RESPONSE TO COMMENT 12-2**

While certain types of Flexible Fleets are envisioned to converge in more dense communities (e.g., micromobility, last-mile delivery), there are also planned Flexible Fleet services that operate outside of Mobility Hubs including in unincorporated communities. These services may include on-demand rideshare, ridehail, carshare, and microtransit services. As an implementation action of the proposed Plan, SANDAG is conducting a Flexible Fleets Implementation Strategic Plan to determine the appropriate use cases and geographic locations that are best appropriate for Flexible Fleet services, including in unincorporated communities of the County. In addition, the proposed Plan includes investments in broadband connectivity that will facilitate improved access to online services and on-demand mobility services.

Ms. Uchitel  
 October 11, 2021  
 Page 2

- 12-3 2. Staff recommends the inclusion of potential investments in roads identified in the County's Mobility Element and in the Regional Arterial System that would further connect the unincorporated area to proposed mobility hubs, with consideration of those roads that also serve as evacuation routes.
- 12-4 3. Staff would also request consideration of how transit can be aligned with recreation access points to increase access to these important regional amenities.
- 12-5 4. The Proposed Plan focuses on mobility and land use changes that would serve three primary user groups: pedestrians, bicyclists, and vehicles. Please consider updating the analysis to consider mobility needs for wildlife (wildlife corridors) and for equestrians where appropriate.
- 12-6 5. From a social equity standpoint, please consider if allowing single occupancy vehicles should be permitted in managed lanes. Allowing single occupants that can afford to travel in managed lanes will create some inequities in the community.

**AIRPORTS**

- 12-7 1. The San Diego County Regional Airport Authority adopted Airport Land Use Compatibility Plans for the eight airports, which included land use compatibility policies related to airspace, noise, safety, and overflight. Those policies have been adopted by the County of San Diego through its General Plan and Zoning Code. After evaluating the forecasted increases in housing and jobs around the Mobility Hubs, there are several land use assumptions made in the Proposed Plan related to safety and noise around Fallbrook Airpark, Jacumba Airport, Gillespie Field, and McClellan-Palomar Airport that County staff would like to better understand. For example, there are forecasted incompatible housing increases within the Runway Protection Zones at Gillespie Field. These inconsistencies could result in making the assumed intensities and density increases included in the Proposed Plan unachievable.

**AESTHETICS AND VISUAL RESOURCES**

- 12-8 1. Page 4.1-10 of the Draft PEIR mentions the County of San Diego Dark Sky Ordinance and associated regulation of outdoor light fixtures within 15 miles of local observatories. This ordinance also includes the minimization of light pollution to reduce impacts to wildlife. Please consider expanding the analysis to address direct and indirect impacts due to light and glare on open space lands and wildlife corridors/linkages.
- 12-9 2. It is not clear what type of trees and vegetation will be used to replace impacted vegetation in cases where vegetation disruption causes potential aesthetic impacts (Mitigation Measures AES-2a, 2b, AES-3a). Mitigation Measure BIO-1e specifies that certain invasive species shall not be used to replace impacted vegetation. Please consider adding that same requirement to the Aesthetic/Visual Resources mitigation measures in the Draft PEIR.

**RESPONSE TO COMMENT 12-3**

The proposed Plan includes improvements for arterial roadways so that they can benefit from management approaches and technology enhancements to increase efficiency and reduce delays (see proposed Plan Appendix A, A-41, Table A.13).

While these regional Mobility Hub coverage areas have been used to model the impact Transit Leap and Flexible Fleet trips to/from these hubs have on reducing VMT, they do not restrict Flexible Fleets from serving neighborhoods that may be between or beyond hubs. Some Flexible Fleet services operating within regional hubs will also need to reach outlying destinations, such as the set of beach and shopping communities cited in this comment. There will be many opportunities for Flexible Fleets to connect to Transit Leap stops located along routes in between hubs. The same applies to improvements on Complete Corridor arterials connecting to and from hubs.

Appendix Q of the proposed Plan describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.

SANDAG also encourages the County to work with staff on any proposals to include additional RAS routes during the next Regional Plan cycle. Eligibility criteria is outlined in Appendix T of the proposed Plan.

**RESPONSE TO COMMENT 12-4**

The proposed Plan aims to improve access to a quality public transportation system for all San Diego residents, especially for seniors, historically underserved communities, and other under-represented populations. SANDAG's social equity analysis projects significant improvements for senior access to high-quality transit service, parks, and recreational facilities. In every metric senior access to transit, retail, medical facilities, and parks improves through 2025 and 2050. More data and analysis is available in Appendix H of the proposed Plan.

In general, the Draft EIR found that the main drivers of demand for recreational facilities is population growth, not transportation network improvements (see, inter alia, EIR page 4.15-40). However, "[t]he transportation network improvements and programs, in particular rail improvements and active transportation facilities, could redistribute a portion of existing travel and attract transit users to recreation facilities

in the vicinity of transit stops and stations leading to minor increases in usage....In addition, active transportation improvements would expand recreation opportunities, such as bicycle facilities” (EIR page 4.15-43).

**RESPONSE TO COMMENT 12-5**

The proposed Plan suggests a Nature-Based Climate Solutions Program that will promote natural infrastructure that uses or mimics natural processes to benefit people and wildlife. SANDAG will prioritize resilience and innovative solutions in transportation infrastructure, Comprehensive Multimodal Corridor Plans (CMCPs), and consistent regional planning and implementation of the Sustainable Communities Strategy actions, emphasizing both nature-based and technological climate solutions. There are also further opportunities to expand upon ongoing efforts to assess the amount of carbon storage and sequestration potential of open space lands and the co-benefits from preserved open space, land management, and restoration activities.

The development CMCPs by SANDAG and Caltrans will consider all relevant and related plans and projects, in collaboration with city and County staff, to ensure there is cohesion and consistency between the CMCP and the communities within and adjacent to them, including active and multi-modal transportation considerations. These are focused efforts to identify projects and strategies that integrate transportation options, wildlife connectivity, and technology deployment to improve mobility and evacuations along the corridors.

This comment asks that the proposed Plan consider mobility needs for wildlife and equestrians in addition to pedestrians, bicyclists, and vehicles. This comment is therefore aimed at the proposed Plan, not the EIR. The EIR analyzes the proposed Plan’s impact on wildlife corridors in Section 4.4, *Biological Resources*. Mitigation measure BIO-3 includes specific measures to facilitate wildlife movements.

**RESPONSE TO COMMENT 12-6**

The intent of the Managed Lanes is to create a flexible system that can be managed in real time. This is similar to how the I-15 corridor is currently managed in North County. Solo drivers will have options to use the lanes but at a price, and transit services can travel congestion free. The result is better optimization of the system that encourages higher occupancy travel but with real alternatives that are competitive with driving.

SANDAG will launch a study in the next year to further examine the potential of usage-based fees and their capabilities in addressing various goals, including equity and GHG emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.

The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.

**RESPONSE TO COMMENT 12-7**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. The land use pattern proposed in the proposed Plan focuses growth and development in the mobility hub areas. The allocation of housing units to subregional areas represents general areas projected for future growth and not precise locations for future housing development or housing unit type. The exercise of land use authority is reserved for local jurisdictions, and projected intensity and density of development under the proposed Plan would be achieved through a variety of strategies without placing housing areas in incompatible areas defined by an Airport Land Use Compatibility Plan (ALUCP).

**RESPONSE TO COMMENT 12-8**

In response to this comment, text has been added to the Dark Sky Ordinance summary on page 4.1-10 of the EIR to indicate that this ordinance also includes the minimization of light pollution to reduce impacts on wildlife. Mitigation measure BIO-2a in Section 4.4 provides measures to reduce impacts from increased temporary and permanent sources of lighting during construction and operation of future development occurring under the proposed Plan.

**RESPONSE TO COMMENT 12-9**

The types of trees and vegetation that would be used to replace impacted vegetation would vary, depending on a number of factors; however, in response to this comment mitigation measures AES-2a, AES-2b, and AES-3a have been modified to include language prohibiting planting of invasive plant species, as designated on the most recent version of the California Invasive Plant Council (Cal-IPC) California Invasive Plant Inventory.

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**BIOLOGICAL RESOURCES**

- 12-10 1. Please clarify the significant reduction in acreages impacted between the 2015 EIR and the 2021 Draft EIR, especially as they relate to Wetlands and Riparian Habitat, Upland Habitat, Agricultural Land, and Transportation. The differences do not appear to correlate with the changes or updates made between the 2015 and 2021 Regional Plan.
- 12-11 2. On January 13, 2017, County staff submitted comments to SANDAG on the Notice of Preparation (NOP) of the Regional Plan Draft PEIR (Attachment B). In that letter, the County requested that SANDAG coordinate with County staff and evaluate in the Draft PEIR potential direct and indirect impacts on the Multiple Species Conservation Plan (MSCP). The comments related to the MSCP still stand (Attachment B). As such, it is not clear how the Proposed Plan would impact the MSCP, or if there is specific mitigation proposed to reduce these impacts. Please consider updating the analysis to clarify these potential impacts and associated mitigation.
- 12-12 3. Please ensure that maps are using the latest GIS data available from SanGIS, which is regularly updated. For example, the maps showing Open Space Parks and Recreation land (Figures 4.15-1 and 4.15-2) seem to be missing some of the County's Department of Parks and Recreation properties. Please ensure all references to County Department of Parks and Recreation properties are updated throughout the 2021 Draft PEIR.
- 12-13 4. Please consider including County parks and preserves and associated proposed project impacts to each specific park and preserve within the Draft PEIR; data on County parks and preserves can be found on SanGIS. For example, on Page 4.4-107, it states that the largest area of encroachment and associated impacts would occur on the Otay Ranch Preserve. However, the level and extent of that potential impact is not clear. Please coordinate in advance with the County Department of Parks and Recreation prior to implementation of projects that may have impacts to County parks and preserves.
- 12-14 5. The figures within the Draft PEIR do not show property ownership overlaid with the proposed project. To better understand and analyze potential impacts of the project, please consider the inclusion of a figure that shows County parks and preserves.
- 12-15 6. Please consider revising "Hardline Preserve" to "MSCP Preserve" throughout the Draft PEIR, as MSCP Preserve is the term most commonly used.
- 12-16 7. In Table 4.2-2 and Table 4.4-6, Otay Ranch and the associated General Development Plan/Subregional Plan are categorized as falling under the jurisdiction of the City of Chula Vista. While the text clarifies that Otay Ranch is jointly owned and managed by the City of Chula Vista and the County, the categorization in the tables is unclear. Please consider revising the tables to show the joint ownership and management of this area.
- 12-17 8. Figure 4.4-16, San Diego Conservation Planning Areas and Conserved Lands, does not appear to be consistent with the Subarea Plans under Adopted MSCP/MHCP Subregional Plans listed in Table 4.4-5. Please consider revising these to show all Subarea Plan Areas.
- 12-18 9. On page 4.4-107, Section BIO-4 Analysis Methodology, please consider updating the methodology to take into consideration requirements of the Public Park Preservation Act of

**RESPONSE TO COMMENT 12-10**

The significant reduction in impact acreages is due to a significantly smaller development footprint in non-urban areas and, thus, a significantly smaller impact on biological resources in general.

**RESPONSE TO COMMENT 12-11**

Thank you for submitting the County of San Diego's comments on the NOP for this EIR. The EIR preparers received your comments and considered them in the preparation of the EIR. Direct and indirect impacts from the proposed Plan land use change and transportation network on the County's adopted MSCP are programmatically addressed under Impact BIO-4 of the EIR. Indirect impacts are assessed qualitatively. Tables 4.4-16 through 4.4-19 quantitatively assess impacts on the County's MSCP Preserve. Consistent with the County's adopted MSCP, the County would be consulted prior to any design of projects that could potentially have an effect on the County's MSCP Preserve. Furthermore, consistent with the EIR, any such projects would be required to be consistent with the County's MSCP, and no impacts on hardline preserve are expected. Should impacts on the MSCP be unavoidable, boundary line adjustments would be required as mitigation for such impacts, pursuant to the County's guidelines and in consultation with the County of San Diego. In addition, please see response to comment USFWS 38-4.

**RESPONSE TO COMMENT 12-12**

Figure 4.4-16 has been revised to include any County of San Diego conserved open space parks that were/are not included in the Conserved Lands database in the Final EIR.

**RESPONSE TO COMMENT 12-13**

The impacts on the Otay Ranch Preserve are a factor of the programmatic nature of the proposed Plan footprint. Specific impact avoidance, minimization, and mitigation measures will be developed during subsequent project-specific CEQA-level review and will require consistency with any adopted HCP. Project-level analysis will include consultation with the County Department of Parks and Recreation.

**RESPONSE TO COMMENT 12-14**

Please see response to comment County of SD 12-12.



**RESPONSE TO COMMENT 12-15**

The text has been revised throughout the document and “hardline preserves” has been replaced with “NCCP Preserves” to identify not just MSCP but also MHCP preserve designations.

**RESPONSE TO COMMENT 12-16**

Table 4.4-6 has been revised to reflect this comment in the Final EIR.

**RESPONSE TO COMMENT 12-17**

Figure 4.4-16 has been revised as suggested in the Final EIR.

**RESPONSE TO COMMENT 12-18**

The text on page 4.4-109 in Section 4.4 has been revised as suggested. The following language has been added:

The Public Park Preservation Act of 1971 (Public Resources Code Sections 5400-5409) requires that any “take” of public parkland may require compensation that is sufficient to acquire substantially equivalent substitute parkland or provide substitute parkland of comparable characteristics.

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- 12-18 | 1971 (Public Resources Code Sections 5400-5409). In the event the Proposed Plan results in "take" of any County MSCP Preserve Lands, this would be considered "take" of designated park land and may require land or other compensation for loss of park land.
- 12-19 | 10. In Figures 4.4-3 through 4.4-8, one of the data sources for these figures is stated as the County of San Diego's SanBios data from 2017. Please consider using the County of San Diego's SanBios data through 2020, as this contains updated data.
- 12-20 | 11. Table 4.4-5 states that the County is pursuing an amendment to the South County Subarea Plan to include the Quino checkerspot butterfly (QCB). Please remove reference to QCB as the County has expanded the project to the Regional Butterflies Habitat Conservation Plan (RBHCP) to include a comprehensive approach that would cover QCB, Harbison's dun skipper, Hermes copper, and the Laguna Mountains skipper.
  - a. Additionally, the RBHCP is currently being developed and has not yet been adopted. Therefore, reference to the RBHCP may not need to be included in Table 4.4-5 related to adopted regional conservation plans. Please consider removing the reference.
- 12-21 | 12. Given the significance and regional importance of wildlife corridors and wildlife linkages, please consider updating the analysis to consider areas where linkages and corridors could be impacted by the Proposed Plan and any mitigation measures that could be implemented to improve wildlife linkages.
- 12-22 | 13. Spread of invasive plants is a significant regional issue that many land managers face throughout the San Diego region. County staff supports Mitigation Measure BIO-1e, which would require a prohibition on planting or seeding of invasive species that appear on the most recent version of the California Invasive Plant Council California Invasive Plant Inventory. Please consider inclusion of an integrated invasive plant control plan with enforceable protocols for maintenance, construction, and emergency activities to follow when working within and moving between important habitat areas.
- 12-23 | 14. Section 4.4 has a description of the TransNet Environmental Mitigation Program (EMP) and states that the EMP provides funding for the acquisition, restoration, and management costs for the implementation of local Natural Community Conservation Plans (NCCPs). The EMP or other funding from TransNet may not provide a long-term regional funding source for conservation, including funding for the acquisition or ongoing management and monitoring. Please consider updating the PEIR to clarify that an adequate regional funding source has not yet been identified or put in place, which leaves local jurisdictions responsible for securing ongoing funding to implement local NCCPs.
- CULTURAL RESOURCES**
- 12-24 | 1. Please consider associated potential impacts on County parks and preserves related to cultural and historical resources. Staff understand that this is a PEIR, so please include the maximum possible area of impacts. Please coordinate in advance with the County Department of Parks and Recreation prior to implementation of projects that may have impacts to County parks and preserves and associated cultural and historical resources.

**RESPONSE TO COMMENT 12-19**

The 2017 reference was an error. The figures and text have been revised to show that the analysis used SanBios 2020 data in the Final EIR.

**RESPONSE TO COMMENT 12-20**

Revisions to Table 4.4-5 and the associated text have been made to remove reference to the Quino checkerspot amendment and the RBHCP in the Final EIR.

**RESPONSE TO COMMENT 12-21**

Thank you for your comment. Figure 4.4-15 has been revised to include the transportation network footprint in the Final EIR. Please also see response to comment CBD 8-7.

**RESPONSE TO COMMENT 12-22**

The text for mitigation measure BIO-1e has been revised to add the following:

Prohibit planting or seeding of invasive plant species that appear on the most recent version of the California Invasive Plant Council (Cal-IPC) California Invasive Plant Inventory, including the development of an integrated invasive plant control plan describing protocols and enforcement schedules for maintenance, construction, and emergency activities working within and moving between important habitat areas in the Final EIR.

**RESPONSE TO COMMENT 12-23**

SANDAG notes the County's concern that the EMP or other TransNet funding may not provide a long-term regional funding source for conservation and may leave local jurisdictions responsible for securing ongoing funding to implement local NCCPs. Please refer to Master Response 1 for discussions regarding including a regional habitat conservation fund.

**RESPONSE TO COMMENT 12-24**

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan, including those that would impact County parks and preserves would be subject to project-specific

environmental review. As a rough estimate the proposed Plan would impact approximately 59 acres of open space parks and 20 acres of recreational lands.

Also, note that County parks and preserves are in general not CEQA-defined cultural resources, i.e., archeological resources or built-environment resources.

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**GEOLOGY, SOILS AND PALEONTOLOGY**

- 12-25 1. The Grading and Erosion Regulations section does not identify and summarize applicable grading and erosion control ordinances. Applicable regulations are generally referenced to support a less-than-significant determination for thresholds (e.g. GEO-3, Result in Substantial Soil Erosion or the Loss of Topsoil). The County's Grading Ordinance appears to only be referenced within the context of paleontological resources. Please consider also referencing the County's Grading Ordinance in the Grading and Erosion Regulations section.
- 12-26 2. Please consider revising Table 4.7-3 to reference the County of San Diego General Plan Goals S-8 and S-9. Local Policies Concerning Geologic and Seismic Hazards references Goal S-7, but it should read "The San Diego County General Plan Goal S-8 and S-9 in the Safety Element requires minimized personal injury and property damage resulting from seismic hazards, and damage caused by mudslides, landslides, or rock falls."
- 12-27 3. Within Table 4.7-4, Local Policies Concerning Unique Geological and Paleontological Features, for the County of San Diego, please consider including the following: "COS-9.1 Preservation. Require the salvage and preservation of unique paleontological resources when exposed to the elements during excavation or grading activities or other development processes."
- 12-28 4. The Draft PEIR states "there would be development on soils incapable of supporting septic tanks or Onsite Wastewater Treatment Systems (OWTS)." However, the analysis also states that through future corrective measures/regulatory requirements, impacts to groundwater would be less than significant. Please consider adding a discussion of which regulations would be applicable and how those regulatory requirements would ensure that there would be no adverse groundwater impacts.

**GREENHOUSE GAS EMISSIONS**

- 12-29 1. On January 13, 2017, the County submitted comments to SANDAG on the Notice of Preparation (NOP) of the Regional Plan Draft PEIR (Attachment B). At the time of these comments, the County was in the process of preparing the 2018 Climate Action Plan (CAP). Since the release of the NOP and submittal of these comments, County staff is now preparing a CAP Update that will set new greenhouse gas (GHG) emissions targets and identify measures to reduce GHG emissions in the unincorporated area. County staff would like to work collaboratively with SANDAG on the Proposed Plan to identify an efficient and cleaner multi-modal transportation system that reduces vehicle miles traveled for unincorporated area residents by providing mobility options, which would reduce greenhouse gas emissions, and improve air quality for all residents in the region (Attachment A). County staff requests that SANDAG consider the comments provided previously and listed below in the Draft PEIR.
  - 12-30 a. Analyze alternatives that address multi-modal transportation options for the unincorporated county, particularly as it relates to transit service and alternative fuel infrastructure. County staff would encourage SANDAG to consider extending the benefits of mobility hubs and transit leap opportunities to unincorporated communities in which these services do not currently exist.

**RESPONSE TO COMMENT 12-25**

Under the County of San Diego's Grading Ordinance it is unlawful for any person to perform any grading or clearing within the County jurisdiction without proper approvals through County officials. While the Grading and Erosion Regulations discussion in Section 4.7, *Geology, Soils and Paleontology*, does not reference the specific grading and erosion control regulations of any of the local jurisdictions that fall within the region, the EIR discusses local jurisdictional requirements and the need to obtain appropriate permits in order to control erosion and sedimentation caused by construction activities. The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects under the Plan are subject to environmental review and will follow applicable laws and regulations, including coordination and permitting requirements of the local jurisdictions within which future development and transportation improvements fall.

**RESPONSE TO COMMENT 12-26**

Revisions were incorporated into Table 4.7-3 as suggested by the comment.

**RESPONSE TO COMMENT 12-27**

Revisions were incorporated into Table 4.7-4 as suggested by the comment.

**RESPONSE TO COMMENT 12-28**

Additional text was added to page 4.7-52 of the EIR regarding which regulations are applicable to an Onsite Wastewater Treatment System. However, as stated in Section 4.7, "all site designs would be reviewed and approved by the appropriate agencies." Approval from reviewing agencies will ensure that the proposed project is in compliance with all regulatory requirements, some of which may differ and vary depending on the jurisdiction within which the development will take place. As noted above, the EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects under the Plan are subject to environmental review and will follow applicable

laws and regulations, including coordination and permitting requirements of the local jurisdictions within which future development and transportation improvements fall.

**RESPONSE TO COMMENT 12-29**

SANDAG looks forward to collaborating with the County to identify an efficient and cleaner multi-modal transportation system that reduces VMT for unincorporated area residents by providing mobility options, which would reduce GHG emissions and improve air quality for all residents in the region.

**RESPONSE TO COMMENT 12-30**

Please see response to comment County of SD 12-2.

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12-31 b. *Analyze whether the developed/urban communities within the unincorporated county meet the Urban Area Transit Strategy.* The Urban Area Transit Strategy, considered in the previous 2050 Regional Transportation Plan, is not considered in this Proposed Plan and is replaced with broad concepts of Mobility Hubs. County staff is supportive of these efforts to centralize mobility investments for all users in urbanized areas. However, staff would encourage SANDAG to consider in the project description and analysis the potential for mobility hubs concepts that can be applied to unincorporated area communities that are not currently identified as being within and benefiting from mobility hubs and associated investments (Attachment A).

12-32 c. *Analyze an environmentally sustainable transportation system that can reduce vehicle miles traveled, gasoline consumption, and GHG emissions, while providing alternative modes of transportation for all economic sectors of our population.* County staff continues to encourage SANDAG to consider and identify sustainable transportation systems and strategies that can reduce vehicle miles traveled and GHG emissions from residents in unincorporated communities. For example, extending existing transit routes and reducing headways to increase transit service to unincorporated communities will encourage increased ridership, reduce vehicle trips, and will assist in decreasing GHG emissions.

12-33 d. *The County requests that SANDAG staff coordinate with County staff to ensure that the most recent planning assumptions are incorporated in the transportation models and growth forecasts.* It is not clear what projects or plans were considered and incorporated into the Proposed Plan modeling. However, there are some areas in which inconsistencies appear between approved development projects in the unincorporated area and projected growth identified in the Proposed Plan modeling. County staff relies on SANDAG population, housing, and job growth forecasts for planning efforts. As recently as July 2021, long-range planning efforts, such as the County's Housing Element Update, have relied on forecasts that project future housing growth in the unincorporated area of 50,184 new units between 2018 and 2050. These prior projections are significantly greater than the forecasted growth of 7,419 units during a similar time period in the Proposed Plan. Further, historic data shows that from 2010 to 2020, 7,330 new homes were built in the unincorporated area. If that trend continued, an additional 22,000 new homes would be built in the unincorporated area by 2050. County staff would appreciate continued coordination with SANDAG staff to ensure the most recent planning assumptions and projects are considered.

12-34 2. Based upon a review of the Draft PEIR, County staff encourages continued collaboration with SANDAG to ensure the most recent planning and land use assumptions (including approved development projects or those that are under construction) are reflected in regional modeling and growth forecasting. Through continued collaboration, the County can support the vision of the Proposed Plan by developing the CAP Update and related efforts based on similar assumptions and goals.

**HAZARDS AND HAZARDOUS MATERIALS**

12-35 1. Within Table 4.9-1 Major EnviroStor Hazardous Waste and Substances Sites in the San Diego Region, the list of sites does not appear to match the current Cortese list on the Department of Toxic Substances Control's (DTSC) website. Please consider adding a figure

**RESPONSE TO COMMENT 12-31**

The coverage area of each regional Mobility Hub is based on a data-informed propensity analysis carried out in parallel with Transit Leap routing assessment. The analysis leveraged Census Block Group geographies, including ones in unincorporated areas, to assess which areas were most conducive to hubs based on factors such as current and forecasted population and jobs, proximity to major destinations, community of concern coverage, and levels of short trip-making.

**RESPONSE TO COMMENT 12-32**

The proposed Plan includes an SCS, as required by SB 375 (Steinberg, 2008), for the San Diego region. When combined with the transportation network, the SCS exceeds the state's target for reducing per capita GHG emissions set by CARB. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements are reflected in Appendix A, Attachment 1 of the proposed Plan. Beyond fixed-route transit service, the proposed Plan envisions unincorporated communities to be served by Flexible Fleet services, offering mobility options that can reduce VMT and GHG emissions through increased carpools, vanpools, ridesharing, and microtransit.

**RESPONSE TO COMMENT 12-33**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Government Code Section 65080(b)(2)(B) provides that an SCS must "use most recent planning assumptions considering local general plans and other factors." It also requires that the SCS "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board." The SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the Plan. The proposed Plan forecasts development through 2050 consistent with projections from the California Department of Finance but does not represent buildout capacity of jurisdictions' general plans. The latest projection for the San Diego region reflects a reduction in expected population growth

compared to prior forecasts. The SCS land use pattern aligns with the RHNA allocation for the County of San Diego, which is 6,700 units in unincorporated areas by 2029. Historic home building data was not a factor considered in development of the forecast. The proposed Plan and its SCS are iterative planning documents that are typically updated every 4 years to account for new data, analysis, policy, and experience.

**RESPONSE TO COMMENT 12-34**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. SANDAG looks forward to continued collaboration with the County.

**RESPONSE TO COMMENT 12-35**

Figure 4.9-3 has been added per the County's request in the Final EIR.



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12-35 cont. to show where these sites are in relation to proposed land use changes and transportation improvements.

12-36 2. Threshold HAZ-1 seems to apply specifically for potential release of hazardous materials during pre-construction, demolition, or construction activities. However, the analysis in this section also discusses the potential for releases during operational activities. Please consider updating the mitigation measure to reduce the risk of hazardous materials releases during project operation.

**HYDROLOGY AND WATER QUALITY**

12-37 1. Please consider augmenting the analysis to consider potential water quality impacts that could affect sensitive wildlife species and their associated habitats.

**LAND USE**

12-38 1. The County's *Community Trails Master Plan* identifies multiple regional trails that are regional resources, as they would benefit residents and visitors throughout the region. Please consider how the potential transportation and land use changes could impact the connectivity of these regional trails. The County also requests that SANDAG consider further coordination with the County Department of Parks and Recreation during implementation of the Proposed Plan when potential regional and community trail impacts are anticipated. Additionally, please consider working with County staff to look for further opportunities to provide trail connections during implementation of transportation infrastructure projects where feasible.

**PUBLIC SERVICES AND UTILITIES (RECREATIONAL FACILITIES)**

12-39 1. Within the Section "County and City General Plans," please consider adding the County's Parkland Dedication Ordinance, Community Trails Master Plan, and County of San Diego Parks Master Plan to the Draft PEIR, as these are all resource documents that discuss regional trail and recreation facilities.

12-40 2. Page 4.15-42 and Page 4.15-45, Section REC-1:  
 a. 2025  
 i. The Regional Growth and Land Use Change section states that "As noted under Threshold PS-1, approximately 78.8 percent of the 2025 population growth would occur within the City of San Diego, City of Chula Vista, and City of Escondido." Of the remaining 21.2 percent, it is unclear what portion is anticipated within the unincorporated County area. Please consider revising the PEIR to further clarify this.  
 ii. Transportation Network Improvements and Programs section: Please consider adding a table showing areas of impacts to recreational facilities belonging to or within the County's jurisdiction. The PEIR does not appear to specify which County of San Diego Recreational Facilities are impacted by the proposed project.

**RESPONSE TO COMMENT 12-36**

In addition to the potential release of hazardous materials during preconstruction, demolition, or construction activities, the analysis under Impact HAZ-1 notes that most land uses are likely to involve activities in which some form of hazardous materials would be routinely used, stored, handled, or transported. Additional operation impacts are discussed under Impacts HAZ-2 through HAZ-4. Furthermore, Impact HAZ-1 would result in a less-than-significant impact, and mitigation measures would not be required. As noted above, the EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects under the Plan are subject to environmental review, and any site-specific mitigation measures would be identified during that process.

**RESPONSE TO COMMENT 12-37**

The analysis under Impact BIO-2 in Section 4.4 discusses the potential water quality impacts that could affect sensitive wildlife species and their associated habitats. The section specifically discusses the impacts on water-dependent species if changes in hydrology occur from the proposed Plan.

**RESPONSE TO COMMENT 12-38**

Regional trails are discussed in the *Recreational Facilities* subsection of Section 4.15, *Public Services and Utilities*. Section 4.15 has been updated to address County-specific trails, including regional trails. The following text was added to page 4.15-43:

In addition, the future transportation network improvements could have impacts on the following County parks and recreation facilities through the year 2050: Eastview County Park and Sweetwater Regional Park (i.e., SR 125 Complete Corridor improvements from SR 905 to SR 54), Lakeside Sports Park (San Diego River Trail from Mast Park to Lakeside baseball park), Los Peñasquitos Canyon Preserve (Commuter Rail), Otay Valley Regional Park (Heritage Road Bridge), San Elijo Lagoon and Ecological Reserve (North Coast Bike Trail), San Luis Rey River Park (San Luis Rey River Trail), and Waterfront Park

(Commuter Rail). None of the County trails would be impacted by transportation network improvements.

No revisions to Section 4.11, *Land Use*, of the EIR have been made as a result of this comment. SANDAG looks forward to working with the County to identify opportunities for increased trail connections during implementation of the proposed Plan.

**RESPONSE TO COMMENT 12-39**

In response to this comment, SANDAG has added a reference to the Parkland Dedication Ordinance, Community Trails Master Plan, and Parks Master Plan on page 4.15-35 of the Final EIR due to their relevance to addressing population growth impacts on park and recreation resources.

**RESPONSE TO COMMENT 12-40**

Table 2-2 in Chapter 2 of the EIR outlines where population growth would occur throughout all jurisdictions in the County. The sentence under the REC-1 discussion simply summarizes the geographic population trends presented in the table and is not intended to be all-inclusive. As shown in Table 2-2, 1 percent of the forecasted population growth would occur in the unincorporated County lands between 2016 and 2050.

To provide further clarification, the following text has been added to page 4.15-43 of the Final EIR:

In addition, the future transportation network improvements could have impacts on the following County parks and recreation facilities through the year 2050: Eastview County Park and Sweetwater Regional Park (i.e., SR 125 Complete Corridor improvements from SR 905 to SR 54), Lakeside Sports Park (San Diego River Trail from Mast Park to Lakeside baseball park), Los Peñasquitos Canyon Preserve (Commuter Rail), Otay Valley Regional Park (Heritage Road Bridge), San Elijo Lagoon and Ecological Reserve (North Coast Bike Trail), San Luis Rey River Park (San Luis Rey River Trail), and Waterfront Park (Commuter Rail). None of the County trails would be impacted by transportation network improvements

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- b. 2035
  - i. As with the comment above under "2025," please consider revising the Regional Growth and Land Use Change section to show the percentage breakdown within the unincorporated area of the county.
  - ii. This section also states, "Between 2026 and 2035, the majority of the open space conversions would occur as a result of growth and land use change in the Warner Springs area shown in Figure 4.15-2, which would convert 275 acres of open space parks to spaced rural residential use." However, the analysis does not appear to explain the potential impact associated with this proposed loss of open space/park land. It should also be noted that this project is not yet approved and therefore may not result in open space conversion for additional growth and land use change(s). Please consider updating the analysis to take this into consideration and to further clarify and explain potential impacts.
- 12-41 3. Page 4.15-47, under REC-1 Implement Mitigation Measures Parks and other Recreational Facilities, please specify and/or provide information on the impacted facilities within the unincorporated areas of the county. Are there impacts to existing parks, campgrounds, trails, etc.? Please also consider including details of impacted County of San Diego facilities within the environmental document.
- 12-42 4. In the Pedestrian Facilities section of the Draft PEIR it states, "It should be noted that trail facilities are also considered part of the pedestrian network. The trail facilities within the San Diego region are further described and analyzed in Section 4.15, Public Services and Utilities, of this PEIR, along with other recreational facilities." Section 4.15 Public Services and Utilities further explains the trail facilities. However, the information is limited in that it only references the California Coastal Trail. Trails are an important aspect of the regional transportation network. Please consider updating the analysis to include existing trails and pathways and include this information as part of the pedestrian facilities assessment. The County's existing *Community Trails Master Plan* may be used as a reference document regarding regional trails.
- 12-43 **TRANSPORTATION**
- 12-44 1. If the boundaries of the proposed mobility hubs are not intended to be static, please include narratives and/or graphics to further clarify that the boundaries are not absolute.
- 12-45 2. County staff recommends that any 5 Big Moves pilot program or case study include and/or consider the unincorporated area (i.e. Flexible Fleet Strategic Plan).
- 12-46 3. Please coordinate with County staff in advance of transportation plans that go through or near County properties and facilities.
- 12-47 4. Regarding page 4.16-34, 4.16.3 SIGNIFICANCE CRITERIA, TRA-1 Conflict with a program, plan, ordinance, or policy addressing the circulation system, including -transit, roadway, bicycle, and pedestrian facilities:

**RESPONSE TO COMMENT 12-41**

The requested information regarding population growth in the unincorporated County is provided in Table 2-2, as noted in response to comment County of SD 12-40.

With regard to the loss of open space parks in the 2035 scenario, the impact analysis applies the recreation significance threshold and concludes that population and growth may result in a physical deterioration of park and recreation facilities. Deterioration caused by overuse can lead to a number of physical environmental impacts including degradation of the quality of biological habitats or increases in erosion near trailheads or along trails, as described in Sections 4.4 of the EIR. Minor edits have been made under the 2025, 2035, and 2050 scenarios to clarify the link between population growth and impacts on recreation facilities. Page 4.15-42 of the EIR acknowledges that local jurisdictions have the means to acquire, develop, and maintain parkland and recreation facilities in the future through funding mechanisms described in Section 4.15.2. However, there are no assurances that future park and recreation facilities would be capable of adequately serving forecasted populations contained in the proposed Plan. For this reason, the EIR concludes that impacts may be significant, should the Plan be approved.

**RESPONSE TO COMMENT 12-42**

The County of San Diego park and recreation facilities that could be impacted by proposed transportation network improvements are listed in response to comment County of SD 12-40. Potential impacts on those facilities have been addressed programmatically in the appropriate sections of the EIR and are illustrated in Figure 4.15-2.

**RESPONSE TO COMMENT 12-43**

SANDAG acknowledges there are many existing and future trails in the region that facilitate pedestrian movements. The trail information specificity requested in this comment is beyond the scope of the EIR; however, as noted in response to comment 12-40, none of the County trails would be impacted by the proposed Plan. A reference to the County's Community Trails Master Plan has been added to the EIR in response to comment 12-39.

**RESPONSE TO COMMENT 12-44**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. The following language has been added to Mobility Hub maps (Figures 2-35 and 2-36) in the Final EIR:

These maps show generalized regional Mobility Hub boundaries for planning purposes and are not intended to be binding or precise. Mobility Hub boundaries are subject to refinement in close coordination with the affected jurisdiction(s).

**RESPONSE TO COMMENT 12-45**

SANDAG looks forward to coordinating with the County on many areas of implementation for the proposed Plan, including the Flexible Fleet Implementation Strategic Plan, Active Transportation Plan, Comprehensive Multimodal Corridor Plans, and advanced transit planning. All of these efforts provide opportunities for refinement of the proposed Plan concepts at a local level.

**RESPONSE TO COMMENT 12-46**

SANDAG looks forward to coordinating with County staff prior to developing transportation plans that go through or near County properties and facilities.

**RESPONSE TO COMMENT 12-47**

The County is currently developing an Active Transportation Plan (ATP) for the unincorporated communities of the county. The ATP will integrate and update several existing plans and documents into a single plan. The ATP will serve as a master plan and policy document to guide the development and maintenance of active transportation infrastructure including sidewalks, pathways, multi-use trails, and bikeways; the ATP will include the Safe Routes to School programs for the unincorporated County. Additionally, the ATP is expected to be one of the implementation measures for the County's Climate Action Plan.

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12-47  
cont.

- a. 2025: Transportation Network Improvements and Programs, under Pedestrian (page 4.16-34). Table 4.16-8 shows a Pedestrian Analysis table showing average daily walking trips, walking mode share, and average length of walking trip. It is unclear as to whether these include an assessment of trail system(s) and trail facilities. Please consider including trails as a part of this analysis.
- b. 2035: Transportation Network Improvements and Programs, Same comment as 2025 above.
- c. 2050: Transportation Network Improvements and Programs, Same comment as 2025 above.

12-48

Thank you again for the opportunity to comment on the Draft PEIR. County staff looks forward to continued discussions with SANDAG on how we can work together to better ensure that consideration is given to future investments and incentives that would result in expanded options for transit, active transportation, and shorter and fewer automobile trips. If you have any questions regarding these comments, please contact Luis Duran, Land Use/Environmental Planner, at (619) 214-4698, or via e-mail at [luis.duran@sdcounty.ca.gov](mailto:luis.duran@sdcounty.ca.gov).

Sincerely,

*Lynnette Tessitore*

Lynnette Tessitore  
Chief, Long Range Planning Division  
Planning & Development Services

cc: Rosa Olascoaga, Policy Advisor, Board of Supervisors, District 1  
Gregory Kazmer, Land Use Director, Board of Supervisors, District 2  
Cody Petterson, Policy Advisor, Board of Supervisors, District 3  
Emily Wier, Policy Advisor, Board of Supervisors, District 4  
Benjamin Mills, Policy Advisor, Board of Supervisors, District 5  
Luis Pallera, CAO Staff Officer, LUEG  
Luis Duran, Land Use/Environmental Planner, PDS  
Sue Waters, Land Use/Environmental Planner, DPW  
Crystal Benham, Group Program Manager, DPR  
Emmet Aquino, Park Project Manager, DPR

## RESPONSE TO COMMENT 12-48

Thank you for your comments. SANDAG looks forward to future coordination with the County of San Diego.

SARAH E. AGHASSI  
DEPUTY CHIEF ADMINISTRATIVE OFFICER



August 6, 2021

Hasan Ikhata  
Executive Director  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

Sent via email to: [SDForward@sandag.org](mailto:SDForward@sandag.org)

**REQUEST FOR COMMENTS ON THE DRAFT 2021 REGIONAL PLAN FOR THE SAN DIEGO ASSOCIATION OF GOVERNMENTS (SANDAG)**

Dear Mr. Ikhata,

Thank you to the San Diego Association of Governments (SANDAG) for your efforts to create a Regional Comprehensive Plan and Sustainable Communities Strategy (Regional Plan) to help design a regional transportation system that is fast, fair, clean and reduces greenhouse gas emissions. As County staff, we are committed to working with SANDAG staff on our shared goals of implementing programs and services to improve the quality of life of our residents as we determine where and how we grow, connect people and places, protect the environment, and provide opportunity for all of our region's residents.

12-49

This comment letter outlines areas within the Regional Plan for which County staff would like to request further clarification, exploration, and consideration. Attachment A provides additional comments from County staff for your consideration and incorporates additional information related to County-specific plans or policies that may further inform the Regional Plan.

**LAND USE, TRANSPORTATION PLANNING, AND SMART GROWTH**

Land use and transportation planning in the San Diego region is evolving to better address the most pressing issues of today, including climate change, quality of life, attainable housing, and social and economic inequities. The County has several planning efforts underway which prioritize addressing these issues, including the Regional Decarbonization Framework, the Climate Action Plan Update, the Electric Vehicle Roadmap, Office of Environmental and Climate Justice, and establishment of VMT thresholds. While independent of the Regional Plan, these efforts are aligned with the goals of the Regional Plan. County staff is interested in further understanding the regional growth modeling assumptions used within the Regional Plan and alignment with these County efforts.

**RESPONSE TO COMMENT 12-49**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Please see Plan responses L165 through L174 in Attachment P.2.

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 Page 2

**PLANNING FOR THE UNINCORPORATED AREAS**

The County represents more than 500,000 residents who live within 34 unincorporated communities throughout the region. County staff would like to better understand how the Regional Plan will address transportation options outside of proposed mobility hubs for those communities. The unincorporated community of Ramona, for example, has a population of 36,000 residents, which is a larger population than the incorporated communities of Imperial Beach, Lemon Grove, Coronado, Solana Beach, and Del Mar.

Less than 1% of the unincorporated area is within the proposed mobility hubs, which is where transit and on-demand travel infrastructure investment will be focused. The unincorporated north and east county communities represent a significant population with higher-than-average VMT in the region. Investment in public transit and other transportation options will make it easier for people to drive less, which results in decreased GHG emissions. However, investment outside of mobility hubs appears to be limited, which would make it difficult for unincorporated residents to use new transit service.

To promote greater equity, County staff see opportunities to expand the proposed mobility hubs to include adjacent unincorporated communities. When we overlay the proposed mobility hubs with the County's VMT efficient areas (using both the unincorporated and regional averages), North County Metro, Lakeside, and Spring Valley (Attachment B) are adjacent to what appear to be proposed mobility hubs. These unincorporated communities would benefit from additional access and investment associated with inclusion in adjacent mobility hubs, as these communities have few existing alternative options to driving.

12-49  
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County staff is also interested in understanding how Regional Housing Needs Assessment (RHNA) allocations would be assigned. For the current 6<sup>th</sup> RHNA cycle, which covers 2021 – 2029, SANDAG allocated 6,700 units for the unincorporated area, with a total housing forecast in the Regional Plan of 7,419 units through 2050 for the unincorporated area. This forecast projects the County's RHNA allocation of 6,700 units being met by 2029, with an additional growth of 719 units by 2035, and projects no further growth in the unincorporated area through 2050. Based on this forecast, it appears that beyond 2035, all future housing needs in the region from RHNA cycles would be allocated to and met by growth in incorporated cities.

In order to fulfill the goals of the Regional Plan in providing access to affordable, reliable, and safe mobility options for everyone in the region, County staff would like to work with SANDAG to ensure consideration is given to future investments and incentives within the unincorporated area that would result in expanded options for transit and active transportation, and to encourage shorter and fewer automobile trips, including locations of mobility hubs, transit leap, flexible fleets, and complete corridors.

**COMMUTER PATTERNS AND MOBILITY IN THE UNINCORPORATED AREA**

The Regional Plan focuses on five key investment opportunities: Next Operating System (OS), Complete Corridors, Transit Leap, Mobility Hubs, and Flexible Fleets. Many of the Regional Plan investments would be contained within proposed mobility hubs and along identified complete corridors. The majority of infrastructure improvements appear to support a shift to new rail and trolley line infrastructure, largely along the coastal areas. However, Ramona, Lakeside, Spring Valley, and other unincorporated east and north county communities represent a significant population that would benefit from similar consideration for infrastructure improvements as that proposed for the coastal communities with less population. According to SANDAG's "Commuting Patterns in the San Diego Region" study, a majority of the unincorporated east and north county residents who are employed commute outside the boundaries of their County Supervisorial



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district, with 84% of District 2 residents working outside the district and 82% of District 5 residents working outside the district. Vehicle miles traveled could be reduced through greater mobility options for the unincorporated area (i.e., expansion of mobility hubs, increased transit options such as bus rapid transit, and improvements to transit frequency and service areas).

The County worked closely with SANDAG as part of the 2015 Regional Plan to identify roads in the unincorporated areas to include in the Regional Arterial System (RAS). Many of these roads serve as evacuation routes during emergencies, provide access to unincorporated communities from Caltrans roads, and create a link to the larger San Diego region.

County staff would like to continue coordinating with SANDAG to further identify Regional Plan investments in infrastructure, technology, and communication improvements for roads identified in both the County's Mobility Element and unincorporated roads included in the RAS and how these investments will further connect the unincorporated area to proposed mobility hubs, flexible fleets, or transit leaps. In addition to providing efficient movement of people and goods, these investments would increase the efficiency of evacuation routes, relay important information on evacuation conditions to first responders, and assist in getting residents safely away from hazardous conditions, all important components of resiliency planning.

**FUNDING AND FINANCING**

County staff appreciates the difficulty in forecasting funding and revenue sources for a regional transportation network. The Regional Plan identifies use of TransNet funds as part of the implementation, but it is not clear whether projects that have previously been planned, programmed, or awarded as part of the previous plan using TransNet would retain that funding allocation, or if there would be a reallocation of these funds as part of the Regional Plan. It is also unclear if there would be any changes to the current allocation or use of funds that local agencies receive directly for local road system improvements. The unincorporated area relies on TransNet funding to build, improve, and maintain transportation facilities that enhance roadway safety and support smart growth development, including road infrastructure to support increased transit options. Loss or reallocation of this funding could affect these projects and limit the County's ability to provide transportation services in support of our goal of reducing greenhouse gas emissions.

The Regional Plan indicates that user fees would help build a transportation system that provides travelers with alternatives to driving. County staff would like to further discuss how the proposed road user charges would be developed, implemented, and applied to ensure that this funding strategy will not disproportionately burden unincorporated communities, which often have longer commutes and less access to alternative transportation options due to lack of regional planning for transit services to these communities. Revenues generated should also be allocated to support additional transportation and mobility options in unincorporated communities, while vehicle use by those with access to alternate modes of transportation should be disincentivized since their communities are receiving significant investments in public transit.

County staff looks forward to learning more about how future funding and investment would be applied to ensure that both the benefits and the costs of the Regional Plan are equitably distributed across the region.

**RESOURCE DISTRIBUTION**

The Regional Plan provides SANDAG with an opportunity to guide future investments in a way that meets smart growth objectives and reduces GHG emissions, but also guides future allocation of resources to achieve equitable outcomes. Several of the unincorporated communities, such as Lakeside, Spring Valley, and Ramona, have larger populations than some of the incorporated

12-49  
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12-49  
cont.

cities that are prioritized in the Regional Plan. In review of the proposed plan expenditures, a majority of the capital investments (55% of RTP funding) appear to go toward mobility hubs, complete corridors, and Next OS investments that are primarily outside of unincorporated communities. It is unclear what proportion of investment would go toward addressing mobility challenges within unincorporated communities and infrastructure investment that would provide linkages between the unincorporated areas and the proposed mobility hubs, transit leap, flexible fleets, and complete corridors. County staff is committed to working with SANDAG to further identify opportunities to equitably distribute the mobility benefits of the 5 Big Moves and further reduce GHG emissions regionwide.

The County appreciates the opportunity to comment on the Draft Regional Plan, and staff looks forward to future discussions regarding these comments. If you have questions regarding this letter, please contact Rami Talleh, Deputy Director with the Department of Planning and Development Services at 858-495-5475 or Rami.Talleh@sdcounty.ca.gov.

Sincerely,



SARAH E. AGHASSI  
Deputy Chief Administrative Officer

- cc: Chair Nathan Fletcher: Board of Supervisors, District 4
- Vice Chair Nora Vargas: Board of Supervisors, District 1
- Supervisor Joel Anderson: Board of Supervisors, District 2
- Supervisor Terra Lawson-Remer: Board of Supervisors, District 3
- Supervisor Jim Desmond: Board of Supervisors, District 5
- Kathleen Flannery, Acting Director, Planning and Development Services
- Jeff C. Moneda, Director, Department of Public Works
- Brian Albright, Director, Department of Parks and Recreation

Attachments:

- Attachment A: Comments from County Departments and Divisions
- Attachment B: Expansion Potential of Mobility Hubs (North County Metro, Lakeside, and Spring Valley)



SARAH E. AGHASSI  
 DEPUTY CHIEF ADMINISTRATIVE OFFICER

**ATTACHMENT A  
 2021 REGIONAL PLAN COMMENTS FROM COUNTY OF SAN DIEGO  
 DEPARTMENTS AND DIVISIONS**

County of San Diego (County) staff in Planning & Development Services, the Department of Public Works, and the Department of Parks and Recreation reviewed the San Diego Association of Governments' (SANDAG) Draft 2021 Regional Plan (Regional Plan), for applicability to their respective work programs and County initiatives that are planned or currently underway. The County offers the following comments for your consideration.

**TRANSPORTATION**

1. County staff would be interested to better understand and discuss further with SANDAG the potential for Regional Plan strategies to be used as part of a potential regional mitigation strategy related to Vehicle Miles Traveled (VMT).
2. When would funding be expected to be implemented related to Transit Leap/Flexible Fleet Connections to Mobility Hub areas, as this is a potential opportunity to reduce VMT for residents living in the unincorporated area?
3. The County has developed an Electric Vehicle (EV) Roadmap and is committed to assisting with the deployment of regionwide EV infrastructure to reduce GHG emissions in the transportation sector. Could SANDAG provide additional details on the future development, application, and implementation of the proposed Road User Fees and other proposed road usage revenues? Will consideration be given to exemptions for use of clean mobility strategies?
4. County staff would like to discuss with SANDAG staff the Regional Plan strategies, including funding for Major Transit (for purposes of CEQA, defined as a rail transit station, ferry terminal served by bus or rail, and a bus stop with two or more lines that provide transit service at 15 minute intervals or better during peak commute periods) in areas of the unincorporated area that are identified as "VMT efficient" in the SANDAG VMT Map.
5. There is significant investment in development and infrastructure in the Otay Mesa area, and Otay Mesa is identified as a "Mobility Hub" area in the RTP. County staff would like to better understand what funding has been identified for this "Mobility Hub" area.
6. County staff would like to discuss with SANDAG the potential for "Major Transit" services along the I-15 corridor, such as the potential for buses on shoulders.

12-50

**RESPONSE TO COMMENT 12-50**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Please see Plan responses L418 through L437 in Attachment P.2.

**ROADS/TRAFFIC/FIELD ENGINEERING**

7. Complete Corridors, such as the SR-67 and I-15 Corridors, are envisioned to act as the backbone of the regional transportation system. In addition to providing for safe and comfortable spaces to get around for all modes of transportation, road improvements such as intersection widening are important for the safe and reliable movement of all road users. County staff would like to discuss further identification and investment within complete corridors that provide linkages to the unincorporated area. These improvements could assist in providing routes for the County's eastern and northern rural regions that could be essential in the event of accidents or fire evacuation. For example, County staff would like to discuss with SANDAG the option of including safety improvements along the SR-67 Corridor on Wildcat Canyon Road, as this road is a relief route to SR-67. Additionally, road improvements on Old Hwy 395 and Pala Temecula Road in the north county may merit further conversation, as both of these roads serve as alternate routes to I-15 during peak traffic hours.
8. County staff would like to further discuss improvements of low flow crossings that are necessary to limit area flooding as well as the safe passage of motorists.
9. County staff would like to work with SANDAG to identify evacuation routes at a regional level, and the possibility of creating a separate section within the Regional Plan that would identify improvements of these routes and potential funding that could be part of the 2021 Regional Plan.
10. County staff would like to discuss with SANDAG how Smart Infrastructure and Connected Vehicles will address the legal and financial challenges with sharing traffic signal data with private entities and the liability of the potential misuse of signal timing data.
11. County staff would like to better understand the impact of Electric Vehicle Infrastructure on County of San Diego public right of way.

12-50  
cont.

**WATERSHED**

12. Stormwater Management & Regional Needs Assessment; suggested edits in Appendix R, page R-2:
  - a. "The County of San Diego has initiated an update of the 2010 Needs Assessment's 40-year water quality cost estimate using more recent water quality planning documents and strategies for achieving regulatory compliance and water quality objectives throughout the region. Since 2010, the Copermittees have worked to formulate Water Quality Improvement Plans (WQIPs) for the region's watersheds, including strategies, planned projects, and schedules to address their respective water quality objectives and compliance needs. The update to the Needs Assessment is intended to assist the County in planning and decision making and will draw upon the most recent WQIPs, with a focus on unincorporated areas to develop updated cost information."

**BIOLOGY**

13. Figure AA.1 shows the conserved habitat lands in the San Diego region (light green) and displays the areas included in the four subregional habitat conservation plans (subfigure).
- The Pre-Approved Mitigation Area (PAMA) of the South County Multiple Species Conservation Program (MSCP) and draft PAMA of the draft North County MSCP are labeled as "Proposed Conserved Habitat Lands" (dark green). This label may be misinterpreted by readers. While the MSCP Preserves will be assembled within the PAMA, not all PAMA designated lands will be conserved or are being actively pursued for conservation at this time.
  - The draft Focused Conservation Area (FCA) of the draft East County MSCP was not included in the "Proposed Conserved Habitat Lands" (dark green). This area is equivalent to the draft North County MSCP's draft PAMA and should be included in this figure.
  - The Rancho Guejito property located north of San Pasqual Valley Road will not be included in future iterations of the draft North County MSCP Permit Area. The portions of this property identified within the draft North County MSCP should be changed from dark green to white to reflect this change.
  - In the subfigure, both the draft North County MSCP and Multiple Habitat Conservation Plan (MHCP) are identified by the number "4." The MHCP area should be identified by the number "1" to correspond with the provided key.
14. Although the draft 2021 Regional Plan mentions the importance of protecting habitat corridors and wildlife linkages through land acquisition, it does not appear to include the construction of safe passageways to connect wildlife to preserved lands bisected by existing and future regional transit corridors. It is recommended that SANDAG work with the San Diego Monitoring and Management Program (SDMMP) and community partners to identify the areas along regional transit corridors that would benefit from wildlife crossings and that these improvements be included in future regional projects.

**PARKS AND RECREATION**

15. For proposed projects that occur adjacent to Department of Parks and Recreation (DPR) County-managed lands, DPR staff would like to coordinate with SANDAG staff to ensure wildlife connectivity is maintained from adjacent lands to preserved County lands, including wildlife-only crossings.
16. For proposed projects that occur adjacent to or near existing or potential future trail connections, DPR staff would like to coordinate with SANDAG staff on trail connectivity throughout the County and incorporate safe multi-use crossings such as bridges or overpasses for recreational use.
17. DPR staff request SANDAG staff coordinate in developing SANDAG's 5 Comprehensive Multimodal Corridor Plans as mentioned in Appendix B: Implementation near DPR facilities:
- Central Mobility Hub and Connections, Coast, Canyons, and Trails – State Route 52, North County – SPRINTER/Palomar Airport Road/State Route 78/State Route 76, San Vicente – State Route 67, South Bay to Sorrento – Purple Line/Interstate 805/Blue Line/Interstate 5 South.

12-50  
cont.

- b. Study additional seven corridors to inform the next Regional Continuing Actions.
- c. Pursue funding opportunities for projects, programs, and services identified in completed CMCPs.

18. County Staff would like to discuss with SANDAG the possibility of including trails and trail systems within the unincorporated area as part of the 2021 Regional Plan and to consider California Coastal Trail connections to DPR facilities.

**AIRPORTS**

19. As the owner and operator for eight airports in the region, County Airports continues efforts to safely operate its facilities, ensure future land uses are compatible with aircraft operations, and protect the health and safety of people and property within the vicinity of an airport. The County's airports serve as transportation hubs, emergency service facilities and economic engines in their communities. McClellan-Palomar Airport is the only commercial airport in North County and has over 145,000 annual aircraft operations. It is also a Customs and Border Protection Port of Entry. In East County, Gillespie Field is the 44<sup>th</sup> busiest airport in the nation with 240,000 annual operations. Both of these airports support thousands of jobs and generate hundreds of millions of dollars in economic activity. The County looks forward to the integration of these airports into the regional transportation system.

20. The San Diego County Regional Airport Authority adopted Airport Land Use Compatibility Plans for the eight airports, which included land use compatibility policies related to airspace, noise, safety and overflight. Those policies have been adopted by the County of San Diego through its General Plan and Zoning Code. After evaluating the forecasted increases in housing and jobs around the Mobility Hubs, there are several land use assumptions related to safety and noise around Fallbrook Airpark, Jacumba Airport, Gillespie Field and McClellan-Palomar Airport that County staff would like to better understand. For example, there are forecasted incompatible housing increases within the Runway Protection Zones at Gillespie Field. These inconsistencies could result in the assumed intensities and densities increases being unachievable.

12-50  
cont.



County of San Diego

SARAH E. AGHASSI  
DEPUTY CHIEF ADMINISTRATIVE OFFICER

LAND USE AND ENVIRONMENT GROUP  
1600 PACIFIC HIGHWAY, ROOM 212, SAN DIEGO, CA 92101  
(619) 531-6256  
www.sdccounty.ca.gov/lueg

**ATTACHMENT B**  
**2021 REGIONAL PLAN PROPOSED MOBILITY HUB EXPANSION AREAS**

The Regional Plan will focus future investment, development, and growth in centralized areas referred to as "mobility hubs." There are locations in the unincorporated area that the County has forecasted for future growth, which included already designated Regional Housing Needs Assessment (RHNA) sites, and are located within close proximity to a proposed mobility hub. The County would like to work with SANDAG to consider the expansion of proposed mobility hubs to include additional unincorporated north and east county communities. As indicated in Figure 1, these proposed expansions include areas in North County Metro, Lakeside, and Spring Valley. Additional details for these three mobility hub expansions are provided below.

12-51

The North County Metro community is located between the proposed Vista and San Marcos mobility hubs. Expansion of the San Marcos mobility hub could include the Buena Creek Sprinter Station and additional housing units, including multiple RHNA sites.

Lakeside has multiple areas that are identified as efficient areas compared to the regional vehicle miles traveled (VMT) average. These areas are located immediately adjacent to the proposed El Cajon mobility hub. Expansion of the El Cajon mobility hub could include these VMT efficient areas as well as potentially including additional growth areas in Lakeside along the I-8 corridor.

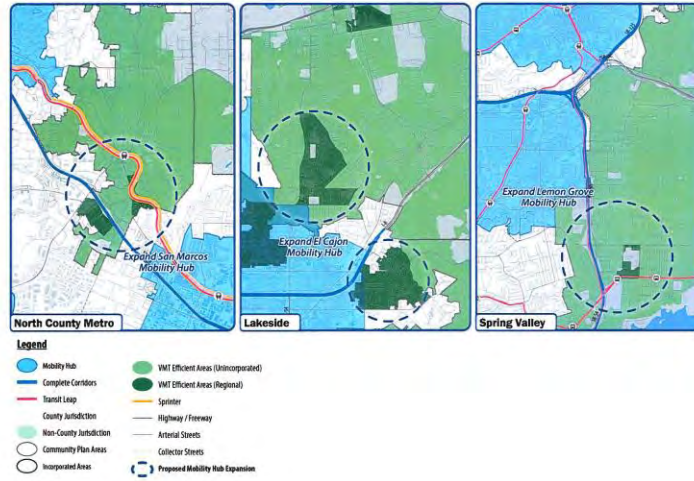
Spring Valley is located east of the proposed Lemon Grove mobility hub and south of the proposed La Mesa mobility hub. This community has existing transit access along Jamacha Boulevard and is in close proximity to the MTS Trolley stations in Lemon Grove. Expansion of this mobility hub could include the Spring Valley areas near SR-125 and along Jamacha Boulevard.

**RESPONSE TO COMMENT 12-51**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Please see Plan response L438 in Attachment P.2.



Figure 1 Proposed Mobility Hub Expansions in North and East County





County of San Diego

MARK WARDLAW  
DIRECTOR

PLANNING & DEVELOPMENT SERVICES  
5510 OVERLAND AVENUE, SUITE 310, SAN DIEGO, CA 92123  
(658) 694-2962 • Fax (658) 694-2555  
www.sdcountry.ca.gov/pds

January 13, 2017

Andrew Martin  
Senior Regional Planner  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

Via email to: [Andrew.martin@sandag.org](mailto:Andrew.martin@sandag.org)

**COMMENTS ON THE NOTICE OF PREPARATION OF A PROGRAM ENVIRONMENTAL  
IMPACT REPORT FOR SAN DIEGO FORWARD: THE REGIONAL PLAN**

Dear Mr. Martin,

12-52 | The County of San Diego (County) has reviewed the Notice of Preparation for the San Diego Forward Regional Plan Program Environmental Impact Report (PEIR). We appreciate the opportunity to provide input for SANDAG's consideration. The County offers the following comments.

**TRAFFIC/TRANSPORTATION**

12-53 | The County is currently developing an Active Transportation Plan (ATP) for the unincorporated communities of the county. The ATP will integrate and update several existing plans and documents into a single plan. The ATP will serve as a master plan and policy document to guide the development and maintenance of active transportation infrastructure including sidewalks, pathways, multi-use trails, and bikeways; the ATP will include the Safe Routes to School programs for the unincorporated county. Additionally, the ATP is expected to be one of the implementation measures for the County's Climate Action Plan. Please consider identifying transit improvements and ATP and Transportation Demand Measures (TDM) in the SANDAG Regional Plan and PEIR which will assist the rural unincorporated areas in meeting the region's greenhouse gas (GHG) emission goals.

**RESPONSE TO COMMENT 12-52**

This comment was submitted during the NOP scoping period for the EIR and is not a comment on the adequacy of the EIR. No additional response is required.

**RESPONSE TO COMMENT 12-53**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

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**AIRPORTS**

12-54

Incorporating the Regional Aviation Strategic Plan (RASP) and Airport Multimodal Accessibility Plan (AMAP) assumptions into the development of the Regional Plan is an important part of planning for the region's future transportation needs. Aviation travel is expected to grow substantially according to projections from the San Diego Regional Airport Authority and SANDAG. Please consider prioritizing the ground transportation network surrounding McClellan-Palomar and Gillespie Field airports to accommodate increased demand as San Diego International Airport nears operational capacity.

**CLIMATE CHANGE AND GREENHOUSE GAS**

12-55

The County is currently developing a Climate Action Plan for the unincorporated county. The largest GHG emission source in the region is the Transportation Sector. The County looks towards the Regional Plan to lead the efforts in reducing GHG emissions in the Transportation Sector. The recommendations noted are important for the local jurisdictions in meeting their share of the region's GHG emission reductions. The County and SANDAG, working collaboratively on the Regional Plan, can move towards an efficient and cleaner multi-modal transportation system. As it relates to SANDAG's Regional Plan, the County requests the following be considered:

- a. Analyze alternatives that address multi-modal transportation options for the unincorporated county, particularly as it relates to transit service and alternative fuel infrastructure;
- b. Analyze whether the developed/urban communities within the unincorporated county meet the Urban Area Transit Strategy;
- c. Analyze an environmentally sustainable transportation system that can reduce vehicle miles traveled, gasoline consumption, and GHG emissions, while providing alternatives modes of transportation for all economic sectors of our population;
- d. Clarify whether the Regional Plan GHG emission reductions will be consistent with the Air Resources Board (ARB) 2030 Target Scoping Plan; and
- e. SANDAG's 2015 Regional Transportation Plan incorporated the County's 2011 General Plan Update Land Use and Mobility Elements. Since 2011, the County has adopted several general plan amendments (GPA) to the 2011 General Plan. The County requests that SANDAG staff coordinate with County staff to ensure that the adopted GPAs are incorporated in the transportation models and growth forecasts for the Regional Plan and PEIR Analysis.

**RESPONSE TO COMMENT 12-54**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. SANDAG has incorporated the Regional Aviation Plan (RASP) and Airport Multimodal Accessibility Plan (AMAP), and these can be found in Appendix BB of the proposed Plan. SANDAG will assess the ground transportation network throughout the region and prioritize transportation projects from the RASP and AMAP where appropriate and most needed.

**RESPONSE TO COMMENT 12-55**

This comment consists of County comments on the NOP, which appear to be similar to comments included in the County's letter on the Draft EIR, and which have been responded to in prior responses. Also note that the comment does not raise any issues about the adequacy of the Draft EIR and no response is required. However, the following clarifications are provided:

(a) The proposed Plan includes a transportation system that includes multi-modal options for the unincorporated county, such as investments in transit service, flexible fleets, active transportation, and electric vehicle programs.

(b) The Urban Area Transit Strategy was not updated for the proposed Plan. The proposed Plan identifies 31 Mobility Hub areas as focus areas for facilitating access to transit, deploying flexible fleet services, implementing complete streets, and focusing future growth and development. Chapter 2 of the proposed Plan also acknowledges the importance of transit priority areas as areas of focus for future planning efforts between SANDAG and local jurisdictions in support of sustainable communities. As shown in Figure 2.6 of the proposed Plan, there are unincorporated communities contained in Mobility Hub areas and/or transit priority areas.

(c) Performance results of the proposed Plan (see Appendix T of the Plan) demonstrate a reduction in per capita vehicle miles traveled and per capita GHG emissions. The Social Equity Analysis of the proposed Plan (see Appendix H of the Plan) demonstrates an increase in access to alternative modes of transportation to low income, minority, and senior populations.

(d) The comment asks SANDAG to clarify whether GHG emissions reductions under the proposed Plan would be consistent with the "Air Resources Board (ARB) 2030 Target Scoping Plan." SANDAG assumes

this is a reference to California's 2017 Climate Change Scoping Plan (2017 Scoping Plan), which identifies measures for how California can achieve the GHG reduction target of SB 32, which set forth in State law a requirement that statewide GHG emissions levels be reduced to 40 percent below 1990 levels by 2030.

The Draft EIR analyzes whether the proposed Plan would be inconsistent with the State's ability to achieve the 2030 reduction target of SB 32 in Impact GHG-5 (Draft EIR pages 4.8-31 to 4.8-33). The proposed Plan would assist in meeting the statewide 2030 GHG target by reducing GHG emissions in the passenger vehicle sector through the implementation of transportation network improvements and programs and efficient land use patterns to ultimately reduce VMT and the combustion of gasoline and diesel fuels pursuant to SB 375. Nevertheless, the Draft EIR concludes in Impact GHG-5 that the proposed Plan's 2030 GHG emissions would be inconsistent with the State's ability to achieve the goals of SB 32 because total emissions in the San Diego region of 20.4 MMTCO<sub>2e</sub> in 2030 would exceed the regional 2030 GHG reference point of 15.6 MMTCO<sub>2e</sub> (which is based on SB 32 targets for 2030). The 2017 Scoping Plan indicates that to achieve the statewide 2030 target, long-term investments in renewable energy generation, electrified transportation, energy efficient and decarbonized buildings, enhanced industry efficiency, restoration of California's natural and working lands, and sustainable solid waste management are among many actions the State must take. Many of the needed actions, including generation of renewable electric power, decarbonizing buildings, vehicle mandates, and sustainable solid waste management, are outside the jurisdictional authority of SANDAG and the scope of the proposed Plan. CARB notes that to reach the State's long-term GHG reduction goals, local, regional, and State agencies must engage with each other and local stakeholders to coordinate climate change solutions and programs to reduce local GHG emissions.

The Draft EIR identifies Impact GHG-5 as a significant impact in the year 2030. The Draft EIR identifies several mitigation measures to reduce this significant impact by achieving additional GHG emissions reductions above and beyond the reductions shown in the analysis for GHG-5 (mitigation measures AQ-3b, AQ-3c, AQ-4, TRA-2, WS-1a, WS-1b, GHG-5a, GHG-5b, GHG-5c, GHG-5d, GHG-5e, and GHG-5f). However, even with additional GHG emissions reductions from these mitigation measures, total regional GHG emissions would remain inconsistent with the State's ability to achieve the 2030 target. Achieving the necessary

level of reductions from all GHG emissions sectors will required a coordinated effort by, at minimum, State, regional, and local agencies, organizations, and stakeholders, and is well beyond the scope and jurisdiction of SANDAG alone. The Draft EIR concludes that Impact GHG-5 would be significant and unavoidable.

(e) In 2016–2018, local jurisdictions, including the County of San Diego, provided data to SANDAG on housing capacity based on their adopted plans to inform the Series 14 forecast development.



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#### MULTIPLE SPECIES CONSERVATION PLAN (MSCP)

12-56 The proposed Regional Plan covers areas that are critical to the County's Multiple Species Conservation Program (MSCP), both North and South County plans—including the assembly of a Preserve in each. The South County Subarea Plan was adopted in 1997; and the North County Plan is currently in development. As the Regional Plan encourages projects that are consistent with an SCS that achieves GHG reductions, we would anticipate that the PEIR would analyze the effects of the proposed Regional Plan on the MSCP South and North County plans, the assembly of the Preserve and full implementation of the plans. Any effect (direct or indirect) of the Regional Plan on the MSCP should be evaluated (and mitigated, if necessary). SANDAG staff should coordinate with County staff to best determine how to evaluate the MSCP South and NC Plan in the upcoming Regional Plan and PEIR.

#### PARKS AND RECREATION

12-57 The County's trails and pathway network provides safe, secure, healthy, affordable, and convenient travel choices between the places where people live, work, and play while reducing use of personal vehicles, thereby reducing GHG emissions. Please consider incorporating a discussion of the County's Community Trails Master Plan and encourage investment in trails and pathways that connect people with places where they live, work, and play.

#### VECTOR CONTROL PROGRAM

The County's Vector Control Program (VCP) is responsible for the protection of public health through the surveillance and control of mosquitoes that are vectors for human disease including West Nile virus (WNV). The VCP has completed their review and has the following comments regarding the Regional Plan.

- 12-58
1. The VCP requests that when implementing transportation projects or components of the environmental mitigation program, impacts from possible mosquito breeding sources are considered. Any area that is capable of accumulating and holding at least ½ inch of water for more than 96 hours can support mosquito breeding and development.
  2. For your information, the County's Guidelines for Determining Significance for Vectors can be accessed at [http://www.sandiegocounty.gov/content/dam/sdc/pds/docs/vector\\_guidelines.pdf](http://www.sandiegocounty.gov/content/dam/sdc/pds/docs/vector_guidelines.pdf).
  3. The California Department of Public Health Best Management Practices for Mosquito Control in California is available at <http://www.cdph.ca.gov/HealthInfo/discond/Documents/BMPforMosquitoControl07-12.pdf>.

#### RESPONSE TO COMMENT 12-56

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Please see response to comment County of SD 12-11.

#### RESPONSE TO COMMENT 12-57

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. At the regional and local level, SANDAG is supportive of planning efforts for locally sponsored trails and pathway networks as alternative transportation options and that foster improved neighborhoods and community connections. Please see discussions provided in Impact LU-1 in Section 4.11 and Section 4.15.

#### RESPONSE TO COMMENT 12-58

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. SANDAG understands the need for vector control and appreciates the information provided by the County and will take these measures into consideration when implementing transportation projects or components of the environmental mitigation programs.

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12-59 | The County looks forward to receiving future documents and/or notices related to this project and providing additional assistance at your request. If you have any questions regarding these comments, please contact Danny Serrano, Land Use / Environmental Planner at (858) 694-3680, or via email at [daniel.serrano@sdcounty.ca.gov](mailto:daniel.serrano@sdcounty.ca.gov).

Sincerely,



MARY KORASKIE, Chief  
Advance Planning Division  
Planning & Development Services

Email cc: Michael De La Rosa, Policy Advisor, Board of Supervisors, District 1  
Adam Wilson, Policy Advisor, Board of Supervisors, District 2  
Dustin Steiner, Chief of Staff, Board of Supervisors, District 3  
Adrian Granda, Policy Advisor, Board of Supervisors, District 4  
Melanie Wilson, Policy Advisor, Board of Supervisors, District 5  
Vincent Kattoula, CAO Staff Officer, LUEG  
Nick Ortiz, Project Manager, PDS  
Everett Hauser, Transportation Specialist, PDS  
Bulmaro Canseco, Planner, PDS  
Jeff Kashak, Planner, DPW  
Richard Chin, Associate Transportation Specialist, DPW  
Eric Lardy, Chief, Community Health Division, DEH

### RESPONSE TO COMMENT 12-59

The County's comments on the NOP were considered during preparation of the Draft EIR.



**COMMENT LETTER 13: CITY OF DEL MAR**

Comment Letter 13



October 4, 2021

SANDAG Regional Plan EIR  
 c/o Kirsten Uchitel, Associate Planner  
 SANDAG  
 401 B Street, Suite 800  
 San Diego, CA 92101  
[RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)

SENT VIA EMAIL

**RE: City of Del Mar Comments on the Draft Environmental Impact Report for the Draft 2021 Regional Plan**

Dear Ms. Uchitel:

On behalf of the City of Del Mar, thank you for the opportunity to provide formal comments on the San Diego Association of Government's (SANDAG) Draft Environmental Impact Report (DEIR) for the Draft 2021 Regional Plan. The City's comments are provided as follows:

- 13-1 | **1. COMMENT – PROJECT DESCRIPTION**  
**Pages 2-32, 2-34, 2-35, 2-36, 2-62 and Figures 2-20, 2-21, 2-22, 2-35**  
  
 The DEIR identifies Mobility Hubs as Coastal, Gateway, Major Employment Center, Suburban, and Urban, but does not provide an illustrative exhibit showing areas considered part of the Mobility Hubs. The City of Del Mar (City) recognizes that Table 2-11 on pages 2-59 and 2-60 provides a list by region for each Mobility Hub, but it is unclear what jurisdictions are associated with the Mobility Hubs. For example, it is unclear what portions of the City are included in the Solana Beach Mobility Hub. Further, the reference to Solana Beach is misleading as it also includes area in the City of Del Mar. From the figures, it appears that the Mobility Hub extends across the northern area of the City referred to as the North Bluff, a portion of North Beach, and a majority of the Del Mar Fairgrounds property.
- 13-2 | **Request 1:** The City requests an illustrative exhibit be provided in the Project Description that adds this clarity to the DEIR.
- 13-3 | **Request 2:** The figures provided in 2-20, 2-21, 2-22, and 2-35 are difficult to understand at a jurisdiction level due to the scale provided. The City requests these figures be separated and included at a smaller scale in greater detail. The City also

1050 Camino Del Mar, Del Mar, CA 92014 | 858.755.9313 | [www.delmar.ca.us](http://www.delmar.ca.us)

**RESPONSE TO COMMENT 13-1**

A map depicting the five different mobility hub types has been added to Chapter 2, *Project Description*, of the Final EIR as Figure 2-37. Figures 2-2.1 through 2-2.11 have also been added to the Project Description of the Final EIR to provide greater granularity on the Mobility Hub areas and projects in the proposed Plan at a corridor level. A portion of the City of Del Mar is included in the Solana Beach mobility hub, as reflected in Figures 2-2.5 and 2-2.8 in the Project Description of the Final EIR.

**RESPONSE TO COMMENT 13-2**

Please see response to comment Del Mar 13-1.

**RESPONSE TO COMMENT 13-3**

Figures 2-20, 2-21, 2-22, and 2-35 are intended to illustrate housing and employment density on a regional scale to demonstrate the process for identifying the areas targeted for development of Mobility Hub Networks. These maps are not intended to demonstrate exact locations of future Mobility Hubs. SANDAG did not include jurisdictional boundaries on these maps because the addition of this layer would have made the maps much harder to read given the amount of information already included. Major regional transportation corridors (i.e., interstates and state routes) are included to provide locational context.

13-3  
 cont. requests City jurisdiction lines be included as a matter of transparency. Otherwise, it is unclear where the City's boundary lines are located.

13-4 **Request 3:** Since the Del Mar Fairgrounds appears to be included in the Solana Beach Mobility Hub, the City requests an additional area southwest of the boundary be studied as part of the Mobility Hub. The City recognizes the DEIR is studying the areas included in the Draft 2021 Regional Plan, so this comment is requesting additional analysis be included so that the southeast boundary can be extended east to meet Jimmy Durante Boulevard (at minimum) or even further east to meet I-5. This is requested because these undesignated areas are immediately adjacent and outside the boundary of the Mobility Hub, as proposed, yet include key access points to major roads, the freeway, and major employment centers.

**2. COMMENT – PROJECT DESCRIPTION**  
**Pages 2-55, 2-56, 2-57 and Figures 2-32, 2-33, 2-34**

13-5 The DEIR illustrates the region's transit networks in 2025, 2035, and 2050 via a mix of Commuter Rail, Light Rail, Next Gen Rapid Bus, Local Bus, and Ferry. In 2025, Commuter Rail and Local Bus are designated in the City; however, in 2035, Next Gen Rapid Bus is introduced east-west on Del Mar Heights Road and north-south on Camino del Mar. Rail relocation inland from the Del Mar Bluffs is of critical importance to the City. The proposed 2025, 2035, and 2050 transit network maps do not reflect a realignment of the rail network in this fragile coastal region. The following requests are intended to ensure transparency and clarification to the public, and that sufficient analysis is provided within this Program-level DEIR.

13-6 **Request 1:** The City requests a callout be added to Figures 2-32, 2-33, and 2-34 indicating that the Commuter Network in said area is pending additional study for future inland realignment. The City further requests this be clarified on the figures via a dashed line through the Del Mar rail corridor and noted in the key legend.

13-7 **Request 2:** The City requests narrative be added to this section of the DEIR describing the planned realignment of the Commuter Rail network through the Del Mar rail corridor. The City further requests a clarification be made regarding the horizon years for: 1) the Del Mar Tunnel, which appears to be 2035; 2) the rail realignment inland from the Del Mar Bluffs, which is not specifically noted, however, Table E-6-3 in Appendix E-6 indicates this may be planned for 2050, not 2035, due to identified marsh and riparian scrub habitat impacts associated with "Commuter Rail 398" projects (although the identified amounts are relatively small at 0.2 acre of marsh and 0.4 acre of riparian scrub so it is unclear if this is intended to account for the inland rail

**RESPONSE TO COMMENT 13-4**

As SANDAG collaborates with cities on proposed Plan project and policy implementation in the years to come, conceptual Mobility Hub boundaries will be refined while taking into consideration city corridor and land use planning goals and policies, similar to what has already begun as part of the Comprehensive Multimodal Corridor Plans (CMCP) planning and design process. The City's request will be considered as part of this process. More detailed network-level analysis will be needed within each Mobility Hub to finalize detailed Transit Leap routing, Complete Corridor cross-sections, Flexible Fleet pilots, and supporting technologies.

**RESPONSE TO COMMENT 13-5**

Resilience of transportation infrastructure to climate impacts is a priority of the proposed Plan. As such, the relocation of the rails off of the Del Mar bluffs is a priority project recognized in the Appendix A of the proposed Plan as part of the 2035 Commuter Rail 398 project (Project ID TL06), with planning already underway.

**RESPONSE TO COMMENT 13-6**

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects subject to project-specific environmental review. The Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and the seasonal platform at the Del Mar Fairgrounds are considered second-tier projects. Callouts showing future second-tier projects on the referenced figure would not be feasible and are not within the scope of this Program EIR's project description.

**RESPONSE TO COMMENT 13-7**

The Del Mar tunnel is a top priority for SANDAG. Planning work is underway with preliminary engineering, and the environmental phase is expected to begin as soon as 2022 if funding is secured. The Del Mar Tunnel project is in the 2035 phase in the proposed Plan and the inland rail realignment is assumed as part of the tunnel project. Timing for bluffs restoration will be determined as the tunnel and inland rail realignment projects progress.

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13-7 relocation component); and 3) and restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures. It is unclear if the rail relocation and bluffs restoration is planned for 2035 or 2050.

13-8 **Request 3:** The City requests a notation on the figures and narrative be included to clarify that the COASTER route through Del Mar is referred to as "Commuter Route 398" in the DEIR.

13-9 **Request 4:** Due to the thick purple line delineation of the Commuter Rail alignment through Del Mar, it is difficult to view the light blue delineation noting the addition of Next Gen Rapid Bus in Figures 2-33 (2035) and 2-34 (2050). The City requests these figures be refined so that the planned Next Gen Rapid Bus along Del Mar Heights Rd (east-west) and Camino del Mar (north-south) are clearly shown and viewable to the public.

**3. COMMENT – PROJECT DESCRIPTION**  
**Page 2-58**

13-10 The DEIR notes that between 2026 to 2035, "major transportation improvements and programs would include continued double tracking at certain locations on the LOSSAN rail corridor, increases in COASTER frequencies, Del Mar Tunnel, new stations at Central Mobility Hub and at Camp Pendleton..." However, this section does not specifically include reference to a relocation of the rail corridor inland from the Del Mar Bluffs (though implied by the Del Mar Tunnel reference) or restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures. See above comment related to the 2035 or 2050 timeframe for the inland rail relocation. Further, this section does not list the proposed station (seasonal platform) at the Del Mar Fairgrounds. Note that the DEIR lists other planned rail stations in the region.

13-11 **Request:** The City requests that the inland rail relocation from the Del Mar Bluffs and seasonal platform at the Del Mar Fairgrounds be added to the project description and included in the DEIR analysis where appropriate, including inclusion into the 2035 or 2050 timeframe. Without the inclusion of these two key items, the extent of the DEIR project description is confusing to the public and inadequate.

**RESPONSE TO COMMENT 13-8**

These figures do not depict the transit leap network at the level of granularity required to complete the request. Route 398 is identified in Table A.5: Interstate North Coast Corridor, in Appendix A of the proposed Plan, as projects TL05, TL06, and TL07.

**RESPONSE TO COMMENT 13-9**

Specific corridor maps have been added to Appendix A of the proposed Plan so that the reader can see the difference between the proposed Plan projects within each corridor. These will be included as maps A.1 through A.12 in the proposed Plan.

**RESPONSE TO COMMENT 13-10**

While not specifically referenced in the 2025 Commuter Rail 398 (COASTER) project, the Bluff Stabilization Project (among others) is included in that phase, and those cost are represented in the \$1.2 billion cost assumptions. Also, the Del Mar Tunnel project is included in the 2035 phase. Specific alignments will be chosen once the project goes through the project-level environmental analysis phase. Relocation away from the bluffs is assumed as part of the tunnel project in the 2035 phase. The Del Mar platform is part of the San Dieguito Double Track Project, which is included in the 2025 Commuter Rail 398 project grouping.

**RESPONSE TO COMMENT 13-11**

The Del Mar platform is part of the San Dieguito Double Track Project, which is included in the 2025 Commuter Rail 398 project grouping. Relocation away from the Bluffs is assumed as part of the tunnel project in the 2035 phase.

13-12	<p><b>4. COMMENT – AESTHETICS</b>  <b>Page 4.1-11, Table 4.13</b></p> <p>Under “Visual Plan or Regulation,” the DEIR includes reference to the City’s Trees, Scenic Views, and Sunlight Protection Ordinance. Under “Local Scenic Resources,” the DEIR notes the City’s Local Coastal Program (LCP) with a date of 1993. These sections do not reflect additional provisions in the City’s codes related to scenic resources.</p>
13-13	<p><b>Request 1:</b> The City requests the correct code reference be made to the Trees, Scenic Views, and Sunlight Ordinance. This is City of Del Mar Municipal Code, Chapter 23.51 (not 30.52).</p>
13-14	<p><b>Request 2:</b> The City requests that “Visual Plan or Regulation” be updated to include reference to the City’s Bluffs, Slopes, and Canyon Overlay Zone (BSC-OZ) which is part of the City’s certified LCP (City of Del Mar Municipal Code, Chapter 30.52). As stated in the chapter, the “BSC Overlay Zone is designed to ... preserve the scenic sandstone bluffs and related canyons and steep slopes which characterize the area within the zone...The unique landforms within the zone provide visual relief and diversity within the City, and they define and separate neighborhoods, enhance the overall quality of Del Mar’s local coastal environment, and preserve the economic integrity of our visitor-oriented community.”</p>
13-15	<p><b>Request 3:</b> The City requests that “Local Scenic Resources” be updated to reflect the correct certification years for its LCP – should read “Local Coastal Program Land Use Plan (1993) and Implementing Ordinances (2001)” and the list should also include references to “canyons and steep slopes.”</p>
13-16	<p><b>5. COMMENT – AESTHETICS</b>  <b>Page 4.1-7</b></p> <p>The DEIR states that “some of the other local jurisdictions within the San Diego region have adopted scenic highway general plan elements or programs.” The City’s Community (General) Plan lists five principal roadways within the City as scenic corridors. These include: 1) Camino del Mar; 2) Crest Road; 3) Carmel Valley Road; 4) Coast Boulevard; and 5) Del Mar Heights Road (Community Plan, Transportation Element, pages 43-47). These roads have been determined by the City to allow for special views of scenic natural resources and to afford greater protection in order to maintain those views. Camino del Mar, Coast Boulevard, and Del Mar Heights Road offer scenic views of the Pacific Ocean. Crest Road offers views of the San Dieguito</p>

**RESPONSE TO COMMENT 13-12**

The text on page 4.1-11 of the EIR, in Table 4.1-3, has been updated as described in response to comments Del Mar 13-13 through Del Mar 13-15, in regards to additional provisions in the City’s codes related to scenic resources.

**RESPONSE TO COMMENT 13-13**

The City of Del Mar Municipal Code reference in Table 4.1-3 has been updated to reference the correct section of the Municipal Code (Chapter 23.51).

**RESPONSE TO COMMENT 13-14**

The “Visual Plan or Regulation” column on Table 4.1-3 has been updated to include a brief discussion of Municipal Code Chapter 30.52, *Bluff, Slope, and Canyon Overlay Zone*.

**RESPONSE TO COMMENT 13-15**

The “Local Scenic Resources” column on Table 4.1-3 has been updated to include the references to the Implementing Ordinances (2001) and to list “canyons and steep slopes” as resources identified in the listed documents.

**RESPONSE TO COMMENT 13-16**

The Draft EIR correctly states that “some of the other local jurisdictions within the San Diego region have adopted scenic highway general plan elements or programs.” Identifying all local scenic roadways or corridors within each jurisdiction is not necessary for programmatic impact analysis in the EIR. The project-specific evaluation of potential aesthetics impacts resulting from planned 2035 development in/adjacent to the City of Del Mar including the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, will occur during the project-specific environmental review process for these improvements.

13-16 River Valley as well as Crest Canyon and the North Bluffs adjacent to North Beach. Del Mar Heights Road and Carmel Valley Road serve as the City's southerly roadway connections to I-5. Views of Los Peñasquitos Lagoon are visible from Carmel Valley Road.

13-17 **Request:** The City requests its five principal roadways as noted above be included in the framework section of the Aesthetics chapter (similar to how other chapters in the DEIR describe relevant General Plan policies by local jurisdiction – see e.g., page 4.4-54, Table 4.4-6 in Biological Resources). This is important for the evaluation of potential aesthetics impacts resulting from planned 2035 development in/adjacent to the City of Del Mar including the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures.

**6. COMMENT - AESTHETICS**  
**Pages 4.1-18, 4.1-20**

13-18 The DEIR states for horizon year 2025 that, "Development in the Coastal Zone would need to adhere to the California Coastal Act and local coastal plans, while typical measures in local plans require development to be sited and designed to protect views to and along the ocean and other scenic coastal areas." A conclusion is noted that "these measures would reduce adverse effects on scenic vistas." A similar conclusion is noted for horizon year 2035 on page 4.1-20 regarding adherence to the Coastal Act. Further, page 4.1-20 states that implementation of the Big 5 Moves would include construction of "Complete Corridor improvements consisting of continued double-tracking at certain locations on the LOSSAN rail corridor, increase in COASTER frequencies, and grade separation at Leucadia Blvd." However, this impact analysis does not include the cited 2035 Del Mar Tunnel on page 2-58 (though it lists all other 2035 components), nor does it include reference to the inland rail relocation from the Del Mar Bluffs, the restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, or the planned seasonal rail platform at the Del Mar Fairgrounds.

13-19 **Request:** The City requests the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, and planned seasonal rail platform at the Del Mar Fairgrounds be included in the Aesthetics section and analyzed accordingly. Without inclusion of these components, including the cited Del Mar Tunnel on page 2-58, and sufficient analysis of these components in this impact section, the City is

**RESPONSE TO COMMENT 13-17**

Page 4.1-17 of the EIR, provides a general characterization of the coastal scenic resources, including scenic vistas in the North County area that would be affected by new development, and includes the long-range views of the coastal mountain ranges and habitat preserves, unobstructed views of the Pacific Ocean from the Pendleton-De Luz area, and views of highly scenic lagoons and waterways such as Batiquitos, Agua Hedionda, Buena Vista, San Elijo, and Los Peñasquitos Lagoons, and the San Dieguito and San Luis Rey Rivers along the I-5 corridor. As stated in the EIR, the locations of some transportation network improvements and certain design features (e.g., above-grade facilities, retaining walls, sound attenuation walls, cut-and-fill activities) cannot avoid physical changes that have substantial adverse effects on scenic vistas, including blocking panoramic views or views of major landscape features or landforms. The EIR concludes that implementation of regional growth and land use change and transportation network improvements would result in new development and infrastructure affecting scenic resources, including trees, rocks, outcroppings, and historic structures within a state scenic highway and local scenic routes and protected public viewsheds. The impact in the year 2035 is significant. Also, see response to comment Del Mar 13-16 regarding program-level vs. project level CEQA analysis of aesthetics impacts.

**RESPONSE TO COMMENT 13-18**

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects would be subject to project-specific environmental review. With a programmatic level of analysis, the EIR provides a general assessment of potential impacts in the coastal regions, as discussed above. The evaluation of potential aesthetics impacts resulting from second-tier projects, including planned 2035 development in/adjacent to the City of Del Mar such as the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, will occur as part of the project-specific environmental review process for these improvements.

**RESPONSE TO COMMENT 13-19**

See response to comment Del Mar 13-18 above.

13-19 cont. | unable to provide further comment on the impacts, conclusions, and/or mitigation measures at this time.

**7. COMMENT- AESTHETICS**  
**Pages 4.1-28, 4.1-29, Table 4.1-5**

13-20 | The DEIR impact analysis does not include the cited 2035 Del Mar Tunnel on page 2-58 (though it lists all other 2035 components), nor include reference to the inland rail relocation from the Del Mar Bluffs, the restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, or the planned seasonal rail platform at the Del Mar Fairgrounds. This includes no reference to these items in Del Mar under Table 4.1-5 on page 4.1-29.

13-21 | **Request:** The City requests the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, and planned seasonal platform at the Del Mar Fairgrounds be included in the Aesthetics section and analyzed accordingly. Without inclusion of these components, including the cited Del Mar Tunnel on page 2-58, and sufficient analysis of these components in this section, the City is unable to provide further comment on the impacts, conclusions, and/or mitigation measures at this time.

**8. COMMENT - AESTHETICS**  
**Page 4.1-23**

13-21 | The DEIR makes the reference, "The SPRINTER rail lines would be extended from Escondido to the North County Fair" as part of the 2050 Transportation Network Improvements and Programs. As a matter of clarification, this is presumed to be the "Westfield North County Shopping Center" and not the "Del Mar Fairgrounds" located in the City of Del Mar.

13-23 | **Request:** The City requests any reference to "North County Fair" be amended to "Westfield North County Shopping Center" in order to avoid confusion with the intended location of the SPRINTER extension.

**9. COMMENT - AESTHETICS**  
**Pages 4.1-42, 4.1-43**

13-24 | The DEIR describes components of the horizon year 2035 Transportation Network Improvements and Programs related to transit service as "increases in service for the COASTER..." but does not include reference to the Del Mar Tunnel, which would

**RESPONSE TO COMMENT 13-20**

See response to comment Del Mar 13-18 above.

**RESPONSE TO COMMENT 13-21**

See response to comment Del Mar 13-18 above.

**RESPONSE TO COMMENT 13-22**

Reference to the "North County Fair" has been amended to "Westfield North County Shopping Center" on pages 4.1-23, 4.1-30, and 4.1-39 of the EIR.

**RESPONSE TO COMMENT 13-23**

See response to comment Del Mar 13-22 above.

**RESPONSE TO COMMENT 13-24**

Page 4.1-43 of the EIR states that "due to the highly urbanized nature of the area surrounding these improvements (increases in service for the COASTER), substantial sources of additional lighting and glare would not occur." The text has been amended to include increases in Amtrack and Freight Service. The EIR does not dismiss aesthetic impacts but acknowledges that impacts would occur on a local level and would be evaluated at a local level on a project-by-project basis. Therefore, the detailed analysis relative to the proposed Del Mar Tunnel including security and/or maintenance lighting will be evaluated at the project-specific level, at which time the level of impacts will be determined and appropriate mitigation measures will be identified.



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13-24  
 cont. | include an inland rail relocation from the Del Mar Bluffs. Potential inland realignments will alter the location of rail service, including the referenced increase in COASTER service as well as AMTRAK and freight rail service through the City of Del Mar. During evening hours, it is anticipated that rail lighting including train headlights will result in new lighting and/or glare effects on public nighttime views not currently experienced under Existing Conditions. Further, it is not known if any other lighting would be associated with the Del Mar Tunnel including security and/or maintenance lighting.

13-25 | **Request:** The City requests this impact section be updated to include the Del Mar Tunnel and inland rail realignment from the Del Mar Bluffs, with associated analysis provided related to the new lighting and/or glare effects from train lights, increased train frequency, and any associated lighting for the Del Mar Tunnel including but not limited to security and/or maintenance lighting.

**10. COMMENT – AIR QUALITY**  
**Pages 4.3-35, 4.3-36**

13-26 | The DEIR describes components of the 2035 Transportation Network Improvements and Programs as including “expanded commuter rail services (Commuter Rail 582) improvements between Sorrento Mesa and National City,” Trolley line improvements, and a People Mover at the San Diego Airport. This section does not include references to increased service for the COASTER (e.g., as cited on pg. 4.1-42), or other rail network service improvements including AMTRAK or freight rail movement, all of which utilize diesel engines. Further, this section does not discuss the Del Mar Tunnel and potential concentrations (could be referred to as “hot spots”) of train emissions produced from tunnel exhaust systems in focused areas and their associated effects on residential areas with sensitive (65+) populations and/or two public elementary schools west of I-5 adjacent to the City’s east boundary (Del Mar Hills Academy and Del Mar Heights). Pursuant to the City’s recently adopted 6<sup>th</sup> Cycle Housing Element, in 2017 nearly 26% of City residents were 65 years or older, and 12% under 18 years based on the American Community Survey, 2017 ([www.delmar.ca.us/DocumentCenter/View/7542](http://www.delmar.ca.us/DocumentCenter/View/7542)). Page 4.3-7 of the DEIR states that “CARB has identified the following people as the most likely to be affected by air pollution: children younger than 14, the elderly older than 65...these groups are classified as sensitive receptors.”

13-27 | **Request:** The City requests this impact section be updated to include the proposed increase in rail service by horizon year 2035 for pedestrian and freight trains, and the Del Mar Tunnel. Further the City requests the associated air quality impacts resulting from increased diesel emissions, both by increased frequency of use and

**RESPONSE TO COMMENT 13-25**

As stated above, detailed analysis related to the new lighting and/or glare effects from train lights, increased train frequency, and any associated lighting for the Del Mar Tunnel and inland rail realignment from the Del Mar Bluffs, will be evaluated at the project-specific level, at which time the level of impact will be determined and appropriate mitigation measures will be identified.

**RESPONSE TO COMMENT 13-26**

These are general comments about the Draft EIR analysis and CARB definitions. The DEIR is in agreement with these comments and no changes have been made. The air quality analysis does not need to be updated to reflect increased service associated with COASTER, AMTRAK, and freight, as well as the Del Mar Tunnel, because the increase in service due to transportation improvements is already accounted for in emissions estimates and modeling. Moreover, the design of the Del Mar Tunnel is not yet known; therefore, it is not possible to analyze detailed construction and operation effects. Regardless, mitigation measures in the EIR would apply to future construction of future tunnels. For example, mitigation measure AQ-5b ensures railway tunnels or other underground features are designed to help reduce localized toxic air contaminant concentrations at sensitive receptors and are located as far away as feasibly possible from nearby sensitive receptors. No changes to the analysis are required.

**RESPONSE TO COMMENT 13-27**

See response to comment Del Mar 13-26. Additionally, mitigation measure AQ-2b ensures that all new train purchases shall be zero emission after 2035. No changes to the analysis are required.

13-27  
 cont. concentrated exhaust points emitted from the Del Mar Tunnel be analyzed in the impact section. Without inclusion of these components, including the cited Del Mar Tunnel on page 2-58 and increased rail service referenced on page 4.1-42), and sufficient analysis of these components being included in this impact section, the City is unable to provide further comment on the impacts, conclusions, and/or mitigation measures at this time.

**11. COMMENT – AIR QUALITY**  
**Pages 4.3-40, 4.3-41, 4.3-42**

13-28 The DEIR addresses the increase in rail activity between 2016 and 2025, and refers to rail operators such as the COASTER and AMTRAK are replacing existing older locomotives with modern, Tier 4 engines by 2025. As a result, the DEIR concludes that contrary to the increase in rail activity, emissions are reduced due to the Tier 4 engines. Further, the DEIR addresses the increase in rail activity between 2016 and 2035 (page 4.3-42) and draws the same conclusion. However, the 2035 conclusion states, "Moreover, while passenger rail activity increases, all passenger rail lines (both current and new) are assumed to be operating completely with modern, Tier 4 engines by 2035." The conclusions made for horizon years 2025 and 2035 appear to be based on an assumption per the Regulatory framework and replacements made at-will by rail operators. It does not appear that Tier 4 replacements would be required as mitigation.

13-29 **Request 1:** As the impact section is based on an assumption that all train engines will be Tier 4, the City requests the impact section discuss the air quality impacts under an alternate scenario where passenger and freight rail would not be replaced with Tier 4 engines by horizon years 2025 and 2035, or only replaced in part. The City further requests clarification be included to understand at what point the increase in rail activity coupled with older engines (or a mix of older and Tier 4) could result in a significant impact to Air Quality. If it is found that a significant impact would occur if all train engines were not replaced with Tier 4 (or a percentage mix), the City requests a mitigation measure be added for horizon years 2025 and 2035 requiring the threshold percentages of all trains being Tier 4.

13-30 **Request 2:** The City requests this impact section be updated to include the Del Mar Tunnel and associated air quality impacts resulting from increased frequency of use and concentrated exhaust points emitted from the Del Mar Tunnel be analyzed in the impact section.

**RESPONSE TO COMMENT 13-28**

This is a general comment that references the fact that use of Tier 4 despite increases in rail service would decrease emissions. The commenter notes that new Tier 4 engines are not a mitigation measure. No specific comment requiring a response is provided.

**RESPONSE TO COMMENT 13-29**

The air quality analysis assumes that all passenger lines will be operating with Tier IV or better engines by 2025. However, both the Coaster and Amtrak Pacific Surfliner lines are operating their full fleet with Tier IV locomotives today, which is ahead of the schedule assumed in the Draft EIR. Both Coaster and Amtrak have retired the older diesel locomotives that were assumed under the EIR’s baseline conditions. Moreover, any new locomotive purchases will be Tier IV or better, in compliance with federal locomotive standards (40 CFR 1033). The suggested additional analysis and mitigation measure are not required.

**RESPONSE TO COMMENT 13-30**

Please see responses to comments Del Mar 13-27 and Del Mar 13-29 above.

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13-31	<p><b>12. COMMENT – AIR QUALITY</b>  <b>Pages 4.3-56, 4.3-57</b></p> <p><b>Request:</b> Same comment made above for Air Quality on Pgs. 4.3-35, 4.3-36</p>
13-32	<p><b>13. COMMENT – BIOLOGICAL RESOURCES</b>  <b>Page 4.4-12, Figure 4.4-2</b></p> <p>Several key lagoons are noted in the figure including Batiquitos and San Elijo to the north of the City. However, two key lagoons that flank the City's northern and southern boundaries are not noted on the figure. These are the San Dieguito (north) and Los Peñasquitos (south) Lagoons.</p> <p><b>Request:</b> The City requests that both the San Dieguito and Los Peñasquitos Lagoons are referenced on the figure as these lagoons are of critical importance to the community and region, and anticipated to be affected by the proposed 2035 Del Mar Tunnel and inland rail relocation from the Del Mar Bluffs.</p>
13-33	<p><b>14. COMMENT – BIOLOGICAL RESOURCES</b>  <b>Page 4.4-56, Table 4.4-6</b></p> <p>The table references the City's Lagoon Overlay Zone (Del Mar Municipal Code Chapter 30.53), Tree Protection Ordinance (Del Mar Municipal Code Chapter 23.50), and General Plan. However, the table does not include the following: 1) the City's Bluff, Slope, and Canyon Overlay Zone (Del Mar Municipal Code Chapter 30.52) and purpose, in part: Protects downstream resources from the adverse impacts of erosion and sedimentation; and 2) the City's Land Conservation Ordinance (Del Mar Municipal Code Chapter 23.33) and purpose: Regulates soil disturbances of existing or natural terrain and vegetation and does not create soil erosion, silting of lower slopes, slide damage, flooding problems, or severe cutting or scarring.</p> <p><b>Request:</b> The City requests the table also include the Bluff, Slope, and Canyon Overlay Zone and Land Conservation Ordinance.</p>
13-34	<p><b>15. COMMENT – BIOLOGICAL RESOURCES</b>  <b>Page 4.4-69</b></p> <p>The DEIR states that "estimated direct impacts on vegetation communities and regulated aquatic resources for the 2035 horizon year are provided in Table 4.4-8. Tables E-6-1 through E-6-3 in Appendix E-6 summarize the project-by-project impacts</p>
13-35	<p>The DEIR states that "estimated direct impacts on vegetation communities and regulated aquatic resources for the 2035 horizon year are provided in Table 4.4-8. Tables E-6-1 through E-6-3 in Appendix E-6 summarize the project-by-project impacts</p>
13-36	<p>The DEIR states that "estimated direct impacts on vegetation communities and regulated aquatic resources for the 2035 horizon year are provided in Table 4.4-8. Tables E-6-1 through E-6-3 in Appendix E-6 summarize the project-by-project impacts</p>

**RESPONSE TO COMMENT 13-31**

Please see responses to comments Del Mar 13-27 and Del Mar 13-29 above.

**RESPONSE TO COMMENT 13-32**

A call-out has been added to Figure 4.4-2 identifying the San Dieguito and Los Peñasquitos lagoons in the Final EIR.

**RESPONSE TO COMMENT 13-33**

A call-out has been added to Figure 4.4-2 identifying the San Dieguito and Los Peñasquitos lagoons in the Final EIR.

**RESPONSE TO COMMENT 13-34**

The cited ordinances in this comment were added to Table 4.4-6 in the Final EIR.

**RESPONSE TO COMMENT 13-35**

The cited ordinances in this comment were added to Table 4.4-6 in the Final EIR.

**RESPONSE TO COMMENT 13-36**

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects. Specific projects under the proposed plan, including the Del Mar Tunnel, Inland Rail alignment from the Del Mar Bluffs, Commuter Rail 398, and restoration of the Del Mar Bluffs, would be subject to project-specific environmental review, and the alignment, alternatives, and biological resources analysis will be included in the project-specific environmental review.

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13-36

on vegetation communities for each horizon year." The City provided an earlier comment under Chapter 2, Project Description where it requested a narrative be added describing the planned realignment of the Commuter Rail network through the Del Mar rail corridor. In this comment, the City requested clarification be made regarding the horizon years for: 1) the Del Mar Tunnel, which appears to be 2035 based on the DEIR Project Description; 2) the inland rail realignment from the Del Mar Bluffs, which is not specifically noted in the DEIR, but implied due to a Del Mar Tunnel being included; and 3) the associated restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures.

13-37

Related to planned Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs (Commuter Rail 398), and restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, the DEIR does not sufficiently describe the potential impacts to vegetation communities for each horizon year in Appendix E-6, Tables E-6-2 and E-6-3. As shown below, Table E-6-2 is for the 2035 horizon year and indicates Commuter Rail 398 would result in impacts to 0.6 acres of Coastal Scrub habitat. If the Del Mar Tunnel is proposed for horizon year 2035, regardless of the final alternative alignment selected, it is anticipated that a greater area of habitat impacts would result from both temporary/construction and permanent impacts associated with the construction of a Del Mar Tunnel. This is because the City is bordered by two lagoons, Los Peñasquitos to the south (which Commuter Rail 398 currently is located within) and San Dieguito to the north. Further, the City is bordered by the Torrey Pines State Natural Reserve Extension on the City's south slope and Crest Canyon on its north slope – areas that include a diversified mix of native plants and trees. It is reasonable that greater upland impacts would result from tunneling through or adjacent to a hillside.

**Appendix E-6, Table E-6-2 (2035)**

Appendix E Environmental Assessment

Project / Activity	Resources and Mitigation						Impacts					
	Wildlife	Vegetation	Soils	Water	Air Quality	Noise	Visual	Historic Resources	Cultural Resources	Geology/Seismicity	Other	
Construction												
Operation												
Restoration												
2035 Horizon Year												
2035 Horizon Year (Total)												
2035 Horizon Year (Total)												
2035 Horizon Year (Total)												
2035 Horizon Year (Total)												

**RESPONSE TO COMMENT 13-37**

Please see response to comment Del Mar 13-36.

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13-38

Similarly, Table E-6-3 for the 2050 horizon year indicates Commuter Rail 398 would result in impacts to 0.2 acres of Marsh habitat and 0.4 acres of Riparian Scrub habitat. As noted in the City's Project Description comment, it is unclear if the inland rail realignment and/or restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures is planned for horizon year 2035 or 2050 as this information is not provided in the DEIR (DEIR only references the Del Mar Tunnel). Based on the identified impacts in Table E-6-3, wetland and riparian impacts are noted for Commuter Rail 398. It is unclear if these impacts are associated with the inland rail realignment. If the inland rail realignment is proposed for horizon year 2050, regardless of the final alternative alignment selected, it is anticipated that a greater area of habitat impacts would result from both temporary/construction and permanent impacts associated with the construction of a Del Mar Tunnel. This is because the City is bordered by two lagoons, Los Peñasquitos to the south (which Commuter Rail 398 currently is located within) and San Dieguito to the north. It is reasonable that greater impacts to wetland and/or riparian habitat would result from any of the inland rail realignment alternatives due to existing conditions in the Del Mar area. Further, the Table does not include reference to and analysis of the planned seasonal platform at the Del Mar Fairgrounds for either 2035 or 2050 which is also in vicinity to the San Dieguito Lagoon.

**Appendix E-6, Table E-6-3 (2050)**

Resource	Impacts and Mitigation		Mitigation	
	Impact	Mitigation	Impact	Mitigation
Wetlands	0.2	0.2	0.2	0.2
Riparian Scrub	0.4	0.4	0.4	0.4
Marsh	0.2	0.2	0.2	0.2
Other	0.0	0.0	0.0	0.0
Total	0.8	0.8	0.8	0.8

13-39

**Request:** In addition to clarifying the horizon years for inland rail relocation from the Del Mar Bluffs and planned seasonal platform at the Del Mar Fairgrounds, the City requests a sufficient level of analysis be provided in the impact section and Appendix E-6 related to planned improvements to Commuter Rail 398 through and adjacent to the City of Del Mar – and in particular the Los Peñasquitos and San Dieguito Lagoons, Torrey Pines State Natural Reserve Extension, and Crest Canyon.

Until this clarification is made and sufficient analysis is included in this impact section, the City is unable to provide further comment on the impacts, conclusions, and/or mitigation measures at this time.

**RESPONSE TO COMMENT 13-38**

Please see response to comment Del Mar 13-36.

**RESPONSE TO COMMENT 13-39**

Please see response to comment Del Mar 13-36.

**16. COMMENT – CULTURAL RESOURCES**  
**Page 4.5-23**

13-40 The DEIR describes the Del Mar Tunnel and continued double-tracking at certain locations on the LOSSAN rail corridor by horizon year 2035, but does not list the inland rail relocation from the Del Mar Bluffs, the restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, or the planned seasonal platform at the Del Mar Fairgrounds. Further, it is unclear which horizon years these components are planned for.

13-41 **Request:** The City requests inclusion of the inland rail relocation from the Del Mar Bluffs and planned seasonal platform at the Del Mar Fairgrounds in the impact section and analysis as applicable.

**17. COMMENT – GEOLOGY, SOILS, AND PALEONTOLOGICAL RESOURCES**  
**Page 4.7-27, Table 4.7-3 and Page 4.7-29, Table 4.7-4**

13-42 The table references the City's Community (General) Plan but does not reference the City's Local Coastal Program.

13-43 **Request 1:** The City requests inclusion of the following Local Coastal Program sections in Table 4.7-3: 1) Bluff, Slope, Canyon Overlay Zone (Del Mar Municipal Code Chapter 30.52) which is designed to protect the health, safety, and general welfare, and to protect downstream resources from the adverse impacts of erosion and sedimentation; 2) Coastal Bluff Overlay Zone (Del Mar Municipal Code Chapter 30.55) which is intended to protect Del Mar's fragile coastal bluffs as a visual resource and avoid the risks to life and property associated with bluff failure and shoreline erosion; 3) the Floodplain Overlay Zone (Del Mar Municipal Code Chapter 30.56), which is intended to avoid hazards to those who will occupy the development; to avoid damage or hazards to the surrounding area; and ensure that development will not obstruct flood flow; will be designed to reduce the need for construction of flood control facilities that would be required if unregulated development were to occur; and to minimize the cost of flood insurance to Del Mar residents; and 4) the City's Land Conservation Ordinance (Del Mar Municipal Code Chapter 23.33) which regulates soil disturbances of existing or natural terrain and vegetation and does not create soil erosion, silting of lower slopes, slide damage, flooding problems, or severe cutting or scarring.

13-44 **Request 2:** The City requests inclusion and reference to its adopted Sea Level Rise Adaptation Plan, which is part of its Community Plan Safety Element (adopted March

**RESPONSE TO COMMENT 13-40**

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. The Del Mar Tunnel project, which is a second-tier project, falls within the 2035 horizon year in the proposed Plan, and the inland rail realignment and bluffs restoration project are assumed as part of the tunnel project.

**RESPONSE TO COMMENT 13-41**

Please see response to comment Del Mar 13-40.

**RESPONSE TO COMMENT 13-42**

See responses to comments Del Mar 13-43 through Del Mar 13-45 for specific requests.

**RESPONSE TO COMMENT 13-43**

Suggested components of the City of Del Mar's LCP have been incorporated into Table 4.7-3 in Section 4.7, *Geology, Soils, and Paleontological Resources*.

**RESPONSE TO COMMENT 13-44**

Suggested reference to the City of Del Mar's Sea Level Rise Adaptation Plan has been incorporated into Table 4.7-3 in Section 4.7.

13-44  
 cont. | 2019). The Adaptation Plan is intended to guide policy decisions related to future development in areas that are identified as vulnerable to projected sea-level rise, flooding, and erosion. The Adaptation Plan identifies a range of adaptation options and prioritizes specific measures to address projected sea-level rise, flooding from the Pacific Ocean and San Dieguito River, and associated coastal bluff and beach erosion. The Adaptation Plan identifies beach nourishment and sand retention as high priority short-to-medium term adaptation measures that would reduce the risk of wave run-up and erosion of the bluff toe. Maintaining a wide public beach will help minimize flood risk to the adjacent public infrastructure, beach access, and private homes and businesses. The City's Sediment Management Plan (October 2018) is a technical document that supports the adopted approach for beach nourishment and maintenance dredging of the San Dieguito river inlet, as set forth in the Adaptation Plan. Currently, the City is seeking local, state, and federal approvals for a Sand Compatibility Opportunistic Use Program (SCOUP) to facilitate beach nourishment adaptation in accordance with the Adaptation Plan and Sediment Management Plan.

13-45 | **Request 3:** The City requests inclusion of the following in Table 4.7-4: 1) Bluff, Slope, Canyon Overlay Zone (Del Mar Municipal Code Chapter 30.52) which is designed to protect the health, safety, and general welfare, and to control the development of properties within the designated zone in order to preserve the scenic sandstone bluffs and related canyons and steep slopes which characterize the area within the zone.; and 2) Open Space Overlay Zone (Del Mar Municipal Code Chapter 30.60) which is intended, in part, to preserve scenic vistas and particularly unique natural features in specific neighborhoods.

**18. COMMENT – GEOLOGY, SOILS, AND PALEONTOLOGICAL RESOURCES**  
**Page 4.7-34**

13-46 | The DEIR describes continued double-tracking at certain locations on the LOSSAN rail corridor by horizon year 2035, but does not list the Del Mar Tunnel, the inland rail relocation from the Del Mar Bluffs, the restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, or the planned seasonal platform at the Del Mar Fairgrounds. Further, it is unclear which horizon years the inland rail relocation and seasonal platform are planned for.

13-47 | **Request:** The City requests inclusion of the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and planned seasonal platform at the Del Mar Fairgrounds in the impact section and analysis as applicable. Provided that all three components would generally be sited within wetland areas with high liquefaction potential and/or hillside with potential seismic-related ground failure and/or landslides, until these components

**RESPONSE TO COMMENT 13-45**

Suggested references to the City of Del Mar’s Municipal Code have been incorporated into Table 4.7-4 in Section 4.7.

**RESPONSE TO COMMENT 13-46**

See response to comment Del Mar 13-47.

**RESPONSE TO COMMENT 13-47**

The EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. The Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and the seasonal platform at the Del Mar Fairgrounds are considered second-tier projects.



13-47  
 cont.

are included and sufficient analysis provided, the City is unable to provide further comment on the impacts, conclusions, and/or mitigation measures at this time.

**19. COMMENT – GEOLOGY, SOILS, AND PALEONTOLOGICAL RESOURCES**  
**Page 4.7-41**

The DEIR generally makes reference to "...transportation network improvements [that] would occur in areas susceptible to slope failure, unstable soils, and expansive soils – particularly improvements in hilly or coastal areas such as the managed lanes along the freeways..." Further, the DEIR generally states that "specific transportation facilities located in areas prone to slope failure, or where the development of these facilities would be likely to cause slope failure, include services through coastal areas or canyons. These improvements may be at a greater risk for effects of slope failure or cause greater risks to people or structures in proximity to these improvements."

13-48

There are three specific rail improvement components that are either within or adjacent to the City and would be sited in "hilly or coastal areas" and/or "through coastal areas or canyons." However, the DEIR does not list these components but refers to them generally. These include the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, and the planned seasonal platform at the Del Mar Fairgrounds. As written, general references to "transportation network improvements" that are "susceptible to slope failure, unstable soils, expansive soils" and could cause "greater risk to people or structures in proximity" can be confusing to the public. Further, general references with the stated conclusions are not a sufficient level of programmatic analysis for the planned LOSSAN rail corridor improvements in/adjacent to the City.

13-49

**Request:** The City requests inclusion of the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, and planned seasonal platform at the Del Mar Fairgrounds in the impact section and analysis as applicable. This is because all three components are within the DEIR's general statements related to "hilly or coastal areas" and/or "through coastal areas or canyons" as well as general references to "transportation network improvements" that are "susceptible to slope failure, unstable soils, expansive soils" and could cause "greater risk to people or structures in proximity." Until these components are included and sufficient analysis is provided, the City is unable to provide further comment on the impacts, conclusion of less than significant, and/or mitigation measures at this time.

**RESPONSE TO COMMENT 13-48**

As noted above, the EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. The Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and the seasonal platform at the Del Mar Fairgrounds are considered second-tier projects, and because the specifications of second-tier projects such as the timing, location, and size, associated with implementation of the proposed Plan, are not known at this time, conclusions regarding the specific geologic risks related to the above-referenced second-tier projects would be speculative.

**RESPONSE TO COMMENT 13-49**

As noted above, the EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. The Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and the seasonal platform at the Del Mar Fairgrounds are considered second-tier projects, and because the specifications of second-tier projects such as the timing, location, and size, associated with implementation of the Plan, are not known at this time, conclusions regarding the specific geologic risks related to the above-referenced second-tier projects would be speculative.

**20. COMMENT – GREENHOUSE GAS EMISSIONS**  
**Page 4.8-24**

13-50

The DEIR describes the Del Mar Tunnel and continued double-tracking at certain locations on the LOSSAN rail corridor by horizon year 2035, but does not list the inland rail relocation from the Del Mar Bluffs, and restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, or the planned seasonal platform at the Del Mar Fairgrounds. Further, it is unclear which horizon years these components are planned for.

13-51

**Request:** The City requests inclusion of the inland rail relocation from the Del Mar Bluffs, the restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, and planned seasonal platform at the Del Mar Fairgrounds in the impact section and analysis as applicable.

**21. COMMENT – LAND USE**  
**Page 4.11-30, 4.11-31**

13-52

The DEIR states that “the planned transportation network improvements for 2035 are described above” which is a reference to a general list of horizon year 2035 projects on page 4.11-30. However, there is no reference made in the impact section to the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, or restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures. As previously noted in earlier comments, the horizon year for the Del Mar Tunnel is 2035 but a reference to an inland rail relocation and its associated horizon year (2035 or 2050) or the restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, is not described in the DEIR. It can be assumed that if the horizon year for the Del Mar Tunnel is 2035, then the inland rail realignment and bluffs restoration including removal of temporary measures would also be 2035. However, as previously noted in the City’s Biological Resources comments, the 2035 impacts for Commuter Rail 398 only affect a small portion of Coastal Scrub habitat, whereas the 2050 impacts for Commuter Rail 398 only affects a small portion of Marsh and Riparian Scrub habitat.

The DEIR provides three horizon years – 2025, 2035, and 2050. It is clear that a Del Mar Tunnel is planned for horizon year 2035, which is also described in Appendix A of the Draft 2021 Regional Plan, Table A.5 as Project ID TL06 (“Oceanside to downtown San Diego (Build Del Mar tunnel, add stations at Central Mobility Hub and Camp Pendleton, and Grade”). However, as previously commented, it is not clear if

**RESPONSE TO COMMENT 13-50**

The EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. Reference to future projects such as the inland rail realignment and bluff restoration projects in the impact analyses were provided as examples of the types of projects that could occur by those horizon years and were not intended to be an exhaustive list of all second-tier projects that would occur by that horizon year.

**RESPONSE TO COMMENT 13-51**

See response to comment Del Mar 13-50.

**RESPONSE TO COMMENT 13-52**

The EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. References to future projects such as the inland rail realignment and bluff restoration projects in the impact analyses were provided as examples of the types of projects that could occur by those horizon years and were not intended to be an exhaustive list of all second-tier projects that would occur by that horizon year. Given the programmatic nature of the EIR, project-specific analysis of the Del Mar Bluffs improvement project is not necessary at this time.

13-52  
 cont.

and when the associated inland rail realignment or bluff restoration including removal of the temporary stabilization measures are proposed.

Assuming it is 2035, the Land Use impact section does not sufficiently describe the indirect effects associated with deferring these critical components of the Transportation Network Improvements and Program to a horizon year post-2025. By not evaluating these critical components in the first horizon year of 2025, use of the LOSSAN rail corridor/Commuter Rail 398 by COASTER, AMTRAK, and freight rail will remain in its Existing Condition on the Del Mar Bluff. This includes associated bluff stabilization projects that have been completed prior to the baseline year of 2016 and post-2016 via a series of comprehensive bluff stabilization projects planned as part of Del Mar Bluffs Stabilization Projects 5 (DMB5), and subsequent Project 6 under consideration.

13-53

Completed projects pre-2016 include: 1) a soil cement buttress and new beach outfall constructed near Mile Post 244.45 (1996); 2) an emergency repair project constructed near the terminus of 8th Street after a failure of the bluff (late 2001); 3) construction of Del Mar Bluffs Stabilization Project 1, which included the addition of surface and subsurface drainage improvements and repair of upper bluff walls; 4) construction of Del Mar Bluffs Stabilization Project 2, which included the installation of Cast-In-Drilled-Holes (CIDH) soldier piles along 1,326 feet of the bluffs in the top priority areas (2007); and 5) construction of Del Mar Bluffs Stabilization Project 3, which included installation of soldier piles at seven additional priority areas along the bluffs that were not completed in previous phases (2012).

Completed/in-construction projects post-2016 include: 1) construction of Del Mar Bluffs Stabilization Project 4 which included urgent repairs to existing drainage systems and lower bluff wood retaining walls and additional upper bluff stabilization measures below 7th Street and lower bluff stabilization measures below Sea Orbit Lane due to bluff failures (2017-2020); 2) emergency bluff repairs below 13th Street and 15th Street (2019); and 3) emergency repairs for a bluff and seawall collapse that occurred in February 2021, under construction.

The next foreseeable project includes Del Mar Bluffs Stabilization Project 5 (DMB5) that is currently in design. As described in the DMB5 Analysis Report (July 2021) (available at [www.delmar.ca/rail](http://www.delmar.ca/rail)), the project is described as a "maintenance of way project, to maintain the existing track and protect it from erosion and seismic events" through various components such as "adding bluff toe protection measures and surface stabilization" (Report page 8). The Report lists consistency with key regional and corridor plans, including the "San Diego Forward: The Regional Plan (SANDAG

**RESPONSE TO COMMENT 13-53**

See response to comment Del Mar 13-52. The project components listed in the comment constitute second-tier projects, and this programmatic EIR does not analyze project-specific land use conflicts. The Draft EIR also does not provide a specific schedule for completion of the second-tier projects. SANDAG will continue coordinating with the City of Del Mar, as well as other local jurisdictions, to determine the prioritization and specific timelines of these second-tier projects, including the bluff stabilization project.

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13-53  
 cont.

2015), the 2016 San Diego regional Transportation Improvement Plan (SANDAG 2016), LOSSAN Corridor wide Strategic Implementation Plan (LOSSAN Corridor Rail Agency 2012), the LOSSAN Program Environmental Impact Report/Environmental Impact Statement (Caltrans and the Federal Railroad Administration 2009), the Infrastructure Development Plan for the LOSSAN Rail Corridor in San Diego County (SANDAG 2013), and the North Coast Corridor Public Works Plan/Transportation and Resources Enhancement Program (NCC PWP/TREP; Caltrans and SANDAG 2016)" (Report page 8). Further, the Report states that "the Proposed Action considers the anticipated bluff retreat for the next 30 to 50 years" (Report page 12).

13-54

As a result of deferring these components post horizon year 2025, the proposed 2021 Regional Plan results in indirect effects that conflict with the City's adopted and certified Local Coastal Program and in particular the Beach Overlay Zone (B-OZ, Del Mar Municipal Code Chapter 30.50) and the Coastal Bluff Overlay Zone (CB-OZ, Del Mar Municipal Code Chapter 30.55). Both overlays are Implementing Ordinances in the City's certified LCP (2001). The B-OZ chapter of the LCP includes a Shoreline Protection Area (SPA) line that begins at the approximate center-line of the railway tracks and covers the area west as specified in B-OZ Exhibit B. Components of the bluff stabilization projects in conflict with the LCP include exposed vertical retaining structures, soil nail reinforced areas with shotcrete facing, and grading within 40 feet of the top edge of a coastal bluff. Further, DMB5 proposes the excavation and removal of an existing coastal bluff berm located west of the track bed and generally below the area of 11<sup>th</sup> Street and 9<sup>th</sup> Street.

Under the certified Del Mar LCP (CB-OZ, Del Mar Municipal Code Section 30.55.080), development on coastal bluffs is regulated under the following provisions (in part):

A. Unless otherwise specified herein, all new or redeveloped principal or accessory structures, including new supporting foundations or supports for existing structures, shall be set back a minimum of 40 feet from the top edge of the coastal bluff as defined in this Chapter. [emphasis added]

C. No grading shall be allowed within 40 feet of the top edge of a coastal bluff. [emphasis added]

D. No grading or construction activities shall be allowed on the face of a coastal bluff unless approved as part of a Shoreline Protection Permit or Setback Seawall Permit issued in accordance with the provisions of this Title and when the

**RESPONSE TO COMMENT 13-54**

See responses to comments Del Mar 13-52 and Del Mar 13-53.

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Planning Commission or City Council, as the authorized review body for the project, makes a finding that the proposed grading has been minimized to the extent feasible to implement the authorized shoreline protection. [emphasis added]

Under the certified Del Mar LCP (B-OZ, DM Section 30.50.060), the construction of a protective structure may be authorized in the SPA area if it meets a list of findings, that include (in part):

C. Will assure stability and structural integrity and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area, nor in any way substantially alter natural landforms along bluffs and cliffs. [emphasis added]

G. Will, if there is a vertical wall element in the proposed protective structure, have the seaward face of the vertical wall located within the Shoreline Protective Area only if there is no other feasible location for effectively protecting a principle structure; there is no feasible, less environmentally damaging alternative; and feasible mitigation measures have been provided to minimize adverse environmental effects; but in no event have the seaward face of the vertical wall more than five feet westward of the Shoreline Protection Area line. [emphasis added]

H. Will, if other than a vertical wall, meet all the conditions of Subsection G above. [emphasis added]

The constructed and planned stabilization components, including exposed vertical retaining structures, soil nail reinforced areas with shotcrete facing, and grading within 40 feet of the top edge of a coastal bluff (including terraced slopes and the excavation and removal of coastal bluff berms west of the track bed) are not consistent with City's LCP and in particular the bolded sections above.

Further, there is a conflict between the timing included in the DMB5 Alternatives Analysis Report of 30-50 years (i.e., 2051 to 2071 from the date of Report preparation) and the DEIR timeframe associated with the Del Mar Tunnel and assumed inland rail realignment from the Del Mar Bluffs (i.e., horizon year 2035) and assumed restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures. The DEIR does not include reference to the DMB5 Alternatives Analysis Report or any other completed or planned Del Mar Bluffs Stabilization Projects, including reports or plans.

13-54  
 cont.

13-55

**RESPONSE TO COMMENT 13-55**

See responses to comments Del Mar 13-52 and Del Mar 13-53. The proposed Plan identifies funding to kick start the environmental, design, and right-of-way phases of the Del Mar Tunnel project by 2025 with construction funding in the 2035 phase, and the inland rail realignment is assumed as part of the tunnel project. Timing for bluffs restoration will be determined as the tunnel and inland rail realignment projects progress. During project-specific analysis of second-tier projects, specific conflicts with reports such as the DMB5 Alternative Analysis Report will be considered.

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13-55  
 cont. This is important because even though SANDAG considers projects, such as DMB5, to be a maintenance of way project, pertinent DMB5 documents such as the July 2021 Alternatives Analysis Report describes the maintenance project's consistency with key regional and corridor plans, including the "San Diego Forward: The Regional Plan (SANDAG 2015), the 2016 San Diego regional Transportation Improvement Plan (SANDAG 2016), LOSSAN Corridor wide Strategic Implementation Plan (LOSSAN Corridor Rail Agency 2012), the LOSSAN Program Environmental Impact Report/Environmental Impact Statement (Caltrans and the Federal Railroad Administration 2009), the Infrastructure Development Plan for the LOSSAN Rail Corridor in San Diego County (SANDAG 2013), and the North Coast Corridor Public Works Plan/Transportation and Resources Enhancement Program (NCC PWP/TREP; Caltrans and SANDAG 2016)" (Report page 8).

13-56 The impact section for 2035 concludes that "...transportation network improvements would conflict with land use plans, policies, and regulations, including general plans, specific plans, and community plans, adopted for the purpose of avoiding or mitigating an environmental effect, impacts are already evaluated in other sections of this EIR, so these conflicts would not cause new significant impacts. Therefore, this impact (LU-2) in the year 2035 is less than significant."

For the reasons described above, the DEIR does not sufficiently describe the impacts associate with Commuter Rail 398 improvements in/adjacent to the City of Del Mar in other sections of the DEIR.

13-57 **Request:** Based on the concerns expressed above, the City requests that an analysis be provided in the impact section discussing the indirect and direct effects resulting from a deferred Del Mar Tunnel to 2035, inland rail relocation to horizon year 2035 (or 2050), and bluffs restoration including removal of the temporary stabilization measures to horizon year 2035 (or 2050). This includes an analysis of completed and planned bluffs stabilization projects, associated documents therewith, and their inconsistency with the City's certified LCP provisions in the CB-OZ and B-OZ. The City further requests the impact section's conclusion of less than significant be re-evaluated (page 4.11-31).

**22. COMMENT – LAND USE**  
**Page 4.11-31**

13-58 The DEIR states that "it cannot be guaranteed that all planned rail extensions would have alignments and design features that would avoid land use conflicts with adopted plans. Individual transportation network improvements would undergo separate environmental review under CEQA and NEPA, where applicable." The impact section

**RESPONSE TO COMMENT 13-56**

See responses to comments Del Mar 13-52 and Del Mar 13-53.

**RESPONSE TO COMMENT 13-57**

See responses to comments Del Mar 13-52 and Del Mar 13-53. The EIR's conclusion of less than significant for Impact LU-2 need not be re-evaluated because it is based on a programmatic vs. project-specific analysis of land use conflicts.

**RESPONSE TO COMMENT 13-58**

See response to comment Del Mar 13-52.

13-58 cont. does not provide specific reference to the Del Mar Tunnel, the inland rail relocation from the Del Mar Bluffs, or the planned seasonal platform at the Del Mar Fairgrounds.

13-59 **Request:** In reference to the statement that “individual transportation network improvements would undergo separate environmental review under CEQA and NEPA, where applicable,” the City requests that the sentence be amended to include specific references to the Del Mar Tunnel, the inland rail relocation from the Del Mar Bluffs, bluffs restoration including removal of the temporary stabilization measures, and the planned seasonal platform at the Del Mar Fairgrounds.

**23. COMMENT – NOISE**  
**Page 4.13-12, Table 4.13-4**

13-60 The table lists various construction equipment types including auger drill rig, blasting, dozer, dump truck, excavator, front end loader, impact pile driver, jackhammer, mounted impact hammer, rock drill, and vibratory pile driver. It is unclear if all types of equipment associated with the construction of a train tunnel are provided in the list.

13-61 **Request:** The City requests the table be amended, as applicable, to include any other equipment typical of rail tunnel construction (taking into account the size of trains used by COASTER, AMTRAK, and freight rail, including structural improvements, drainage, and emission exhaust) and update the associated analysis within the impact section accordingly.

**24. COMMENT – NOISE**  
**Pages 4.13-39, 4.13-40**

13-62 The DEIR describes continued double-tracking at certain locations on the LOSSAN rail corridor along with increases in COASTER frequencies and the Del Mar Tunnel, but does not reference the inland rail relocation from the Del Mar Bluffs, the restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, or the planned seasonal platform at the Del Mar Fairgrounds.

13-63 **Request:** In addition to the City’s prior Noise comment on tunnel construction equipment, the City requests inclusion of the inland rail relocation from the Del Mar Bluffs and planned seasonal platform at the Del Mar Fairgrounds in the impact section and analysis as applicable. Provided that these components would occur near residential areas, until these components are included and sufficient analysis provided, the City is unable to provide further comment on the impacts, conclusions, and/or mitigation measures at this time.

**RESPONSE TO COMMENT 13-59**

Requested text has been added to page 4.11-31 in the EIR. In addition, see response to comment Del Mar 13-52.

**RESPONSE TO COMMENT 13-60**

Table 4-13-4 includes the typical construction equipment mix that could be used in projects that would occur under the proposed Plan. The table is not meant for project-level analysis and does not include an exhaustive list of construction equipment, as the EIS is a program-level document. The exact mix of construction equipment for the commenter-referenced project would be included in project-level environmental documents.

**RESPONSE TO COMMENT 13-61**

See response to comment Del Mar 13-60. As discussed, the table is not meant to be exhaustive, and it is unknown at this time what type of tunneling equipment will be utilized for the project. Specific analysis will be conducted during project-level analysis.

**RESPONSE TO COMMENT 13-62**

As noted above, the EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. Noise increases associated with projects that would occur under the proposed Plan are discussed under Impact NOI-1 in Section 4.13, *Noise and Vibration*. The discussion is programmatic and outlines some of the projects that would occur during the time horizons referenced in the document. References to future projects in the impact analyses were provided as examples of the types of projects that could occur by those horizon years, and were not intended to be an exhaustive list of all second-tier projects that would occur by that horizon year.

**RESPONSE TO COMMENT 13-63**

See response to comment Del Mar 13-62.



- 13-64 **25. COMMENT – NOISE**  
**Page 4.13-47**
- The DEIR describes continued double-tracking at certain locations on the LOSSAN rail corridor along with increases in COASTER frequencies and the Del Mar Tunnel, but does not reference the inland rail relocation from the Del Mar Bluffs, the restoration of the Del Mar Bluffs, including the removal of installed temporary bluff stabilization measures, or the planned seasonal platform at the Del Mar Fairgrounds.
- 13-65 **Request:** In addition to the City’s prior Noise comment on tunnel construction equipment, the City requests inclusion of the inland rail relocation from the Del Mar Bluffs and planned seasonal platform at the Del Mar Fairgrounds in the impact section and analysis as applicable. Provided that these components would occur near residential areas, until these components are included and sufficient analysis provided, the City is unable to provide further comment on the impacts, conclusions, and/or mitigation measures at this time.
- 13-66 **26. COMMENT – POPULATION AND HOUSING**  
**Page 4.14-8**
- The Regulatory Setting section describes four State laws, regulations, plans, and policies including State Housing Element Law (generally), California Relocation Assistance Act, Assembly Bill 1730 of 2019, and the Sustainable Communities and Climate Protection Act of 2008 (Senate Bill 375). The DEIR does not provide a summary of applicable State housing laws where additional density and streamlined processing is available for development projects within a Transit Priority Area and/or within a distance (e.g., one-half mile) of points such as a “Major Transit Stop” or a “High Quality Transit Corridor.”
- 13-67 **Request:** The City requests relevant statutes be provided with summaries that relate to development within areas such as a Transit Priority Area, Major Transit Stop, High Quality Transit Corridor, etc. and update the associated impact sections as applicable. This will help cities, such as the City of Del Mar, that currently only has Local Bus service understand the potential impacts associated with development and density once Next Gen Rapid bus service is introduced at the 2035 horizon year.

**RESPONSE TO COMMENT 13-64**

See response to comment Del Mar 13-62.

**RESPONSE TO COMMENT 13-65**

See response to comment Del Mar 13-62.

**RESPONSE TO COMMENT 13-66**

Additional recently adopted housing legislation related to streamlining approval for high density housing or housing within Transit Priority Areas has been incorporated into the Regulatory Setting in Section 4.14, *Population and Housing*.

**RESPONSE TO COMMENT 13-67**

See response to comment Del Mar 13-67. In addition, as noted above, the EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. The Next Gen Rapid bus service would be a second-tier project, and analysis of direct and indirect impacts associated with these second-tier projects would occur during project-specific environmental review.

**27. COMMENT – POPULATION AND HOUSING**  
**Page 4.14-14**

13-68 The DEIR in Chapter 2 Project Description (pages 2-55, 2-56, 2-57 – Figures 2-32, 2-33, 2-34) indicates that in 2025 (similar to the baseline year of 2016), Commuter Rail and Local Bus are designated in the City. However, in horizon year 2035, Next Gen Rapid Bus is introduced east-west on Del Mar Heights Road and north-south on Camino del Mar. The impact section for 2035 does not reference the addition of Next Gen Rapid Bus service in the City or the associated direct effects (e.g., Next Gen Rapid Bus results in new types of transit stops and corridors in the City, resulting in changes to development and density, and CEQA streamlining per State statute) or indirect effects (e.g., the extension of bus service types and commuter frequencies).

13-69 **Request:** The City requests the introduction of Next Gen Rapid Bus service in 2035 be discussed and potential impacts on population growth and housing per State statute related to development in areas such as Transit Priority Areas, Major Transit Stops, High Quality Transit Corridors, etc. As the 2021 Regional Plan had not been adopted prior to the State's 6<sup>th</sup> Housing Cycle deadline of April 5, 2021, the City's 6<sup>th</sup> Cycle Housing Element and associated 6<sup>th</sup> Cycle Housing Element EIR did not consider the addition of Next Gen Rapid bus service through the City, nor accounted for the potential land use and development/density changes, and CEQA streamlining that could result due to the addition of this type of service in the City. Until this is included and sufficiently analyzed, the City is unable to provide further comment on the impacts, conclusions, and/or mitigation measures at this time.

**28. COMMENT – WILDFIRE**  
**Page 4.19-10, Table 4.19-2**

13-70 The table does not include reference to the City's amended Community (General) Plan in 2019 to its Safety Element. In particular, wildfire is referenced in the current version of the Community (General) Plan (reference the online version at [https://library.municode.com/ca/del\\_mar/codes/community\\_plan?nodeId=THCOPLD-EMACA-PLAN-ENVIRONMENTAL-MANAGEMENT-SPECIFIC-RECOMMENDATIONSORPANO34-42](https://library.municode.com/ca/del_mar/codes/community_plan?nodeId=THCOPLD-EMACA-PLAN-ENVIRONMENTAL-MANAGEMENT-SPECIFIC-RECOMMENDATIONSORPANO34-42)). The amended Community (General) Plan now reads, in part, "The safety element is intended to protect the public health and safety, minimize the risk of hazards, and address local needs for climate change adaptation and resilience. Potential hazards in Del Mar include the threat of coastal storms, flooding, bluff erosion, beach erosion, sea level rise, dam failure, earthquake, landslide, tsunami, wildfire, structure fire, and drought."

**RESPONSE TO COMMENT 13-68**

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan would be subject to project-specific environmental review. The Next Gen Rapid Bus service is considered a second-tier project, and the specifications of these projects such as the timing, location, and size would be defined and specific impacts related to project characteristics would be identified during project-level analysis.

**RESPONSE TO COMMENT 13-69**

See response to comment Del Mar 13-68.

**RESPONSE TO COMMENT 13-70**

Language has been added to Table 4.19-2 to clarify that the City of Del Mar Safety Element was updated in 2019. Wildfire is now listed as a "potential hazard" in Table 4.19-2.

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13-71 | **Request:** The City requests the table be updated to reflect the 2019 Safety Element amendment date and remove the statement that "Wildfire is not mentioned in the Safety Element."

13-72 | **29.COMMENT – ALTERNATIVES**  
**Page 6-2**

This is related to the City's prior comment made in Land Use (pages 4.11-30, 4.11-31).

13-73 | **Request 1:** The City requests that an Alternative be included in the DEIR that analyzes the indirect and direct impacts associated with a 2025 horizon year for the Del Mar Tunnel, inland rail relocation from the Del Mar Bluffs, and bluffs restoration including removal of the temporary stabilization.

13-74 | **Request 2:** The City requests that an Alternative be included in the DEIR (or joined with the Alternative request above) that analyzes the direct and indirect impacts associated with a even further inland realigned rail corridor for passenger and freight rail following the planned southerly alignments for High Speed Rail generally near SR-52 or SR-163 and I-15, and then connects with freight rail corridor near SR-78 (shown in red outlines below).

**RESPONSE TO COMMENT 13-71**

The statement that "Wildfire is not mentioned in the Safety Element" was removed from Table 4.19-2.

**RESPONSE TO COMMENT 13-72**

This is an introductory comment for the following comments. No response is required.

**RESPONSE TO COMMENT 13-73**

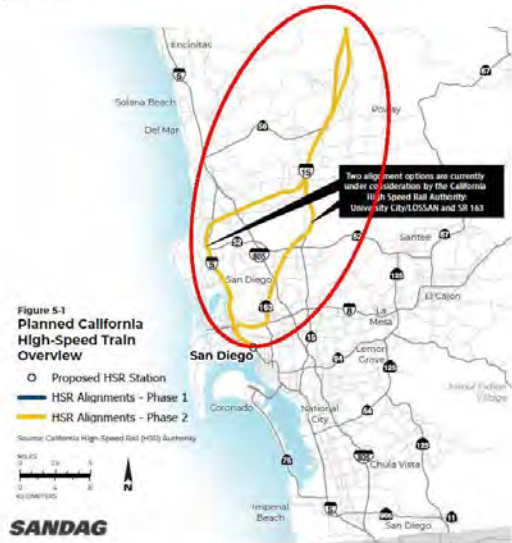
See Master Response 1 regarding the range of alternatives analyzed in the EIR. In addition, the comment requests analysis of an alternative to a specific project, not an alternative to the proposed Plan. Such a project would be a second-tier project and would have project-specific alternatives analysis as part of its environmental review. The proposed project-specific alternative is therefore not an appropriate alternative for this first-tier Program EIR.

**RESPONSE TO COMMENT 13-74**

See Master Response 1 regarding the range of alternatives analyzed in the EIR, and response to comment Del Mar 13-73.

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13-74



**30. COMMENT – ALTERNATIVES**  
**Page 6-12**

13-75

In a 2019 Notice of Preparation (NOP) Scoping letter, the Coastal Commission requested an alternative be provided referred to as the “Coastal Protection Alternative” to consider the effects of sea level rise and minimize the need for shoreline armoring with the relocation of the rail corridor along the Del Mar bluffs. The letter also requests that the expected life of the rail corridor along the Del Mar bluffs and other existing infrastructure be analyzed given sea level rise and other environmental impacts. This alternative was rejected on the basis that is an individual project included in the proposed Plan rather than an alternative for the proposed Plan as a whole, and that the lead agency need not discuss alternatives to each particular component of a project.

13-76

**Request:** Based on the City’s prior comment made in Land Use (page 4.11-30, 4.11-31), the City requests SANDAG reconsider a “Coastal Protection Alternative” on page 6-12 and not reject it from further consideration. As part of the reconsideration, the City’s two requests noted above should be included as part of an updated Coastal Protection Alternative. While the City recognizes the reasons stated on page 6-12 as to why a Coastal Protection Alternative was rejected, the planned improvements to Commuter Rail 398 are programmatic components of the draft 2021 Regional Plan and discussed as part of the Transit Leap components in Chapter 2, Project Description (page 2-53) and Phased Transit Leap Network Improvements in Chapter 2, Project Description (page 2-58). The City recognizes that future implementation of the Commuter Rail 398 improvements at a project-level will require further environmental analysis per CEQA and NEPA at the project-level. However, the City disagrees with the reasons for rejecting the Coastal Protection Alternative on the basis that it is an individual project included in the proposed Plan rather than an alternative for the proposed Plan as a whole.

13-77

As noted throughout the City’s comments, sufficient analysis at a programmatic level of the planned Commuter Rail 398 improvements may find that impacts to the coastal region may be reduced via an alternative alignment outside of the coastal corridor. However, unless this analysis is completed at a programmatic level, the proposed Plan’s alignment in horizon years 2025, 2035, and 2050 for Commuter Rail 398 (including associated freight rail) will continue to be along the coastal corridor. The lead agency can include this alternative for further study in the DEIR and should include it given the extent of feedback and public interest on this critical programmatic component of SANDAG’s Draft 2021 Regional Plan.

**RESPONSE TO COMMENT 13-75**

See Master Response 1 regarding the range of alternatives analyzed in the EIR. As noted in the comment, the Coastal Protection Alternative was rejected from further consideration because it is a “second-tier” project-specific alternative. An EIR is not required to consider alternatives to a project component, and instead focuses on alternatives to the project (in this case the proposed Plan) as a whole. *California Native Plant Society v. City of Santa Cruz* (2009) 177 Cal. App. 4<sup>th</sup> 957,993.

**RESPONSE TO COMMENT 13-76**

See response to comment Del Mar 13-75.

**RESPONSE TO COMMENT 13-77**

See response to comment Del Mar 13-75.

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13-78 | The City looks forward to ongoing coordination in SANDAG's development of its draft 2021 Regional Plan and requests Responses to Comments be provided via email to the City staff emails noted. Should you have any questions, please contact the City at (858) 755-9313.

Sincerely,



Terry Gaasterland  
Mayor

cc: Del Mar City Council  
Ashley Jones, Interim City Manager ([ajones@delmar.ca.us](mailto:ajones@delmar.ca.us))  
Kristen Crane, Assistant City Manager ([kcrane@delmar.ca.us](mailto:kcrane@delmar.ca.us))  
Joseph Smith, Planning & Community Development Director ([jsmith@delmar.ca.us](mailto:jsmith@delmar.ca.us))  
Amanda Lee, Principal Planner ([aalee@delmar.ca.us](mailto:aalee@delmar.ca.us))

### RESPONSE TO COMMENT 13-78

SANDAG would like to thank the City of Del Mar again for the comments on the DEIR. We look forward to continued coordination, and a copy of this response to comments will be provided via email to City staff as requested. Please continue to follow along in this process by visiting SDForward.com.



**COMMENT LETTER 14: DESCANSO COMMUNITY PLANNING GROUP**

Comment Letter 14

**From:** Descanso Planning Group <[descansocpg@gmail.com](mailto:descansocpg@gmail.com)>  
**Sent:** Tuesday, October 5, 2021 11:06:07 PM (UTC+00:00) Monrovia, Reykjavik  
**To:** RegionalPlanEIR <[RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)>  
**Subject:** Request for Comments on the DEIR Regional Plan

**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

Kirsten Uchitel,  
I am sending you the Descanso Community Planning Group comments on the Draft EIR for SANDAG 2021 Regional Plan, attached.  
I am also sending you a copy USPS.  
As residents of the unincorporated community of Descanso, we feel we have not received any public outreach on this process, nor has any community in the East County Rural areas.  
The comment letter will outline our community's concerns of inequity, lack of representation, lack of services and being "taxed" without representation.  
I look forward to more inclusion of the unincorporated areas of the County in the next iteration of the DEIR and revision of the Regional Plan.  
Kerry Forrest,  
Chair Descanso Community Planning Group

14-1

**RESPONSE TO COMMENT 14-1**

SANDAG appreciates the Descanso Community Planning Group's (DCPG) feedback on the proposed Plan and your participation in the environmental review process. Please refer to subsequent responses to your comments below for detailed responses regarding your concerns.



DESCANSO COMMUNITY PLANNING GROUP  
 Post Office Box 38, Descanso CA 91916-0038

October 4, 2021

Attn: Kirsten Uchitel Associate Planner,  
 SANDAG, 401 B Street, Suite 800,  
 San Diego CA, 92101  
 Sent via email to: [RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)

**REQUEST FOR COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT REPORT FOR THE 2021 REGIONAL PLAN FOR THE SAN DIEGO ASSOCIATION OF GOVERNMENTS (SANDAG)**

Dear MS Uchitel,

14-2 I am writing this comment letter in representation of the Descanso Community Planning Group. Descanso is a rural country town located in the East County of San Diego County. The Regional Plan location includes all of San Diego County, not just the 18 cities. The unincorporated area of the county is not identified as significant in this regional plan.

The rural residents of the unincorporated areas of the county, those of us outside of Mobility Hub Network (table 2-5), represent more by population (1,813,718) than those within the Mobility Hub Network (1,657,130). The San Diego Forward- The 2021 Regional Plan does nothing to benefit those of us who reside outside of the Mobility Hub Network (Network) and yet we will be expected to financially contribute to it in a significant cost.

OUTREACH FOR PUBLIC COMMENT

14-3 "1.5.3 COMMENTS ON THE DRAFT EIR. *The Draft EIR has been distributed to the agencies, organizations, and individuals that provided written comments on the NOP, the SANDAG Board of Directors, SANDAG member agencies, public libraries throughout the region, and other interested parties and stakeholders.*" The local county libraries in Alpine, Descanso and Pine Valley do not have copies of the EIR. There may be more rural county libraries which do not have the EIR for review. The rural areas of

**RESPONSE TO COMMENT 14-2**

The comment raises concerns about the proposed Plan not benefiting those who reside outside of the Mobility Hub Network. The comment does not raise any concerns about the adequacy of the EIR. No further response is required.

**RESPONSE TO COMMENT 14-3**

SANDAG initiated the EIR scoping process on November 14, 2016, through the circulation of a NOP. Receipt of the NOP by the State Clearinghouse at the California Office of Planning and Research on November 14, 2016, initiated a 60-day comment period that ended January 13, 2017. The NOP provided formal notification to all federal, State, and local agencies involved with funding, and to other interested organizations and members of the public, that an EIR was to be prepared for the proposed Plan. The NOP was intended to encourage interagency communication concerning the proposed Plan and provide sufficient background information so that agencies, organizations, and individuals could respond to SANDAG with specific comments and questions on the scope and content of this EIR. Appendix A summarizes the issues raised in the NOP comments and identifies the EIR section(s) that address that issue or provides another response to the issue raised as appropriate. The NOP is provided in full in Appendix A-1. The written comments are provided in full in Appendix A-2.

Consistent with CEQA (PRC Section 21083.9), SANDAG noticed and held a public scoping meeting on December 8, 2016, at SANDAG's office at 401 B Street, San Diego, CA 92101. The purpose was to receive perspective and input from agencies, organizations, and individuals on the scope and content of the environmental information to be addressed in the EIR.

To support the development of the proposed Plan, SANDAG implemented a comprehensive public outreach and involvement program consistent with State and federal requirements. Early in the planning process, SANDAG developed a Public Involvement Plan (PIP) to guide the public outreach program, which was updated in mid-2019. The PIP identifies public engagement techniques to involve the public and collect input for the proposed Plan, including public workshops, social media, visualizations, and other means. It describes how to connect with hard to reach communities such as tribal nations and low-

income and minority populations. A detailed description of the PIP can be found in Appendix G of the proposed Plan.

The Draft EIR for the proposed Plan was released to the public on August 27, 2021, and was available for a 45-day public review period, as required by CEQA. SANDAG published a Notice of Availability (NOA) for the Draft EIR in local newspapers on August 27, 2021, and mailed the NOA to an extensive distribution list. SANDAG also filed a Notice of Completion (NOC) with the State Clearinghouse to indicate the availability of the Draft EIR for public review and comment on August 27, 2021. The Draft EIR was distributed to the agencies, organizations, and individuals that provided written comments on the NOP, the SANDAG Board of Directors, SANDAG member agencies, and other interested parties and stakeholders. Agencies, organizations, and individuals were invited to provide written comments on the Draft EIR during the public review period from August 27 to October 11, 2021.

The Draft EIR and all appendices were available for review online at [www.sdforward.com](http://www.sdforward.com); at SANDAG offices located at 401 B Street, Suite 800, San Diego, California 92101; and at the San Diego Central Library located at 330 Park Boulevard, San Diego, California 92101. The Central Library will facilitate inter-library transfers upon request by a member of the public in order to provide access at local libraries. On a case-by-case basis, the San Diego Central Library can also digitize documents and transfer them to other libraries. No such requests were made of the Central Library with respect to the Draft EIR, nor were any requests made of SANDAG with respect to providing access to the Draft EIR during the Public Comment period.

There will be a further opportunity for public participation on December 10, 2021, at the SANDAG Board of Directors meeting discussing adoption of the proposed Plan and certification of the EIR.

14-3 cont. the county are stakeholders but have not been contacted in the SANDAG outreach much less had the opportunity to review the draft EIR on the Regional Plan. Due to the lack of broad band internet and the lack of outreach by SANDAG to their communities many of those impacted by this action are being deprived of their right to participate in this process that may impact them significantly. **This review process should be delayed until the rest of the County residents have been included in the review and comment on the DEIR Regional Plan.**

PLANNING FOR THE UNINCORPORATED AREAS

14-4 "Public Services and Utilities San Diego Forward: The 2021 Regional Plan Page 4.15-19 Program Environmental Impact Report Broadband refers to a high-speed internet connection that can transport multiple signals and traffic types. According to the Federal Communications Commission (FCC) (2017), 100 percent of residents in the San Diego region currently have access to broadband via at least one provider." There is an opportunity here to develop investment strategies for working from home if broad band internet at a reasonable cost was made available to rural communities. Despite what has been reported Broad Band internet is NOT accessible to many of us in the county. Satellite and Cellular options can be very costly and unreliable, not efficient enough for home school study or work needs. This has not been identified as a strategy to reduce Vehicle Miles Traveled (VMT) for residents living outside the "Network" and should be considered and implemented within the Regional Plan.

14-5 How will the Regional Plan provide transportation options for those residents outside of the "Network"? The unincorporated East and North County communities represent a significant population with higher -than- average VMT within the County. Social Justice/Equity concerns regarding the Indian Reservations in the east County should be considered. Will the VMT fees be applied to tribal nations and the tribal members who may travel off tribal lands? Sequan, Viejas, Barona, Campo, La Posta, Jamul and Ewiiiaapaayp nations are in the rural areas of East County.

14-6 Many rural residents are of lower income and of Hispanic decent, how will this plan invest equitably in public transportation? Walking, riding a bike or using flexible fleets will not work in these areas. A possibility is frequent bus rapid transit using pickup points at the park- and -ride lots located on the Interstates such as I-8 and the State Highway 94 to the nearest mobility hub for further transport options. A rural transit line such as a train or bus service traveling from the ends of the county to the Mobility Hubs should be part of the plan.

ROADS/TRAFFIC

14-7 SANDAG should do more to identify and invest in routes for the County's eastern and northern rural regions that could be essential in the event of a natural disaster, earthquake, flood, or wildfire. Road improvements such as curve straightening and widening would benefit the drivers as well as recreational bike riders on roads like Highway 79 and Highway 94. Evacuation routes for disasters should be identified, developed, and marked in a manner like the Tsunami routes recently put into place

**RESPONSE TO COMMENT 14-4**

The Plan includes an investment in the backbone fiber infrastructure needed to support the transportation network; however, SANDAG is also developing a Regional Digital Equity Strategy & Action Plan to support the expansion of broadband county-wide. The Strategy & Action Plan will define strategies for expanding broadband and internet connectivity in the San Diego region to support quality of life, transportation, and equity.

**RESPONSE TO COMMENT 14-5**

The proposed Plan includes Mobility Hubs for East County which can facilitate creating additional economic opportunities within that hub. Mobility Hubs are communities with a high concentration of people, destinations, and travel choices. They offer on-demand travel options and supporting infrastructure to enhance connections to high-quality Transit Leap services while helping people make short trips around the community on Flexible Fleets. Mobility Hubs will be implemented in close coordination with local jurisdictions to align with the unique needs of each community.

SANDAG is also developing a Flexible Fleet Implementation Strategic Plan to identify near-term opportunities for Flexible Fleet pilots that support mobility, equity, and sustainability goals.

The Intra-regional Tribal Transportation Strategy was used to inform many of the improvements identified for the rural corridors. These examples have been added to the description of rural corridor improvements in Appendix A of the proposed Plan in the section titled *Rural Corridors* and Table A.12: Rural Corridors.

**RESPONSE TO COMMENT 14-6**

The Plan includes investments in Flexible Fleets, expansion of broadband, investment in zero emission vehicles, and improvements on rural corridors. These benefit rural communities with improved access to mobility options via technology, increased safety on hazardous roads particularly during emergency situations, and advanced deployment of zero emission vehicles.

**RESPONSE TO COMMENT 14-7**

The Comprehensive Multimodal Corridor Plans identify ways to improve roadway safety, enhance the urban-rural transportation interface (with special consideration given to limiting impacts on

surrounding environmental habitats and wildlife), engage with tribal nations, and create greater trip reliability and efficiency throughout the study area while supporting climate action initiatives. The suite of solutions will include active transportation, clean transportation, transit, resilience and environment, right-of-way and utilities, equity, and evacuation considerations.

14-7  
cont. within the county. The intersections of Highways to feeder roads should be evaluated for improvements and safety. There are more and more visitors to the rural areas of the county, and this has adversely impacted the safety of these intersections.

FUNDING AND FINANCING

14-8 The Regional Plan indicates that user fees would help build a transportation system that provides residents an alternative to driving in their vehicle. This plan must address how the proposed road use charges will be developed, implemented, and applied to ensure that this funding strategy will not disproportionately burden unincorporated communities, which have longer a commute, less access to alternative transportation options, don't use electric cars because SDGE cuts power off during potential high wind and wildfire events and have not yet had a voice in expressing their comments to this process (see outreach).

14-9 County VMT fees on top of State VMT fees on top of Federal VMT fees on top of existing gasoline taxes would unfairly penalize the driver of a gas-powered vehicle. Owners of gas-powered vehicles are frequently the low-income residents who live in the rural areas of the county where housing costs are less. This is not equitable for 50% or more residents living in the County (table 2-5). Those that have the least are being asked to sacrifice the most. You are creating a class of people who live in the rural areas of the county without alternative transportation options, a voice or opportunity but will be penalized by the VMT fees.

It is unclear what proportion of investment would go toward addressing mobility between unincorporated communities and infrastructure investment that would provide linkages between rural communities and the "Network".

14-10 SANDAG must address the equitable distribution of mobility benefits of the 2021 Regional Plan and the costs associated with it. The residents of the unincorporated areas of the county should not have to pay more than the benefits they may receive.

14-11 I look forward to the development of a more equitable draft Regional Plan which recognizes and includes the needs of residents in the unincorporated areas of San Diego County. The County does not end at El Cajon, as shown on your maps in the DEIR, there is much more of it you are not considering in your draft Regional Plan.

Kerry Forrest

Chair, Descanso Community Planning Group

cc: Supervisor Joel Anderson: Board of Supervisors, District 2

Senator Brian Jones, 38<sup>th</sup> Senate District, CA

**RESPONSE TO COMMENT 14-8**

SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and GHG emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.

The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as rural residents, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system. For example, drivers of fuel-powered vehicles in the state of Oregon receive a credit for fuel tax and remote emissions testing through their road usage charge program called OReGO.

**RESPONSE TO COMMENT 14-9**

The proposed Plan includes a variety of projects and programs to improve the transportation system for all modes of transportation in the San Diego region over 30 years. This includes investments to improve roads and freeways as well as public transit and active transportation. Gas tax revenues have been declining as vehicles become more fuel efficient and more electric vehicles are on the roads. A road usage charge would be a new funding mechanism to replace the gas tax. Road usage charges are being considered by transportation agencies across the country.

**RESPONSE TO COMMENT 14-10**

Investments in the proposed Plan for unincorporated communities include improvements to local bus service (increased frequencies and span of service) and Flexible Fleet services. Attachment 1 to Appendix A of the proposed Plan provides the frequencies and spans of service

proposed for Transit Leap, including local bus routes. In addition, the investments in the mobility hubs also serve residents of the unincorporated area as many residents live near a mobility hub and will be able to access the transit system within a reasonable amount of time on a Flexible Fleet service, then be able to make use of the Rapid bus, light rail, or commuter rail systems.

SANDAG looks forward to coordinating with the County on many areas of implementation for the proposed Plan including the Flexible Fleet Implementation Strategic Plan, Active Transportation Plan, Comprehensive Multimodal Corridor Plans, and advanced transit planning. All of these efforts provide opportunities for refinement of the proposed Plan concepts at a local level.

The proposed Plan puts in place a regional framework for a reimagined transportation system. The plans and studies identified as implementation actions in Appendix B of the proposed Plan will provide opportunities for SANDAG to work closely with the County to apply the 5 Big Moves concepts to the unincorporated areas and improve mobility options and safety.

#### **RESPONSE TO COMMENT 14-11**

The proposed Plan considers the current and future needs of the whole region, including unincorporated communities. The reimagined transportation system offers benefits that extend through the region as residents and visitors travel outside their communities for work, recreation, school, entertainment, and accessing basic needs. The investments in Next OS, Flexible Fleets, Mobility Hubs, and other programs are presented as regional investments, and SANDAG intends to work collaboratively with each jurisdiction to implement the proposed Plan and customize mobility solutions for the unique needs of each community.



**COMMENT LETTER 15: ENDANGERED HABITATS LEAGUE**

Comment Letter 15

**From:** Dan Silver <[dsilver1a@me.com](mailto:dsilver1a@me.com)>  
**Sent:** Monday, October 11, 2021 1:48 PM  
**To:** Kirsten Uchitel  
**Cc:** Michael Beck  
**Subject:** Draft EIR for San Diego Forward: The 2021 Regional Plan (RTP/SCS)

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October 11, 2021

Kirsten Uchitel, Associate Planner  
 San Diego Association of Governments  
 401 B Street  
 San Diego, CA 92101

**RE: Draft EIR for San Diego Forward: The 2021 Regional Plan (RTP/SCS)**

Dear Ms Uchitel:

15-1 Endangered Habitats League (EHL) is supportive of the 2021 RTP/SCS and its forward-looking transportation initiatives and housing allocations. We wish to comment on biological impacts. For your reference, EHL is a Southern California conservation group dedicated ecosystem protection and sustainable land use.

The EIR acknowledges significant and unavoidable impacts to biological resources, including to wetlands, sensitive species, and movement corridors/wildlife connectivity. There will also be significant impacts to greenhouse gas emissions and climate change, albeit less than a trend scenario.

15-2 For biological impacts, all feasible mitigation should be undertaken, and should take the form of *advanced, programmatic mitigation*. Such mitigation is comprehensive rather than project-by-project. A good model is the Orange County Transportation Authority's Measure M2 program for its Freeway Projects, in which a fraction of revenues were set aside to fund the mitigation. Because the San Diego region has existing and planned multiple species habitat plans (MSCP, MHCP, North County MSCP, etc.) establishment of a regional funding source for their acquisition and management – as called for in the MSCP – is a logical direction for the advanced, programmatic mitigation.

Please let me know of questions.

Yours truly,  
 Dan Silver

Dan Silver, Executive Director  
 Endangered Habitats League  
 8424 Santa Monica Blvd., Suite A 592 Los  
 Angeles, CA 90069-4267

213-804-2750  
[dsilver1a@me.com](mailto:dsilver1a@me.com)  
<https://ehleague.org>

**RESPONSE TO COMMENT 15-1**

Thank you for the Endangered Habitat League’s participation in the environmental review process. Further elaboration regarding your organization’s comments is addressed below.

**RESPONSE TO COMMENT 15-2**

This comment states that the Draft EIR should include “advanced, programmatic mitigation” of biological impacts, specifically, that funds should be set aside for the acquisition and management of habitat plans. As an initial matter, the EIR found that the proposed Plan has no significant impacts relating to conflicts with the provisions of adopted HCPs, NCCPs, or other conservation plans, or any local policies or ordinances protecting biological resources.

To meet the region’s habitat conservation goals, the proposed Plan identifies approximately \$3 billion for habitat-related efforts. This includes \$2,087 million for an enhanced habitat conservation, management, and monitoring program (see Land Use and Habitat programs in Appendix B of the proposed Plan), a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (see Climate Adaptation and Resilience programs in Appendix B of the proposed Plan), and \$300 to \$500 million of land acquisition and restoration for habitat mitigation of transportation projects (incorporated in project costs presented in Appendix A of the proposed Plan). As identified in Appendix B of the proposed Plan, SANDAG will continue to monitor the implementation of the Plan on a four-year cycle and make the data accessible to the public. Please refer to Master Response 1 for additional discussion regarding including a regional habitat conservation fund.

**COMMENT LETTER 16: FRIENDS OF ROSE CREEK**



**Friends of Rose Creek** \*  
 "Connecting Our Communities"  
 4629 Cass Street #188  
 San Diego CA 92109

Comment Letter 16



October 11, 2021

*2021 via email transmission to Kirsten.Uchitel@sandag.org*

Kirsten Uchitel, Associate Planner  
 SANDAG  
 401 B Street, Suite 800  
 San Diego, CA 92101  
 Subject: Draft EIR for San Diego Forward: The 2021 Regional Plan (RTP/SCS)

Dear Ms. Uchitel:

16-1 Thank you for the opportunity to comment on the Regional Plan. The Friends of Rose Creek cares for, enhances, and advocates for the protection of Rose Creek and the entire Rose Creek Watershed, which provides critical park services to a diverse community of workers, military personal and their families, as well as bird watchers and bicyclists from around the county. Our vision is for lower Rose Creek to be an open space park providing recreational and learning opportunities and a clean, healthy, aesthetically pleasing environment for residents, visitors, businesses, and native plants and animals.

16-2 We would like to request removal of the proposal to add travel lanes and carpool lane connectors to Highway 52 between I-5 and I-805. This critical stretch of Marian Bear Natural Park is part of the City of San Diego's MSCP program and is already negatively impacted by the existing highway and connectors. Furthermore, the Mid-Coast Trolley extension damaged the western portion of the critical habitat corridor between MCAS Miramar, Rose Canyon Open Space Park and the in-the-works planning for restored wetlands at the mouth of Rose Creek.

16-3 The EIR acknowledges potentially significant and unavoidable impacts to biological resources, including to wetlands, sensitive species, and movement corridors/wildlife connectivity. Pages 4.4-61 to 79 describe the substantial adverse effects on riparian habitat, wetlands and other sensitive natural habitats, their potential significance, and possible mitigation for unavoidable impacts. Pages 4.4-79 to 95 describe the proposed Plan's anticipated impacts to sensitive and rare, threatened and endangered species, their potential significance, and possible mitigation for unavoidable impacts. Pages 4.4-95 to 106 present comparable descriptions of the anticipated impacts to corridors and linkages that are essential to the continued survival of wildlife (and plants), their potential significance, and possible mitigation for unavoidable impacts.

\*A member of the Rose Creek Watershed Alliance  
 \*A Friends Group of San Diego Canyonlands, Inc.  
 Visit us on-line at <http://www.saverosecreek.org>

**RESPONSE TO COMMENT 16-1**

Thank you for the Friends of Rose Creek's participation in the environmental review process; further elaboration regarding your organization's comments will be addressed in subsequent responses below.

**RESPONSE TO COMMENT 16-2**

This comment relates to the proposed Plan, and not the analysis in the Draft EIR. Many of the complete corridor projects in the proposed Plan utilize existing right-of-way and, in many cases, existing roadway shoulders without encroaching into any additional land. This will greatly reduce environmental impacts, speed project delivery, and reduce costs. Where this is not an option additional project-specific outreach and engagement will be conducted with affected residents and stakeholders. This process aims to develop projects with minimal impacts.

**RESPONSE TO COMMENT 16-3**

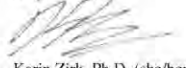
This comment accurately recites content of the Draft EIR. As identified in Section 4.4 of the EIR, implementation of mitigation measures would reduce impacts related to biological resources. However, there is no assurance that mitigation measures would be implemented for all projects or be equally effective due to the wide variety of circumstances, complexity of some sites, complexity of impacts on those sites, lack of available mitigation sites, shortage of acreage at mitigation banks, mitigation complexity and cost, lack of long-term management and monitoring, and lack of enforcement. Instances may occur in which impacts are not reduced to less-than-significant levels. Therefore, these impacts have been identified as significant and unavoidable.

16-4 The Friends of Rose Creek are strongly opposed to the loss of even one acre of biological resources, wetlands, or wildlife corridors. Plans like the Regional Plan take away habitat and nature from the communities where people are desperate to get out in nature and move them to the east and north east portions of the county. This then increases VMT as people with means drive to nature instead of being able to walk or bike to hiking trails. People without vehicles are then shut out from access to nature and this exasperates the social injustices in the county and leaves communities of concern without access to nature.

16-5 We reject the argument that staying within the Right-of-Way avoids impacts to biologic resources as these areas are often critically important habitats. Hiking five feet from a highway is not an enjoyable experience. We need more distance between natural areas and highways not less. We need more trees and shrubs not less. What we need is less concrete!

16-6 We need real solutions to address climate change and that includes insure we have nature in urban areas that serves as cooling places from heat islands, can absorb CO2, and contribute to our quality of life.

Respectfully,



Karin Zirk, Ph.D. (she/her)  
 Executive Director  
 Friends of Rose Creek  
 \*\*\* Connecting Our Communities \*\*\*  
<http://www.saverosecreek.org>

**RESPONSE TO COMMENT 16-4**

This comment relates to the proposed Plan, and not the analysis in the Draft EIR.

See response to comment FORC 16-3.

In addition, many of the complete corridor projects in the proposed Plan utilize existing right-of-way and, in many cases, existing roadway shoulders without encroaching into any additional land. This will greatly reduce environmental impacts, speed project delivery, and reduce costs. Where this is not an option additional project-specific outreach and engagement will be conducted with affected residents and stakeholders. This process aims to develop projects with minimal impacts.

The conservation of native species and their habitat is a key component of SANDAG's SCS. The land use pattern of the proposed Plan envisions greater compact development in areas served by high frequency, efficient transit. The result is less urban sprawl and fewer impacts on native habitat and species. Appendix AA, *Regional Habitat Conservation Vision of the Regional Plan*, describes the region's efforts to develop and implement a system of open space for conservation of San Diego's unique biodiversity.

**RESPONSE TO COMMENT 16-5**

The Draft EIR does not find that transportation projects within existing rights-of-way categorically avoid impacts on biological or recreational resources. Both Sections 4.4 and 4.15 analyze impacts of the proposed Plan's transportation projects, projects within *and* outside existing rights-of-way.

As discussed in prior responses, where impacts on biological resources cannot be avoided, mitigation has been identified to avoid and reduce these impacts for the future construction of transportation and land use projects. Through the implementation of the proposed Plan, SANDAG will continue to support habitat conservation with the proposed establishment of the \$565 million Nature-Based Climate Solutions Program.

**RESPONSE TO COMMENT 16-6**

SANDAG acknowledges that more work needs to be done in this area and that various climate action plans developed for the region, along with federal and State agency initiatives, are being incorporated as

SANDAG's comprehensive strategies for addressing climate change in this and future regional plans.

**COMMENT LETTER 17: FRIENDS OF ROSE CANYON**

Comment Letter 17



October 11, 2021

Kirsten Uchitel, Associate Planner  
 SANDAG  
 401 B Street  
 San Diego, CA 92101

Submitted via email: [Kirsten.Uchitel@sandag.org](mailto:Kirsten.Uchitel@sandag.org)

Subject: Comments on the Draft EIR for San Diego Forward: The 2021 Regional Plan

Attachment: As an additional comment on the Draft EIR, we are resubmitting our Aug. 6, 2021 comments on the Draft Regional Plan about corrections needed to the San Diego Coastal Rail Trail project. These corrections were not incorporated in the Draft EIR, so we are submitting them again.

Dear Ms, Uchitel:

Friends of Rose Canyon (FRC) is a 501(c)(3) non-profit organization dedicated to the protection, preservation and restoration of Rose Canyon and the Rose Creek Watershed. The Rose Creek watershed begins east of I-15, crosses MCAS Miramar in two creeks (Rose Creek and San Clemente Creek, with Rose Creek flowing under I-805 and through Rose Canyon and San Clemente Creek flowing under the SR 52/I805 interchange and through San Clemente Canyon (also known as Marian Bear Park). San Clemente Creek joins Rose Creek at the SR-52/I-5 intersection. Rose Creek flows southward and is the main freshwater tributary of Mission Bay.

Much of the City-owned land in Rose Canyon is core MSCP habitat. Most of the City-owned land in San Clemente Canyon is part of Marian Bear Memorial Park and is core MSCP land.

FRC also works to protect habitat in areas near the Rose Creek watershed, including habitat adjacent to Carroll Canyon Creek, both east and west of the riparian corridor under I-805 that continues through Sorrento Valley to Penasquitos Lagoon.

**1. We concur with the following comments in the DEIR Comment Letter submitted by SWIA:**

- We strongly recommend the Plan be modified to reduce the number of managed lanes, initiate roadway pricing immediately, and increase transit options right away.

**RESPONSE TO COMMENT 17-1**

Thank you for your participation in the environmental review process and for the detailed comments for SANDAG’s consideration. For comments related to the San Diego Coastal Rail Trail Project, please refer to Appendix P.2 under Comment ID #1126. For other comments included in this letter, please refer to detailed responses below.

**RESPONSE TO COMMENT 17-2**

This comment is related the proposed Plan, not the analysis within the Draft EIR.

The proposed Plan is focused on creating more mobility options for all people in the San Diego region through a fast, reliable, and fair public transportation system and micromobility options including e-bikes and scooters, rideshare, and microtransit shuttles. The proposed Plan also proposes a network of Managed Lanes using existing infrastructure that provide priority access to people using transit, carpooling, or vanpooling. The Managed Lane network supports transit services, making transit a compelling alternative to driving.

The final draft of the proposed Plan has been updated to reflect 2030 as the start of implementation for the road usage charge to better align with the timing that the State and other regions are expecting for transitioning to a road usage charge.

The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A of the proposed Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021.

Regarding an alternative that prioritizes transit over the construction of new highway capacity, please see Master Response 1.

- 17-2 cont. - Adoption of an alternative that prioritizes transit over the construction of new highway capacity. That could include converting existing lanes to Managed Lanes.
- 2. For road and rail projects in urban areas, the Plan should mitigate all environmental impacts in the area the impacts occur.**
- 17-3 Our MSCP lands, wetlands, and wildlife corridors areas are the last remaining ones we have in our urbanized areas. They should be highly protected from further environmental impacts. Yet the DEIR indicates that multiple proposed road and (presumably) rail projects in the 2021 RTP would have highly negative direct and indirect impacts on these MSCP lands and wildlife movement corridors. We strongly disagree with the assumption in the DEIR that these impacts are acceptable. The approach is the usual mantra of impacting the urban habitat and mitigating far away. Historically in the Rose Creek watershed SANDAG has not mitigated impacts to urban habitat in the area those impacts occurred. SANDAG has instead mitigated the impacts at distant mitigation banks. Over time, this approach has led to a cumulative and ever-increasing degradation of our urban habitat areas, including urban MSCP lands, wetlands, riparian corridors and wildlife movement corridors. For example, SANDAG's \$30 million Rose Creek Bikeway project, completed last year, impacted the Rose Creek riparian corridor with construction of a major concrete structure for the bikeway. The creek in that location is a highly degraded urban waterbody, thick with invasive plant species and full of trash. It would have been a prime location for SANDAG to do wetland mitigation. Instead, SANDAG exported the mitigation to a distant mitigation bank, leaving Rose Creek as bad or worse than before.
- 17-4 Bicyclists using this \$30 million bikeway cycle along the edge of this still highly degraded creek. Similarly, SANDAG's recent MidCoast Trolley Project and Elvira to Morena Double Tracking Project impacted Rose Creek riparian areas with multiple new concrete structures. Yet SANDAG carried out mitigation for those impacts in distant mitigation banks
- 17-5 The DEIR proposes to continue this practice. It dismisses the impacts to our urban MSCP lands and watersheds by proposing to do mitigation elsewhere. The DEIR should instead acknowledge that in reality when impacts to urban area habitat are mitigated elsewhere, the environmental impacts in the urban area are permanent and cumulative.
- 17-6 The Plan promotes concentrating growth in high density urban areas in order to promote environmental benefits related to climate change and air quality. The Plan should therefore take a new approach to the environmental impacts of the projects it proposes to build in those urban areas: it should strongly consider not building road and other projects that impact urban MSCP lands, riparian areas, wildlife corridors and parks and mitigate impacts that do occur due to projects in urban areas in the area they occur,
- 17-7 **3. The Plan fails to identify the existence of Marian Bear Memorial Park.** It is one of the City of San Diego's oldest Open Space Parks, and it provides recreational and nature enjoyment opportunities in an area that is increasingly urbanized (thanks in part to SANDAG's projects). The area is also core MSCP and provides key wildlife corridor linkages to Rose Canyon in the west and MCAS Miramar in the east. Nevertheless, the Plan proposes a massive highway

2

**RESPONSE TO COMMENT 17-3**

Please see response to comment Del Mar 13-36 regarding the programmatic nature of the EIR. The EIR addresses mitigation on a programmatic level. On a project-specific level, and as often required by the regulatory agencies and local ordinances, onsite mitigation and mitigation within the same watershed is preferred, but if mitigation lands are not available, mitigation may need to occur elsewhere. The Draft EIR does not make a finding that impacts are "acceptable" or "unacceptable."

**RESPONSE TO COMMENT 17-4**

This comment provides a concern with the mitigation of a previous SANDAG project and does not provide a comment regarding the adequacy of this EIR. Therefore, no further response is required. However, the comment will be provided to the SANDAG Board of Directors for their consideration.

**RESPONSE TO COMMENT 17-5**

Please see response to comment FRC 17-3. The EIR provides programmatic mitigation measures to address impacts of the overall proposed Plan. The implementation of projects under the proposed Plan will require subsequent CEQA review, and the project-specific impacts and mitigation measures will be identified in that subsequent CEQA document. The Draft EIR discloses that offsite mitigation and mitigation banks are part of the programmatic mitigation measures (see BIO-1b, BIO-1c, BIO-2b, BIO-2c). The Draft EIR also discloses that despite implementation of these mitigation measures, impacts would remain significant and unavoidable.

**RESPONSE TO COMMENT 17-6**

This comment relates to the content of the proposed Plan, not the Draft EIR. Please see response to comments FRC 17-3 and FRC 17-5.

**RESPONSE TO COMMENT 17-7**

SANDAG's proposed Plan includes freeway improvements along I-5 and implementation of the Coastal Rail Trail in this area for the 2035 horizon, as well as the SR 52 bikeway from I-5 to Santo Road that would impact Marian Bear Memorial Park. Although SANDAG appreciates the concerns expressed in this comment, the improvements are required to

accommodate planned population growth and related transportation improvements identified in the proposed Plan.

The implementation of projects under the proposed Plan will require subsequent CEQA review, and the project-specific impacts and mitigation measures will be identified in that subsequent CEQA document, including the implementation of mitigation measures identified in Section 4.4, *Biological Resources*, of the EIR.



17-7 cont. project on SR-52 immediately adjacent to the park and MSCP, and likely cutting into it.

**The following projects should be removed from the Plan:**  
**For SR 52 between I-5 and I-805:**

- Remove the proposed three additional lanes (4 F to 4F + 3 ML)
- Remove the Managed Lane Connectors going in all directions between SR-52 and I-5
- Remove the Managed lane connectors between SR 52 EB and I-805 SB

17-8 Marian Bear I Park is immediately adjacent to this entire stretch of SR 52. Marian Bear Memorial Park, one of the City of San Diego's oldest open space parks. The Plan fails to identify its existence. The Park's trails provide beloved recreational opportunities for residents who live in the increasingly dense surrounding areas, a density increase that is promoted by the Plan as one of its core goals. The Plan is working at cross purposes if it simultaneously promotes major density increases in this area while simultaneously building a huge noisy intrusive highway project immediately adjacent to the very park that makes life move livable in those increasingly dense areas.

17-9 Marian Bear Park is core MSCP habitat. It provides wildlife corridor connectivity via the ever more constrained wildlife linkages to Rose Canyon in the west, to MCAS Miramar in the east, and to the south via the Rose Creek riparian corridor to Mission Bay. SANDAG's projects have increasingly constrained these corridors in recent years: with the Midcoast Trolley and the Elvira to Morena Doubletracking projects at the west end, and with the previous construction of the SR-52/I-805 intersection which left only a hugely constrained undercrossing for wildlife between Marian Bear Park and MCAS Miramar.

17-10 **4. Adding road capacity produces induced demand: the Plan should significantly reduce the number of lane miles of roadway it proposes to build.**  
 As the DEIR states, the Regional Plan adds a large amount of capacity to our roadways: It would add 799 lane miles of roadway by 2050 (Figure 4.16-74).

- 412 miles of additional freeway miles
- 32 miles of additional State Highway miles
- 392 miles of additional arterial miles
- 7 miles of Tollway (the plan removes 38 miles of Tollway)

17-11 a. The DEIR needs to explain its assumptions and conclusions around induced demand. It is now well accepted that adding road capacity induces demand. Induced demand occurs with HOV lanes as well as general purpose lanes. A potential way to address the issue of induced demand is with an aggressive pricing structure. But the issues around the pricing of Managed Lanes/HOV Lanes and whether and how much pricing impacts induced demand and VMT are debated. Moreover, while the construction of the 799 lane miles of new road capacity is built into the plan, no specific pricing structure is guaranteed. The DEIR should explain what its models show the pricing would need to be to counter the issue of induced demand and reduce VMT. Would it apply to general purpose lanes as well as managed lanes? What decisions would need to be made, and by whom, to implement the pricing

3

**RESPONSE TO COMMENT 17-8**

This comment relates to components of the proposed Plan, not the analysis within the Draft EIR. Many of the complete corridor projects in the Draft Plan utilize existing right-of-way, and, in many cases, existing roadway shoulders without encroaching into any additional land. This will greatly reduce environmental impacts, speed project delivery, and reduce costs. Where this is not an option additional project-specific outreach and engagement will be conducted with affected residents and stakeholders. This process aims to develop projects with minimal impacts.

**RESPONSE TO COMMENT 17-9**

Please see response to comment FRC 17-7. In addition, as discussed in Section 4.4, the transportation network improvements projected in the proposed Plan would impact wildlife movement. As noted under regional growth and land use change, adherence to the existing federal, State, and local laws, regulations, and programs discussed in Section 4.4.2 would reduce impacts on wildlife movement; however, it cannot be concluded that adherence would result in less-than-significant impacts for all projects. Considering both direct and indirect impacts, transportation network improvements under the proposed Plan would interfere substantially with fish and wildlife movement, wildlife corridors, and nursery sites. This would be a significant impact.

The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the Plan include site-specific transportation network improvements and development projects that would be subject to project-specific environmental review. Specific projects that would impact on Marian Bear Park would be considered second-tier projects and would be subject to project-specific environmental review.

**RESPONSE TO COMMENT 17-10**

This comment relates to components of the proposed Plan, not the analysis within the Draft EIR.

The proposed Plan places emphasis on maximizing the use of existing facilities to add corridor capacity to ease congestion while also trying to achieve meeting State and federal GHG and air quality targets. The proposed Managed Lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools, and low-emission vehicles with

appropriate decals. The system of Managed Lanes and supporting connectors support Transit Leap and HOVs to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes.

Improvements to arterials are primarily part of SANDAG's Complete Corridor Regional Arterials. Complete Corridors are designed to provide priority access for transit and flexible fleet shared ride services on our regional arterials, and provide safe and comfortable transportation options to get people to their destinations safely and efficiently.

#### **RESPONSE TO COMMENT 17-11**

SANDAG is required to analyze induced demand impacts of the proposed Plan, which are documented in Appendix D of the proposed Plan. The activity-based model and other analyses used to inform the proposed Plan have been reviewed through SANDAG's peer review process and documented in the technical methodology submitted to CARB, also included in Appendix D. Where possible, the Plan proposes repurposing of general purpose lanes or shoulders to create Managed Lanes. The Managed Lane system is important for supporting the transit network and Flexible Fleets envisioned in the proposed Plan. The Regional Plan is updated every 4 years, providing opportunities to reflect changes in the network.

Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like GHG emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle: the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently fund different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources. This study will also give SANDAG a better idea of the interaction between included demand and usage-based fees.

17-11 cont. structure ? Would it be a road user charge? Given the unpopularity of the concept of a road usage charge, what is the likelihood of a pricing policy being implemented that is aggressive enough to counter the forces of induced demand?

17-12 Moreover, the DEIR proposes to move quickly to add road capacity: it would add 245 of those new lane miles by 2025, including 23 miles of General Purpose Lanes, 39 miles of HOV/Managed Lanes, 10 miles of Tollway, 27 miles of State Highway and 146 miles of Arterials.

17-13 The DEIR thus proposes to front load the proposed new road capacity projects before it is clear what the fee structure will be and what the impact of that fee structure is in terms of VMT, GHG emissions, and induced demand. And what will be the ridership of transit using the Managed Lanes? And what is a realistic time frame for when a comprehensive toll or road usage charge would be implemented? Will it be for use of both Managed Lanes and General Purpose Lanes? What vehicles will be allowed to use the MLs and under what conditions? (SANDAG staff have said that in their model, Single Occupancy Vehicles would be allowed to use the Managed Lanes.)

17-14 The Plan should be modified to reduce the construction of Managed Lanes built and implement the fee structure and some BRT routes to establish the viability of the Plan.

17-15 5. A major impact of the 799 new lane miles of roadway in the plan is severe and unmitigated environmental impacts to MSCP habitat and wildlife corridors and movement. (It is unclear how many of these would be due to commuter rail and LOSSAN projects, since their alignments are not specified).

- The Regional Plan (p. 4.4-112) Table 4.4-18 states that Transportation Network Improvements will encroach onto 78 acres of City of San Diego MHPA 100 Percent Conserved lands and 132 acres of MSCP South County Hardline Preserve, and 13 acres of Conserved Lands and Habitat Preserves.

A number of these impacted acres are in the urban areas of the City of San Diego, where MSCP habitat and wildlife corridors are already highly impacted and constrained. Removing from the Plan the projects on SR-52 between I-5 and I-805 (including the connectors) would reduce the impacts on the MSCP.

**6. Wildlife Corridors and Linkages**

17-16 In yet another acknowledgment of the severe environmental impact from the Plan's additional roadways, the DEIR states: "Almost the entire planned transportation network could potentially affect regional wildlife corridors and linkages."

The DEIR states on P. 4.4-35:  
 "A primary landscape features (sic) known to provide wildlife movement are ridgelines and drainages. Riparian corridors provide sufficient structural vegetative cover to allow the passage

4

**RESPONSE TO COMMENT 17-12**

Although this comment uses the term "DEIR," the substance of the comment relates to components of the proposed Plan, not the analysis within the Draft EIR.

The comment summarizes information provided in Table 4.16-6, *Roadway Network Analysis – Year 2025*, from Section 4.16, *Transportation*, of the Draft EIR regarding the number of lane miles of roadway that would be added under the proposed Plan. Generally, this summary provides introductory information for the following comments. However, the proposed Plan places emphasis on maximizing the use of existing facilities to add corridor capacity to ease congestion while also trying to achieve meeting State and federal GHG and air quality targets. The proposed Managed Lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools, and low-emission vehicles with appropriate decals. The system of Managed Lanes and supporting connectors support Transit Leap and HOVs to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes.

**RESPONSE TO COMMENT 17-13**

Although this comment uses the term "DEIR," the substance of the comment relates to components of the proposed Plan, not the analysis within the Draft EIR.

As discussed in Appendix V of the proposed Plan, the Managed Lanes Feasibility Tool was used to forecast Managed Lane performance. The Managed Lanes Feasibility Tool is an interactive dashboard model developed by SANDAG's consultant, HNTB, that can be used to forecast Managed Lane performance and revenues. It has been used by agencies around the country to inform implementation of Managed Lane projects, phasing, and the development of associated operational policies. When outputs from the tool are compared to data from Managed Lanes once they are built, it has been found to be very accurate. The methodology uses revealed preference data from existing operating Managed Lanes across the country that were specifically selected to be representative based on conditions found to be similar to facilities in the San Diego region. The model analyzes existing traffic and

proposed lane configuration for the San Diego facilities that are included in the Managed Lane network to assign traffic volumes. It assumes a baseline volume must be reached before drivers will be willing to pay for the Managed Lanes. Usage of the Managed Lanes is predicted based on the overall level of demand above the baseline volume, available capacity in the Managed Lane, and remaining capacity in the general purpose lanes. It includes assumptions around HOV and clean air vehicle policies and discounts, traffic levels, growth rates, cost assumptions, lane capacity, toll rates, and inflation.

SANDAG will also launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and GHG emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources. The road usage charge provides an alternative to replace an old tax system that is no longer relevant.

The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. The mechanism to collect a future road usage charge has not yet been determined, but as the State of California transitions from the gas tax towards a road usage charge, SANDAG is anticipating leveraging the mechanism selected by the State. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving gas fueled vehicles, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.

#### **RESPONSE TO COMMENT 17-14**

The proposed Managed Lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools, and low-emission vehicles with appropriate decals. The system of Managed Lanes and supporting

connectors support Transit Leap and HOVs to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes.

**RESPONSE TO COMMENT 17-15**

The project-specific impacts of commuter lane rail and LOSSAN projects will be addressed at the project-specific CEQA level and avoidance, minimization and mitigation measures will be identified pursuant to the Analysis Methodology Section in Chapter 4 of the EIR, and consistent with CEQA, local ordinance and guidelines, and the requirements by the Wildlife Agencies. As noted above, the Draft EIR discloses that the proposed Plan will have significant, unavoidable impacts on biological resources.

**RESPONSE TO COMMENT 17-16**

This comment correctly quotes from the Draft EIR.

17-16 cont. of many different types of wildlife. ...In many parts of Southern California, the linear habitat provided by riparian corridors is the only habitat left providing connectivity to core areas or unfragmented habitat patches. The Regional Plan, through land use and regional growth and climate adaptation and resiliency policies, intends to include wildlife movement corridors in the planned transportation network by conserving existing known corridors, identifying local corridors, and facilitating wildlife movement through project design."

17-17 The Plan should do exactly as it proposes to do by conserving the existing corridors in Marian Bear Park and deleting from the Plan the proposed three additional lanes and the huge connectors proposed to be on the SR 52 between I-5 and I-805. The corridor at SR 52 and I-805 is particularly constrained. If any of the proposed connectors at this location are built, it could be the final blow for that wildlife corridor.

17-18 Another reason to remove from the Plan the MLs on the 52 between I-5 and I-805 and the ML connectors to I-5 and I-805 is that both the I-5 and I-805 intersections already include a multi-level spaghetti pile of concrete roadways. Adding yet more would likely be extremely expensive and require rebuilding the existing portions of the spaghetti pile.

17-19 Figure 4.4-15: Regional Wildlife Movement Corridors. This shows the constrained wildlife movement corridors between Rose Canyon and MCAS Miramar and Marian Bear Park and MCAS Miramar, and in turn connectivity from MCAS Miramar to areas east of I-15, including Mission Trails and MCAS Miramar lands.

**Direct impacts to wildlife movement by 2050**  
 The Plan identifies Transportation Network Improvement impacts on the following acres of MSCP Core and linkages and SDSU Climate Resilient Wildlife Movement Corridors:  
 17-20 35 acres by 2025  
 554 acres between 2026 and 2035  
 440 acres between 2036 and 205

Again, reducing the number of additional lane miles of roadway would reduce this impact.

**7. I-805/Nobel**  
 17-21 The DEIR states (P. 4.4-71) that between 2026 and 2035, many of the Plan's projects are not expected to result in greater than a 5-acre loss of sensitive vegetation communities. However, two that are include:  
 I-805 from SR 52 to Carroll Canyon Road  
 I-5 widening along Rose Canyon

17-22 The DEIR should delete from the plan Project ID CC114 (Complete Corridor: Transit Operational Improvement at I-805/Nobel Drive). This may be the project that would cause a greater than 5 acre loss of sensitive vegetation communities (referred to on Page 4.4-71) Assuming it does, there is no need for a project at Nobel/805. Presumably, this project is to

**RESPONSE TO COMMENT 17-17**

This comment relates to components of the proposed Plan, not the analysis within the Draft EIR. The proposed Plan includes the Managed Lanes and connectors for SR 52; however, it also specifies that improvements to SR 52 will not expand beyond the current improved width. As projects move into advanced planning and design stages, more details will be defined to reduce impacts and develop mitigation strategies where necessary.

**RESPONSE TO COMMENT 17-18**

This comment relates to components of the proposed Plan, not the analysis within the Draft EIR.

The proposed Plan places emphasis on maximizing the use of existing facilities to add corridor capacity to ease congestion while also trying to achieve meeting State and federal GHG and air quality targets. The proposed Managed Lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools, and low-emission vehicles with appropriate decals. The system of Managed Lanes and supporting connectors support Transit Leap and HOVs to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes.

In terms of the Managed Lanes proposed on SR 52 between I-5 and I-805 plus Managed Lane Connectors at I-5 and SR 52 and at I-805 and SR 52, the improvements for this segment are envisioned to be within the existing corridor footprint where the Managed Lanes would be designed through repurposing the existing shoulders and landscaped median.

Decisions on where to construct proposed Managed Lane connectors, including defining and designing site-specific elevation profiles and or structural/physical footprint construction components, will be examined through more detailed operational and technical studies. These efforts are generally undertaken during the project development and environmental clearance phase, which is generally carried out with public input and following the CEQA Guidelines to evaluate proposed project impacts and identify necessary mitigation measures.

**RESPONSE TO COMMENT 17-19**

Thank you for your comment. SANDAG appreciates the summary of Figure 4.4-15.

**RESPONSE TO COMMENT 17-20**

SANDAG appreciates the summary of impacts on the region's preserve system. The EIR addresses impacts on a programmatic level. Specific impact avoidance, minimization, and mitigation will be developed at the project-specific CEQA level. Please also see response to comment FRC 17-15.

**RESPONSE TO COMMENT 17-21**

SANDAG appreciates your comment regarding the potential impacts on sensitive vegetation communities from the I-805 from SR 52 to Carrol Canyon Road project, and I-5 widening along Rose Canyon. The comment does not identify any specific comments on the EIR adequacy. No further response is required.

**RESPONSE TO COMMENT 17-22**

The Direct Access Ramp at Nobel/I-805 has been removed from the proposed Plan. There are a number of constraints that limit the ability of the Rapid bus to access La Jolla Village Drive via the Managed Lanes. The current plan is to use existing ramps or operational improvements that would give the bus some level of priority to enter the existing ramps. More planning will need to occur as this project moves forward.



17-22  
cont. get BRT buses on and off at Nobel. However, this is concept is a holdover from an ill-conceived project many years ago and should be eliminated. There is no reason to get BRT buses on the 805 and off at Nobel Drive. It is far from the jobs/housing density that the BRT route is designed to serve. The DEIR should delete any proposed changes to the Nobel/805 location. The habitat at the Southwest corner is critical habitat for spreading Navarettia and has multiple special status species. It should not be impacted. Any BRT route on the I-805 should get on and off at La Jolla Village Drive or Mira Mesa Blvd or Sorrento Valley Road. There are existing high density jobs all along LJ Village Drive to Genesee Avenue and UTC, with lots more density planned for the coming years. There is also high density housing, with lots more likely to come. Coming SB on the I-805 from Sorrento Valley, the BRT buses can simply get on the I-805, stay in the auxiliary lane, and exit at LJ Village Drive, a distance of about a mile. For BRT buses entering I-805 NB at LJ Village Drive, they can stay in the on ramp and then almost immediately enter the off ramp for Sorrento Valley Road

17-23 **8. Intended Uses of the EIR (2.6, p. 2-72)**  
The DEIR should clarify that Project level EIRs will likely be required for a high percentage of the road and rail projects. It is worrisome that the DEIR states: "Subsequent activities implementing the proposed Plan will be examined in light of this EIR to determine whether additional environmental documentation, if any, such as a Negative Declaration, Supplemental or Subsequent EIR, or Addendum, must be prepared. We have seen CALTRANS prepare an MND for a huge, highly environmentally impactful highway project. Future avoidance of appropriate project level environmental review should not be suggested or implied.

Sincerely,

Deborah Knight  
Executive Director

**RESPONSE TO COMMENT 17-23**

The referenced statement is not intended to suggest or imply that this document will be used as a means to avoid following proper environmental review procedures for future projects. The statement is only stating that proper project-level environmental documentation will be conducted at the proper time, while following all applicable federal, State, and local environmental review requirements and procedures.



PO Box 221051, San Diego, CA 92192-1051  
858-597-0220 \* rosecanyon@san.rr.com  
[www.rosecanyon.org](http://www.rosecanyon.org)

August 6, 2021

Submitted via email: SDForward@sandag.org  
Comments on the Draft 2021 Regional Plan

Active Transportation Projects:

**The City of San Diego's chosen alignment for the Coastal Rail chosen between Gilman/La Jolla Colony Drive and Sorrento Valley Coaster Station should be added to the RTP and the old alignment should be deleted (Rose Canyon, "UTC" (along Judicial Drive), Roselle Canyon and Roselle St to the Sorrento Valley Coaster station). This old alignment was thoroughly studied and rejected due to multiple major problems.**

17-24

The Draft RTP contains inconsistent and out-of-date labeling of a portion of the City of San Diego's Coastal Rail Trail. The City is the Lead Agency for the Coastal Rail Trail in the City, and it has selected the alignment and completed final design of the alignment along Gilman Drive to UCSD.

The City has deleted from its Bike Master Plan the old Rose Canyon, "UTC", and Roselle Canyon alignment. The City studied that route for years and rejected it for multiple reasons.

The RTP therefore needs to:

- cut three planned CRT segments and trim one CRT segment
- relabel the CRT route in the RTP to coincide with the approved Gilman Drive CRT segment, adding the UC San Diego CRT segment plus the I-5 Bicycle Corridor.
- Amend Appendix A and Appendix L in the SANDAG RTP to be consistent with this change.

The RTP should make the following changes summarized in the following tables:

## RESPONSE TO COMMENT 17-24

A full response to this letter is included beginning from ID L189 in Appendix P.2.

17-24  
cont.

CRT route as presented in the SANDAG RTP

SANDAG Project ID	Name/Description	SANDAG 2020 Cost	The RTP should make the following change	RTP Page reference
AT032	CRT - Carmel Valley to Sorrento to Roselle Canyon	\$20M	Change Carmel Valley to Roselle via Sorrento by removing Sorrento to Roselle. Carmel Valley to Sorrento remains.	Appendix A Table 1 p. A-6
AT036	CRT - Roselle Canyon	\$12M	Cut	Appendix A Table 1 p. A-6
AT037	CRT - UTC to Rose Canyon	\$11M	Cut	Appendix A Table 1 p. A-6
AT023	CRT - Rose Canyon	\$31M	Cut	Appendix A Table 1 p. A-8

The RTP needs to add the CRT route the City of San Diego has chosen for the segment from Sorrento Valley Coaster Station to the Gilman Drive/La Jolla Colony intersection

Segment	Start	End	Notes
CRT – I-5 Bicycle Corridor	Sorrento Valley	Voigt and Gilman	Already completed by Caltrans
CRT - UC San Diego	Voigt and Gilman Dr.	Gilman and La Jolla Village Dr.	UC San Diego is adding major bike infrastructure improvements through the campus on this route
CRT - Gilman	Gilman Dr. and La Jolla Village Dr.	Gilman Dr. and I-5 / Rose Creek Bike Path and La Jolla Colony Dr.	Protected bike lanes fully designed by City. Partial construction funding in SD City 2022 CIP budget.

17-24  
cont.

**Reallocation of funds and equity**

The savings for the three old, out-of-date segments to be cut is \$53 million (Rose Canyon, UTC (Judicial Drive) and Roselle Canyon, plus any savings from trimming the route AT032 by cutting Sorrento to Roselle, a segment made unnecessary by the I-5 bike path from the Sorrento Valley Coaster Station to UCSD. Two of the three segments in the City’s chosen CRT route are either complete or funded, so it can be anticipated that almost all of the \$53 million in the RTP can be freed up for active transportation projects that address equity, for example, in Chollas Creek, South Bay, or the Midway Corridor.

**Community and City of San Diego support and action for the CRT alignment up Gilman:**

The CRT route has City and Community support:

- The SANDAG RTP routes do not exist in the City of San Diego Bike Master Plan. They were explicitly deleted by the San Diego City Council in December 2013.
- The approved CRT Project route in San Diego has been selected, with the final Gilman Dr. link ready for construction and on the CIP list for 2020-2021.
- The approved CRT route was developed and selected by a City of San Diego Public Working Group in 2013-2014.
- The approved CRT route is supported by the Community Planning Groups: the UCPCG in 2013 and 2021, and the La Jolla Planning Association in 2021.
- The approved CRT route has been supported by the City of San Diego in 2013, 2016 and budgeted in 2021.

**The City’s approved CRT route enhances important existing connections:**

- With the Rose Creek bikeway open, it is a connecting link to UC San Diego from the south.
- With the existing I-5 Bicycle Corridor, it is a connecting link to UC San Diego from Sorrento and the Coaster.
- The completed UC San Diego Gilman Bridge over I-5 provides comfortable and safe bicycle links to the east UC San Diego Campus, industry along Eastgate Mail, and the commercial center at UTC.

**COMMENT LETTER 18: DAVID GRUBB (QUALITY OF LIFE COALITION)**

Comment Letter 18

October 11, 2021

*Via E-mail (RegionalPlanEIR@sandag.org)*

Kirsten Uchitel  
Associate Planner, SANDAG  
401 B Street, Suite 800  
San Diego CA, 92101

Dear Ms. Uchitel,

Please accept the following comments regarding the Draft 2021 SANDAG Regional Plan (“Regional Plan” or “Plan”) and Draft Environmental Impact Report (“DEIR”).

18-1 Please note that these comments have also been included in the combined comments document from the Quality of Life Coalition.

I am suggesting changes to Alternative 3 to avoid some of the significant impacts identified in the DEIR. While the DEIR states that impacts to GHG Emissions and Air Quality are “unavoidable”, that is not correct. Some of these impacts can be avoided or mitigated by changes to the Plan, as described below.

**I. Eliminate all addition of freeway lanes.**

18-2 The Regional Plan proposes to add lanes to a number of freeway segments in order to provide “managed” lanes. These additional lanes will increase capacity, inducing additional driving and increasing regional VMT and GHG Emissions, as well as PM-10 pollution from tire, brake, and road wear. Conversely, eliminating them will avoid some of these “Unavoidable” impacts and also reduce the GHG emissions attributable to the construction of new lanes.

**II. Replace “Managed” lanes with “Transit-only” lanes.**

18-3 Define “Transit” to include carpools of 3 or more, vanpools, shuttles, and other unconventional multi-passenger vehicles in addition to conventional transit vehicles. Restrict some freeway lanes to use only by transit, with no provision for paid access by non-transit vehicles. This will reduce the relative advantage of solo driving and make transit more attractive, further reducing the VMT, GHG, and PM-10 impacts. The Transit-only lanes should be taken from existing general-purpose or managed lanes, never from new construction.

**RESPONSE TO COMMENT 18-1**

Thank you again for the Quality of Life Coalition’s participation in the environmental review process and for the detailed comments for SANDAG’s consideration. Please see subsequent responses to specific comments for additional details regarding the Quality of Life Coalition’s concerns, including avoidance of certain significant impacts.

**RESPONSE TO COMMENT 18-2**

SANDAG is required to analyze induced demand impacts of the proposed Plan, which are documented in Appendix D of the proposed Plan. The activity-based model and other analyses used to inform the Plan have been reviewed through SANDAG’s peer review process and documented in the technical methodology submitted to CARB, also included in Appendix D. Where possible, the proposed Plan proposes repurposing of general purpose lanes or shoulders to create Managed Lanes. The Managed Lane system is important for supporting the transit network and Flexible Fleets envisioned in the proposed Plan. The Regional Plan is updated every 4 years, providing opportunities to reflect changes in the network

Please also refer to SANDAG’s response to a similar proposed alternative to eliminate all additional freeway lanes in letter 35 (response to comment SOFAR 35-3), and to Master Response 1 regarding alternatives.

**RESPONSE TO COMMENT 18-3**

Improvements to the freeway system are limited to Managed Lanes using existing infrastructure such as general purpose lane conversion and shoulders to facilitate additional transit and high occupancy vehicle travel. Please also refer to SANDAG’s response to a similar proposed alternative in letter 35 (response to comment SOFAR 35-3), specifically, making all managed lanes transit only.

18-4 **III. Add electrified rail transit where increased capacity is needed.**  
 Where additional transportation capacity is needed, as it is in most of the major corridors in the region, provide that capacity in the form of electrified rail transit. For a hundred years we have been adding capacity primarily in the form of roads. That has resulted in an unsustainable pattern of development. That must change starting today. Electric rail transit is the most efficient way to move people and goods, and it is very effective in shaping the pattern of development.

18-5 **IV. Start charging for road use sooner rather than later.**  
 We are in a climate emergency. We do not have the luxury of waiting until we build a great transit system before we try to reduce driving. We must reduce solo driving immediately and significantly. People who choose to drive should eventually be required to pay the full cost of driving and parking. This can be ramped up over time, but the process needs to start now.

18-6 **V. Conclusion - Give us an alternative that we can support.**  
 There is much that is good in the Draft Regional Plan, but it does not go far enough or fast enough. The changes described above could provide an alternative that we could all support.

Thank you for your consideration of this matter.

Sincerely,  
 David Grubb

**RESPONSE TO COMMENT 18-4**

SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Fast and frequent mass transit is the most efficient and sustainable way to move large amounts of people, particularly in our urban corridors that are carrying the largest number of trips the longest distances. These corridors experience the greatest congestion, which is why they have been slated for commuter rail that is much faster and more frequent than the rail service provided in the region today. The type of vehicles and propulsion will be determined during the advanced planning phase of each project.

Please see response to comment Chatten-Brown 34-2 for more information regarding changes to mitigation measure GHG-5b, “Establish New Funding Programs for Zero-Emissions Vehicles and Infrastructure,” that will further reduce GHG emissions with, in part, electrified public transit.

**RESPONSE TO COMMENT 18-5**

The proposed Plan has been updated to reflect 2030 as the start of implementation for the road usage charge to better align with the timing that the State and other regions are expecting to transition to a road usage charge.

**RESPONSE TO COMMENT 18-6**

SANDAG appreciates the Quality of Life Coalition’s feedback, and we hope the responses above provided some clarification. Please continue to follow along in the environmental process by visiting [www.SDForward.com](http://www.SDForward.com).

Title Page and Table of Contents

Executive Summary (Español)

P. ES-25 states that Alternative Three is considered the environmentally superior alternative.

18-7

Attachment 1 in supporting material for Item 6 on 10/8: "Achieving the state's mid-century goals will require major shifts in the energy sector, decarbonization of existing buildings and new construction, electrification of the entire transportation sector, sustainable solid waste and wastewater management practices, and direct carbon dioxide removal strategies that are well beyond the scope of and jurisdiction of SANDAG alone."

**Chapters:**

Chapter 1.0 – Introduction

Chapter 2.0 – Project Description

**Page 2-6**

If the goal is to "Incentivize sustainable growth and development" (which is a good one) the actions should be expanded to include

Collaborate with local jurisdictions on sustainable development land use planning and fund programs to accelerate housing production while also addressing equity, climate resilience, natural resource protection, and mobility.

18-8

This "update" below isn't reflected in the Project description. As mentioned above there is a lack of collaboration among local jurisdictions which sabotages efforts to have a top grade system.

**We're One Step Closer! – An Update from Kim Becker: 1/9/20**

I'm writing to you today with good news: The Airport Authority Board of Directors has certified the Final Environmental Impact Report for the Airport Development Plan, which envisions the replacement of the 53-year-old Terminal 1. This brings us one step closer to realizing our goal of providing a significantly upgraded customer experience, similar to what our passengers in Terminal 2 enjoy every day. *Of course, the plan also provides for new transportation and transit options that will make it easier for everyone to access San Diego International Airport.*

**RESPONSE TO COMMENT 18-7**

SANDAG looks forward to collaborating with local jurisdictions to implement the proposed Plan and support implementation of the local Climate Action Plans.

**RESPONSE TO COMMENT 18-8**

Land use authority is reserved to local jurisdictions: the cities and the County. The cities and the County are best positioned to effectively implement the objectives outlined in the proposed Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed Plan. SANDAG's Housing Incentive Program will include development of a regional anti-displacement strategy, considering climate change and resilience, consistency with the transportation improvements included in the proposed Plan, and alignment with SANDAG grant programs. No revisions to the Project Description are necessary.

**RESPONSE TO COMMENT 18-9**

This comment is noted. Figure 2-2, *Corridor Geographies*, has been updated.

**Figure 2-2 Corridor Geographies**

Parts of this map should be amended or clarified. In the 'corridor geography' of North County, most of the area between the I-15 and the San Vicente green area has 1,000s of acres with no (or very few) people living there. Although people do travel along the 78 to the east, the designation of this area is over-large. It should be refined to show just along the actual 78...not 1,000s of acres to the north. IN fact, if you look at later Figure 2-9 thru 2-12, no more houses or population is projected in this areas and more is projected south of the east 78.

Proposed revision to Figure 2-2



Reading later in the document(2-32, even more concern arises when the text suggests....



18-10 *GENERAL INTENSIFICATION OF LAND USES The SCS land use pattern represents a continuing trend in the San Diego region to provide more housing and job opportunities in the existing urbanized areas of the region. In 2012, SANDAG projected 17 percent of future housing growth would occur in the unincorporated area of the county under local general plans at the time. Today, SANDAG expects 12 percent of growth to occur in the unincorporated areas, much of that focused in the Lakeside, Spring Valley, and North County Metro. Tables 2-2 through 2-4 above show the forecasted growth in population, jobs, and housing units for each jurisdiction from the SCS land use pattern.*

Actually, other than the corridor geography 2-2, there is little to no intensification of housing, jobs shown in this area in the follow on figures. Again, figure 2-2 should be refined significantly in this area.

18-11 **Figures 2-17 to 2019**

What does a 'vacant' designation mean? No land is vacant. It is unclear where these lands are, but they should be called something else. Vacant implies not-developed. If there isn't any development, then there is probably some natural or artificial habitat present there.

Page 2-70

The text reads:

18-12 *CLIMATE ACTION PLANNING To help reach regional and State GHG emissions-reduction targets, the proposed Plan focuses heavily on the conversion to clean transportation and a shift from personal vehicle dependency through the 5 Big Moves. To help local jurisdictions make this transition and achieve broader reductions in GHG emissions, SANDAG will provide technical assistance, guidance resources, templates, and grant funding to incorporate the 5 Big Moves and SCS actions into their Climate Action Plans (CAPs) and plan for more well-connected, sustainable, healthy communities that are accessible to all.*

However, success in this area will require more aggressive actions on the part of SANDAG to assist in the reduction/elimination of sprawl development proposals that will undermine the success of the GHG reductions. Development speculators have now shifted to an 'annexation' approach and are expected to continue. The

**RESPONSE TO COMMENT 18-10**

This comment is noted. Figure 2-2 has been updated.

**RESPONSE TO COMMENT 18-11**

This comment is noted. "Vacant" denotes land without dwelling units or other structures or land usage type. The land use types and descriptions relevant to the GIS analyses in the proposed Plan and EIR can be found at:

[https://www.sandag.org/resources/maps\\_and\\_gis/gis\\_downloads/downloads/codes/Land\\_Use\\_Definitions.html](https://www.sandag.org/resources/maps_and_gis/gis_downloads/downloads/codes/Land_Use_Definitions.html).

**RESPONSE TO COMMENT 18-12**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. The land use pattern of the proposed Plan envisions greater compact development in areas served by high frequency, efficient transit. The result is less urban sprawl and greater reductions in GHG emissions. SANDAG has limited authority to "punish" local governments.

18-12  
cont. Plan should propose additional consequences to local governments who attempt to subvert these important transportation and climate actions in favor of sprawl.

Chapter 3.0 – Environmental Setting

Chapter 4.0 – Environmental Impact Analysis Approach

Chapter 4.1 – Aesthetics and Visual Resources

Chapter 4.2 – Agricultural and Forestry Resources

Chapter 4.3 – Air Quality

Chapter 4.4 – Biological Resources

**Page 4.4-76**

18-13 As we experience over and over, too often issues of science get politicized. This is true of wildlife and habitat management and mitigation. The Natural Resources Agencies often get undercut in their ability to oversee important habitat management issues. Therefore, we recommend the following addition in red

*... Consistent with the resource agencies' **approval** and applicable adopted plans, ordinances, and policies, provide compensatory mitigation for sensitive upland vegetation communities through the following:...*

**Page 4.4-77**

18-14 *BIO-1c Prepare a Habitat Restoration Plan. During planning, design, and project-level CEQA review of transportation network improvements or development projects, and as part of the regulatory permitting process, SANDAG shall, and other transportation project sponsors, the County of San Diego, cities, and other local jurisdictions can and should—as specified through consultation **and approval by** ~~with~~ resource agencies, and consistent with approved MSCP or MHCP guidelines and agreements, and applicable federal and State regulatory requirements—prepare and implement a habitat restoration plan for impacts on sensitive natural communities or a Habitat Mitigation and Monitoring Plan (HMMP) consistent with the requirements of and **approved by** USACE, RWQCB, and CDFW for all impacts on regulated waters, including wetlands. .*

**RESPONSE TO COMMENT 18-13**

The text has been revised as suggested in the Final EIR.

**RESPONSE TO COMMENT 18-14**

The text has been revised as suggested in the Final EIR.

Page 4.4-78	18-15	<p><i>BIO-1d Prepare Habitat/Long-Term Management Plans. During project-level CEQA review of transportation network improvements or development projects and as part of the regulatory permitting process, SANDAG shall, and other transportation project sponsors, the County of San Diego, cities, and other local jurisdictions should—as specified through consultation <b>and approved by</b> with resource agencies, and consistent with approved MSCP or MHCP guidelines and agreements, and applicable federal and State regulatory requirements—prepare and implement a Long-Term Management Plan (LTMP) consistent with the requirements of USACE, RWQCB, and CDFW for all impacts on regulated waters, including wetlands; or a Habitat Management Plan (HMP) or Resources Management Plan (RMP) for upland mitigation areas. <b>Further, the Management Plan must include, where relevant, the hiring of a certified recreation ecologist or comparable expertise to develop appropriate recreational measures, limitation, monitoring, and enforcement etc...</b></i></p>
4.4-78	18-16	<p><b>The DEIR needs a BIO-1(f)- Creation and funding of a Regional Funding Source for the implementation of mitigation and monitoring plans as outlined and committed to in the South County MSCP and as needed for this project. The Conservation Regional Funding Source should be a required mitigation in this document.</b></p>
4.4-82	18-17	<p>Related to the indirect impacts, Unauthorized recreational uses, illegal trail construction, trail related erosion, presence of dogs, etc.. all should be analyzed here as well and mitigations proposed.</p> <p><i>Permanent, indirect impacts would arise from increased human use of the area and unauthorized trespass, <b>illegal trail use, presence of dogs, trail related erosion, direct mortality of species,</b> increased nighttime lighting that may increase predation, increased noise associated with increased traffic volumes, and the increase in exotic species invasion.</i></p>
18-18		<p>Figure 4.4-16 seems incorrect, or at least confusingly presented. As it stands, the map appears to mix up several related regional HCP/NCCP items. The green is a mix of Chula Vista and unincorporated County Preserve land. The purple City of San Diego MHPA appears correct but the North County planning area appears to be a mix of the Multiple Habitats Conservation Program and North County MSCP. And the Cleveland National Forest and East County Bureau of Land Management lands should not be shown as entirely conserved because much of them are not conserved nor managed for HCP/NCCP resources. The MSCP planning areas and PAMA designated</p>

**RESPONSE TO COMMENT 18-15**

The text has been revised as suggested in the Final EIR; the following text revisions have been made on page 4.4-79:

The management plans can and should be consistent with the SDMMP MSP (SDMMP 2017), be prepared by qualified and experienced ecologists to develop appropriate management and monitoring measures. The management plans should outline describe management in perpetuity of the mitigation and conservation areas, identify illustrate adaptive management measures (Atkinson et al. 2004), outline management goals and objectives, and identify management tasks pursuant to these goals and objectives.

**RESPONSE TO COMMENT 18-16**

To meet the region’s habitat conservation goals, the proposed Plan identifies approximately \$3 billion for habitat-related efforts. This includes \$2,087 million for an enhanced habitat conservation, management, and monitoring program (see Land Use and Habitat programs in Appendix B of the proposed Plan), a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (see Climate Adaptation and Resilience programs in Appendix B of the proposed Plan and mitigation measure GHG-5c in Section 4.8 of the EIR), and \$300 to \$500 million of land acquisition and restoration for habitat mitigation of transportation projects (incorporated in project costs presented in Appendix A of the proposed Plan). As identified in Appendix B of the proposed Plan, SANDAG will continue to monitor the implementation of the Regional Plan on a four-year cycle and make the data accessible to the public. Monitoring would occur two years after adoption of the Regional Plan. Furthermore, SANDAG has committed to monitor the implementation for the Sustainable Communities Strategy on a two-year cycle pursuant to California Assembly Bill 1730 (Gonzalez 2019). Please refer to Master Response 1 for additional discussion regarding including a regional habitat conservation fund.

**RESPONSE TO COMMENT 18-17**

The text has been revised as suggested. The following text revisions have been made on page 4.4-84:

Permanent, indirect impacts would arise from increased human use of the area and unauthorized trespass, unauthorized trail use, presence

of dogs and feral cats, trail-related erosion, direct mortality of species, increased nighttime lighting that may increase predation, increased noise associated with increased traffic volumes, and the increase in exotic species invasion.

**RESPONSE TO COMMENT 18-18**

Figure 4.4-16 has been revised and the nomenclature in the legend has been corrected.

area is much larger than shown here. Further, the areas of the NC MSCP do not appear to be shown and the red seems like the MHCP of which only Carlsbad has completed its plan. This should be re-done to be clearer in what is actually conserved, PAMA, and in planning areas.

18-18  
cont.



In fact, here is the County map for South County MSCP From <https://www.sandiegocounty.gov/content/sdc/sustainability/cap/SouthMSCP.html> These boundaries should be reflected in the DEIR.





18-19 Page 4.4-58  
 Please add the following General Plan policy in the Escondido category  
 Escondido General Plan page 11-13, states that the focus of the Escondido General "Plan's smart growth principles represent a shift in focus from 'how to develop vacant land' to 'how to reinvest in existing neighborhoods.'"

Chapter 4.5 – Cultural Resources

Chapter 4.6 – Energy

Chapter 4.7 – Geology, Soils, and Paleontological Resources

Chapter 4.8 – Greenhouse Gas Emissions

**Failure to Reduce GHG Emissions**

The most significant concern is that the plan fails to reduce greenhouse gas emissions. It shows a reduction in per capita VMT, but that reduction is overwhelmed by the projected population increase, leading to an overall increase in VMT and the resulting emissions. That may satisfy the letter of the legal requirements, but it cannot be regarded as success. Climate disruption is the existential issue of our time. Failure to do our part to reduce the emissions that are disrupting the climate is clearly a failure of the plan.

The main reason for this failure of the plan is that it continues to promote and subsidize inefficient ways to move people and goods around the region.

18-20 The science tells us that we have a very short time to significantly reduce emissions. The realities of the market tell us that the only way to do that is to reduce driving starting immediately.

Increasing highway capacity does the opposite. It will induce additional driving, and make driving an even more attractive alternative to other modes. Instead of a positive mode shift away from driving, it will create a negative mode shift away from walking, biking, transit and telecommuting.

Adding managed lanes does not cure this problem. Increased capacity is increased capacity and it will induce more driving. Shifting some vehicles to managed lanes increases the capacity of the general purpose lanes.

Some specific questions for discussion.

**Added Freeway Lanes**

**RESPONSE TO COMMENT 18-19**

This has been added per the comment.

**RESPONSE TO COMMENT 18-20**

The proposed Plan is required to reduce GHG emissions from passenger vehicles and light-duty trucks by 19 percent per capita by 2035 compared to 2005 levels, as mandated by SB 375. Reducing GHG emissions and achieving State goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, State agencies, and other partners to reduce emissions beyond what is included in the proposed Plan.

SANDAG acknowledges that more work needs to be done in this area and that various climate action plans developed for the region, along with federal and State agency initiatives, are being incorporated as SANDAG's comprehensive strategies for addressing climate change in this and future regional plans. SANDAG continues to partner with local jurisdictions and other agencies to support the implementation of their specific climate action plans.

18-21 1. Table 4.16-14 shows an increase of 374 lane-miles of freeway by 2050, about a 15% increase over current conditions. That increased capacity will induce additional VMT. How is that handled in the modeling? How much VMT is projected to be added as a result of the added lane-miles? What mitigation is proposed to reduce that impact?

18-22 2. How do the added freeway lanes relate to the 450 acres of habitat impacts shown in Tables 4.4-7, 4.4-8, and 4.4-9?

18-23 3. Can SANDAG provide a map showing where lanes will be added, including any HOV-to-HOV transitions?

18-24 4. What would be the VMT and mode shift impacts of removing the added lanes from Alternative 3? In other words, what is the balance between VMT reductions due to BRT and the VMT increase due to induced driving?

18-25 5. Would it be possible to advance any transit projects to reduce the need to add lanes?

**Tolling and Road Use Charges**

18-26 Allowing single-occupancy vehicles with internal combustion engines to use HOV lanes for a fee defeats the purpose of having HOV lanes to reduce GHG emissions. It is also inherently inequitable. Making the fee somehow means-tested would further reduce the effectiveness as a GHG reduction measure. Tolling only some lanes and not others is not a good way to reduce VMT.

A road use charge is a much better option, but will be politically difficult. The discussion of Alternative 3 says there will be a road use charge of 3 cents a mile. That is not enough to motivate mode shift. Please provide more information on how a Road Use Charge will be implemented.

[Chapter 4.9 – Hazards and Hazardous Materials](#)

[Chapter 4.10 – Hydrology and Water Quality](#)

[Chapter 4.11 – Land Use](#)

[Chapter 4.12 – Mineral Resources](#)

[Chapter 4.13 – Noise and Vibration](#)

[Chapter 4.14 – Population and Housing](#)

**RESPONSE TO COMMENT 18-21**

SANDAG is required to analyze induced demand impacts of the proposed Plan, which are documented in Appendix D of the Plan. The activity-based model and other analyses used to inform the Plan have been reviewed through SANDAG’s peer review process and documented in the technical methodology submitted to CARB, also included in Appendix D.

**RESPONSE TO COMMENT 18-22**

Roughly 75 percent of the transportation network improvements impacts listed in Tables 4.4-7 through 4.4-9 are associated with Complete Corridor projects. However, as discussed in prior responses, the EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan will be further evaluated and project design and alignments will be refined to minimize impacts on biological resources to the extent practicable. As such, impact values presented in this EIR are subject to change.

**RESPONSE TO COMMENT 18-23**

The Data Viewer accessible on SDForward.com includes maps of the improvements included in the proposed Plan.

**RESPONSE TO COMMENT 18-24**

SANDAG is required to analyze induced demand impacts of the proposed Plan, which are documented in Appendix D of the Plan. The activity-based model and other analyses used to inform the proposed Plan have been reviewed through SANDAG’s peer review process and documented in the technical methodology submitted to CARB, also included in Appendix D.

**RESPONSE TO COMMENT 18-25**

Additional lanes included in the proposed Plan directly support Transit Leap; the facilities and enhanced transit service function together as a system. These facilities improve transit operations, including transit priority functions that make transit a compelling alternative to driving.

**RESPONSE TO COMMENT 18-26**

Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like GHG emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle: the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers.

The study will determine how existing revenues currently fund different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources. The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.



Chapter 4.15 – Public Services and Utilities

Chapter 4.16 – Transportation

Chapter 4.17 – Tribal Cultural Resources

Chapter 4.18 – Water Supply

Chapter 4.19 – Wildfire

Chapter 5.0 – Cumulative Impact Analysis

Chapter 6.0 – Alternatives Analysis

**Alternative 3**

I am suggesting changes to Alternative 3 to avoid some of the significant impacts identified in the DEIR. While the DEIR states that impacts to GHG Emissions and Air Quality are “unavoidable”, that is not correct. Some of these impacts can be avoided or mitigated by changes to the Plan, as described below.

18-27

**I. Eliminate all addition of freeway lanes.**

The Regional Plan proposes to add lanes to a number of freeway segments in order to provide “managed” lanes. These additional lanes will increase capacity, inducing additional driving and increasing regional VMT and GHG Emissions, as well as PM-10 pollution from tire, brake, and road wear. Conversely, eliminating them will avoid some of these “Unavoidable” impacts and also reduce the GHG emissions attributable to the construction of new lanes.

**II. Replace “Managed” lanes with “Transit-only” lanes.**

18-28

Define “Transit” to include carpools of 3 or more, vanpools, shuttles, and other unconventional multi-passenger vehicles in addition to conventional transit vehicles. Restrict some freeway lanes to use only by transit, with no provision for paid access by non-transit vehicles. This will reduce the relative advantage of solo driving and make transit more attractive, further reducing the VMT, GHG, and PM-10 impacts. The Transit-only lanes should be taken from existing general-purpose or managed lanes, never from new construction.

**RESPONSE TO COMMENT 18-27**

Please refer to responses to comments Grubb 18-1 and 18-2.

**RESPONSE TO COMMENT 18-28**

Please refer to the response to comment Grubb 18-3.

18-29 **III. Add electrified rail transit where increased capacity is needed.**

Where additional transportation capacity is needed, as it is in most of the major corridors in the region, provide that capacity in the form of electrified rail transit. For a hundred years we have been adding capacity primarily in the form of roads. That has resulted in an unsustainable pattern of development. That must change starting today. Electric rail transit is the most efficient way to move people and goods, and it is very effective in shaping the pattern of development.

18-30 **IV. Start charging for road use sooner rather than later.**

We are in a climate emergency. We do not have the luxury of waiting until we build a great transit system before we try to reduce driving. We must reduce solo driving immediately and significantly. People who choose to drive should eventually be required to pay the full cost of driving and parking. This can be ramped up over time, but the process needs to start now.

18-31 **V. Conclusion - Give us an alternative that we can support.**

There is much that is good in the Draft Regional Plan, but it does not go far enough or fast enough. The changes described above could provide an alternative that we could all support.

[Chapter 7.0 – Other Considerations Required by CEQA](#)

[Chapter 8.0 – References](#)

[Chapter 9.0 – Preparers of the Environmental Document](#)

**Appendices:**

[Appendix A – Notice of Preparation](#)

[Appendix B – Transportation Projects and Phasing Tables \(Español\)](#)

[Appendix C – Climate Change Projections, Impacts, and Adaptation](#)

[Appendix D – Air Quality Technical Report](#)

**RESPONSE TO COMMENT 18-29**

Please refer to the response to comment Grubb 18-4.

**RESPONSE TO COMMENT 18-30**

Please refer to the response to comment Grubb 18-5.

**RESPONSE TO COMMENT 18-31**

Please refer to the response to comment Grubb 18-6.

Appendix E – Biological Resources Appendix

Appendix F – Energy Appendix

Appendix G – GWP Summaries Using AR4 and AR5 Values

Appendix H – Appendix X of the Proposed Plan; 2016 GHG Emissions Inventory and Projections for the San Diego Region

Appendix I – Appendix F of the Proposed Plan; Regional Growth Forecasts and Sustainable Communities Strategy Land Use Pattern

Appendix J – Analysis of Potential for Conflicts Between the 2021 Regional Plan and Adopted Local Plans to Reduce Greenhouse Gas Emissions

Appendix K – Appendix B of the Proposed Plan; Implementation Actions

Appendix L – Subregional Plan Consistency Analysis

Appendix M – Mineral Resources Appendix

Appendix N – Noise Contour Maps

Appendix O – Alternatives Data

**COMMENT LETTER 19: TOSHI ISHIHARA**

Comment Letter 19

**From:** Toshi Ishihara <toshiishihara58@gmail.com>  
**Sent:** Friday, September 17, 2021 11:27 AM  
**To:** Keith Greer <Keith.Greer@sandag.org>  
**Subject:** Your EIR presentation during the trans com meeting today

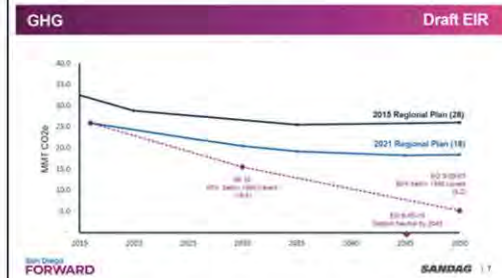
**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

Hi Mr Greer

I watched your presentation on EIR today. The EIR document on GHG does not have any plots, it has only tables, but your presentation helped me understand the impacts of the RP on our region's GHG emissions.

I have one question about the GHG plot below.

Question: The 2021 RP will not reduce GHG emissions much after 2035 according to the plot. As you know, California has a 2035 100% EV mandate for passenger cars. How did the SANDAG's GHG emission model include that mandate?



Toshi Ishihara, PhD  
 Climate Change and Transportation Justice Advocate  
 Board Member, SanDiego350  
 Member, San Diego Transportation Equity Working Group

**RESPONSE TO COMMENT 19-1**

The comment asserts that “California has a 2035 100% EV mandate for passenger cars” and asks how this “mandate” was included in the GHG emissions projections for the San Diego region reported in the EIR.

In Impacts GHG-1 and GHG-5, the Draft EIR analysis is based on GHG emissions projections from 15 emissions categories, including the on-road transportation and off-road transportation sectors (Draft EIR pages 4.8-19 to 4.8-26; pages 4.8-31 to 4.8-35). The analysis in Impacts GHG-1 and GHG-5 is based on the *2016 GHG Inventory and Projections for the San Diego Region* report (Draft EIR Appendix H). This report provides an estimate of 2016 GHG emissions for the San Diego region and GHG projections for the years 2025, 2030, 2035, 2045, and 2050.

The 2016 inventory and projections report take into account existing laws, regulations, programs, and policies in effect as of May 2021 to project future GHG emissions out to 2050. The report does not attempt to predict the types of legal, regulatory, policy, economic, technological, and social changes that governments, the private sector, and individuals might make to reduce GHG emissions by 2050. This is because there is substantial uncertainty in projecting future emissions, especially for 2050; in general, the level of uncertainty regarding future emissions increases as the projections get closer to 2050. The 2016 inventory and projections report does not and cannot account for several factors that are unknown at this time but will affect future GHG emissions in the San Diego region, including: future changes in local, State, and federal laws, regulations, and public policy; local, State, national, and global economic conditions; multinational or global agreements; investments and decision-making by private sector actors, including local, national, and global businesses; and personal and group behavior. The Draft EIR analysis is therefore considered conservative and may overstate actual GHG emission trends in future years.

As described in Draft EIR Appendix H, the GHG emissions projections from the on-road transportation sector are based on the CARB Emissions FACTor model (EMFAC2017), which includes the effect of all

key federal and State laws, regulations, and legislative actions that were adopted as of December 2017.

Executive Order N-79-20, which was published on September 23, 2020, establishes, among other things, goals for the State to achieve: 100 percent of in-state sales of new passenger cars and trucks will be zero-emission by 2035; 100 percent of medium- and heavy-duty vehicles in the State will be zero-emission by 2045 for all operations where feasible and by 2035 for drayage trucks; 100 percent of off-road vehicles and equipment will be zero-emission by 2035 where feasible. It also directs that CARB, to the extent consistent with State and federal law, shall develop and propose regulations to achieve these goals for passenger cars and trucks and medium- and heavy-duty vehicles, including drayage trucks, and develop strategies to achieve these goals for off-road vehicles and equipment operations in coordination with other State agencies, the U.S. Environmental Protection Agency, and local air districts. When developing these regulations and strategies, CARB is directed to “act consistently with technological feasibility and cost-effectiveness.” It is important to recognize that EO N-79-20, while establishing a goal for 100 percent of in-state *sales* of new passenger cars and trucks to be zero emissions by 2035, does not mean 100 percent of all cars and trucks operating on the road will be zero emissions.

Regulations to implement this EO have not been adopted, nor have they been developed or proposed. At this time it is not known if such regulations will be adopted, or if they are adopted, how they will be designed and how they will affect the composition of the on-road transportation and off-road transportation vehicle and equipment fleets (i.e., the proportion of zero-emission versus non-zero-emission vehicles) in the San Diego region over time after they go into effect. As a result, their effect on future regional GHG emissions from the on-road transportation sector is not known at this time and is therefore not included in the GHG impact analysis of the Draft EIR.

The comment does not raise any issues with the adequacy of the Draft EIR, and no further response is required.

**COMMENT LETTER 20: JACUMBA COMMUNITY SPONSOR GROUP**

Comment Letter 20

**Jacumba Community Sponsor Group (JCSG)**

To: Kristen Uchitel, Associate Planner at SANDAG (via [RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org))

**COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT REPORT (DEIR) FOR SAN DIEGO FORWARD: THE 2021 REGIONAL PLAN DEVELOPED BY THE SAN DIEGO ASSOCIATION OF GOVERNMENTS (SANDAG)**

October 11, 2021

Dear Ms. Uchitel,

20-1 Page 1-4 of the DEIR, states “on August 27, 2021, a Notice of Availability (NOA) was published in local newspapers and a Notice of Completion (NOC) was filed with the State Clearinghouse and that copies of the document were placed in public libraries throughout the region.” While a NOA may have been published in newspapers, it is highly doubtful that many San Diegans were reached through that medium. Also, library branches in the rural parts of the county were not provided copies of the document. In fact, it was not until September 7, 2021, that rural community planning/sponsor groups, charged with advising the County about the impacts of projects such as this regional transportation plan (RTP) on their respective communities, received written notification of the public comment period. By then, the 45-day public comment window had been reduced to just 36 days, an inadequate review period for this detailed 1300+ page document. Unlike many other project DEIRs which are often of interest to a specific community, the RTP will impact residents in all areas of the county. Contrary to what is stated on page 2-1, there was no extensive engagement with the public on the development of the DEIR and the general public had no real input into this document. **As a minimum, SANDAG should aggressively recirculate the DEIR and extend the public comment period for an additional 45 days, so that county residents have a genuine opportunity to submit their comments.**

20-2 The San Diego county region which encompasses 4,200 square miles, is geographically diverse, with rural landscapes comprising about two-thirds of the total land area. So, it was disappointing to learn that the draft 2021 RTP only proposes meaningful transportation improvements to the metropolitan areas of the county where Mobility Hubs, including expanded mass transit opportunities will provide a variety of affordable programs and services for urban residents. In fact, the RTP maps do not even identify individual communities east of El Cajon that will be disproportionately impacted by its urban focus. This freedom-restricting plan, in conjunction with other GHG regulatory programs currently under development like the Climate Action Plan and the Regional Decarbonization Framework, will make it costlier to live in the San Diego Region. Taken together, these plans will impact the personal choices of the county’s low-income residents who will no longer be able to afford to raise their families in rural communities or even drive and park a personal vehicle. Burdensome regulations may also cause residents to relocate to less regulated and expensive counties or states.

20-3 After its review of the DEIR, the JCSG provides the following specific comments and questions:  
 --Page 2-2, Figure 2-1, the regional setting map does not show the communities in the entire region: it is missing Spring Valley, Otay Mesa (which the plan describes elsewhere as an area of major growth), Ramona, and, of course, all the smaller communities located in the southeastern

**RESPONSE TO COMMENT 20-1**

SANDAG initiated the EIR scoping process on November 14, 2016, through the circulation of a NOP. Receipt of the NOP by the State Clearinghouse at the California Office of Planning and Research on November 14, 2016, initiated a 60-day comment period that ended January 13, 2017. The NOP provided formal notification to all federal, State, and local agencies involved with funding, and to other interested organizations and members of the public, that an EIR was to be prepared for the proposed Plan. The NOP was intended to encourage interagency communication concerning the proposed Plan and provide sufficient background information so that agencies, organizations, and individuals could respond to SANDAG with specific comments and questions on the scope and content of this EIR. Appendix A summarizes the issues raised in the NOP comments and identifies the EIR section(s) that address that issue or provides another response to the issue raised as appropriate. The NOP is provided in full in Appendix A-1. The written comments are provided in full in Appendix A-2.

Consistent with CEQA (PRC Section 21083.9), SANDAG noticed and held a public scoping meeting on December 8, 2016, at SANDAG’s office at 401 B Street, San Diego, CA 92101. The purpose was to receive perspective and input from agencies, organizations, and individuals on the scope and content of the environmental information to be addressed in the EIR.

To support the development of the proposed Plan, SANDAG implemented a comprehensive public outreach and involvement program consistent with State and federal requirements. Early in the planning process, SANDAG developed a PIP to guide the public outreach program, which was updated in mid-2019. The PIP identifies public engagement techniques to involve the public and collect input for the proposed Plan, including public workshops, social media, visualizations, and other means. It describes how to connect with hard to reach communities such as tribal nations and low-income and minority populations. A detailed description of the PIP can be found in Appendix G of the proposed Plan.

The Draft EIR for the proposed Plan was released to the public on August 27, 2021, and was available for a 45-day public review period, as required by CEQA. SANDAG published a Notice of Availability for the

Draft EIR in local newspapers on August 27, 2021, and mailed the Notice to an extensive distribution list. SANDAG also filed a Notice of Completion with the State Clearinghouse to indicate the availability of the Draft EIR for public review and comment on August 27, 2021. The Draft EIR was distributed to the agencies, organizations, and individuals that provided written comments on the Notice of Preparation, the SANDAG Board of Directors, SANDAG member agencies, and other interested parties and stakeholders. Agencies, organizations, and individuals were invited to provide written comments on the Draft EIR during the public review period from August 27 to October 11, 2021. SANDAG's mail distribution list is open to any subscriber and has been maintained and utilized for e-mail notifications throughout the planning process for the proposed Plan as well as the Draft EIR. SANDAG is unaware of the means through which JCSG received written notification of the public comment period on September 7, 2021. SANDAG's August 27, 2021 notification of the start of the public comment period was consistent with the requirements of CEQA and does not warrant recirculation.

The Draft EIR and all appendices were available for review online at [www.sdforward.com](http://www.sdforward.com); at SANDAG offices located at 401 B Street, Suite 800, San Diego, California 92101; and at the San Diego Central Library located at 330 Park Boulevard, San Diego, California 92101. The Central Library will facilitate inter-library transfers upon request by a member of the public in order to provide access at local libraries. On a case-by-case basis, the San Diego Central Library can also digitize documents and transfer them to other libraries. No such requests were made of the Central Library with respect to the Draft EIR, nor were any requests made of SANDAG with respect to providing access to the Draft EIR during the Public Comment Period.

There will be a further opportunity for public participation on December 10, 2021, at the SANDAG Board of Directors meeting discussing adoption of the proposed Plan and certification of the EIR.

#### **RESPONSE TO COMMENT 20-2**

The comment addresses the content of the proposed Plan, not EIR adequacy.

The proposed Plan was developed through a data driven planning process. The forecasted development pattern for the proposed Plan SCS is driven by regional goals for sustainability, mobility, housing affordability, and economic prosperity. The SCS land use pattern uses

areas in the region known as Mobility Hubs to concentrate future development. Mobility Hubs are communities with a high concentration of people, destinations, and travel choices. The SCS land use pattern represents a continuing trend in the San Diego region to provide more housing and job opportunities in the existing urbanized areas of the region.

Rural corridors, mostly located along state routes traversing the eastern two-thirds of the region, provide people access to rural towns and lands (including Jacumba), as well as connectivity to the interstate system. Rural corridors are economic lifelines for rural communities and the region's many tribal nations. Rural corridors provide access to jobs, education, and healthcare, as well as needed infrastructure for the movement of goods, deliveries, and emergency vehicles.

Along I-8 in East County, projects included in the proposed Plan benefit interchanges to this freeway with substantial safety improvements for SR 94, SR 76, and SR 79 and other state routes. Physical safety improvements are realized with a variety of projects including shoulder widening and curve straightening. Our rural and tribal communities also need new investments in broadband infrastructure. This infrastructure is an essential part of the transportation technology envisioned along rural corridors, by providing travelers with real-time travel information and enabling access to Flexible Fleet options such as shuttles and other on-demand transportation services. But it will not only improve mobility along rural corridors; it will enable residents to work remotely, learn online, and conduct other business over the internet.

Technology enhancements such as ATDM, as well as SIS are also aimed at improving safety. These improvements provide people with a variety of benefits, including expediting the movement of goods to rural communities during disaster recovery efforts. Projects related to ATDM will provide motorists with real time roadway conditions, including speeds, roadway visibility conditions, and other tactical information. Smart sensors, closed circuit television cameras, changeable message signs, and traffic detection equipment will all help provide people with a safer environment to walk and bike, while also adding the capability to prioritize the movement of freight or emergency vehicles along a rural corridor.



**RESPONSE TO COMMENT 20-3**

In response to this comment, Figure 2-1 has been revised to include tribal lands in the San Diego region.

- 20-3 cont. | portion of the county. It is also missing several Indian reservations/tribes such as the Campo, Manzanita, etc. Same comment about missing Indian reservations applies to the maps through Figure 2-16. **Provide inclusive maps throughout the EIR which identify rural communities as well as Indian reservations.**
- 20-4 | --Page 4-3 states, "Not all of the proposed plan impacts can meaningfully be analyzed quantitatively through the year 2050." **If SB 375 only sets GHG reductions for the years 2020 and 2035, then why does the RTP attempt to regulate transportation methodology which can be expected to drastically change well before the 2050-time horizon?**
- 20-5 | --Page 2-8 states, "...that by the 2030s, growth will slow to about 0.4 percent per year and decrease after 2040 to 0.3 percent per year, or less than 10,000 persons entering the region yearly." This statement appears to be in conflict with the population forecasts provided in Table 2-1 on page 2-11. **Review RTP for consistency.**
- 20-6 | --Page 2-32, Table 2-5 makes predictions/assumptions that the areas around Mobility Hubs will see the greatest increases in future population growth. Unfortunately, these are the areas where the cost of living is very high, which means that low income residents will be unable to afford to buy a home. It is the lack of affordability and personal safety that drives residents away from urban neighborhoods into the suburbs and rural communities. Based on modeling, this table shows an unsubstantiated decline in the population located outside to the mobility hubs from the baseline year of 2016 and 2050.
- 20-7 | --Page 2-37, Table 2-8 shows the RTP's GHG reductions for cars and light trucks at 17 percent in 2020. **Since we have 2020 in our rear-view mirrors, why doesn't this RTP use 2020 GHG figures instead of 2016 GHG figures as a baseline?**
- 20-8 | --Page 2-38 describes "Complete Corridors" that claim to provide everything to everyone. "Managed Lanes" (MLs) appear to be the RTP's preferred solution for reducing travel times on our freeways instead of building additional traffic lanes. **Where is data that shows existing MLs on I-15 significantly reduce gridlock during the morning or afternoon commutes?**
- 20-9 | --Page 2-42 has a map that shows Completed corridors by 2050. **Why doesn't I-8, which is a major east-west corridor and an evacuation route, show any road improvements east of El Cajon? Is this yet another instance where the RTP overlooks the impacts to rural residents who do not have other viable transportation options for getting to work?**
- 20-10 | --Page 2-49 states that over 2 million trucks pass through the Port of Entry (POE) at Tecate and Otay Mesa. These vehicles are not required to have the same strict emission standards as U.S. registered vehicles. **How will the RTP regulate/mitigate for the higher amounts of GHG emitted from Mexican trucks and passenger vehicles idling at POEs?** California could require that Mexican transport companies comply with the state's emission requirements and that Mexican truckers could be charged a per vehicle fee when crossing into the United States. (U.S. truckers should not be penalized over foreign truckers.)
- 20-11 | --Page 2-50, Figure 2-30 is a map which identifies rural corridors. Missing from that map is Highway 80 and SR-1. Both of these roads should be considered to be an integral part of the rural corridor system as they provide alternative routes for rural residents when I-8 or Highway 79 are

**RESPONSE TO COMMENT 20-4**

In addition to complying with SB 375, SANDAG's regional transportation planning efforts must also comply with CFR Section 450.324(a), which requires that "The metropolitan transportation planning process shall include the development of a transportation plan addressing no less than a 20-year planning horizon as of the effective date. In formulating the transportation plan, the MPO shall consider factors described in § 450.306 as the factors relate to a minimum 20-year forecast period. In nonattainment and maintenance areas, the effective date of the transportation plan shall be the date of a conformity determination issued by the FHWA and the FTA. In attainment areas, the effective date of the transportation plan shall be its date of adoption by the MPO." SANDAG has projected out to 2050 in its 2011, 2015, and 2021 regional transportation planning efforts. The Regional Plan and its SCS are iterative planning documents that are typically updated every 4 years to account for new data, analysis, policy, and experience.

**RESPONSE TO COMMENT 20-5**

The population numbers have been reviewed for consistency and have been confirmed to be accurate. Expected growth of 0.4 or 0.3 percent per year as stated on page 2-8 does not conflict with the population forecasts presented in Table 2-1.

**RESPONSE TO COMMENT 20-6**

SANDAG is currently developing a housing incentive program. This program will fund local plan updates and increasing affordable housing in transit-rich areas with infrastructure, services, and jobs. Please see Appendix B: Implementation Actions of the proposed Plan for more details.

**RESPONSE TO COMMENT 20-7**

Table 2-8 in Chapter 2, *Project Description*, of the Draft EIR, is not establishing baseline conditions, but rather GHG reduction targets established by SB 375. As stated on page. 2-38, "In accordance with SB 375, the proposed Plan must include an SCS that demonstrates that the San Diego region will reduce GHG emissions (GHG emissions for SB 375 compliance are calculated using carbon dioxide [CO<sub>2</sub>] emissions) from automobiles and light-duty trucks to achieve, if there is a feasible way to do so, the GHG emission reduction targets approved by CARB. Targets are expressed as percent change in per capita GHG emissions relative to

2005. Consistent with the targets established by CARB, the targets for the San Diego region are a 15 percent per capita reduction in passenger vehicle GHG emissions by 2020 and a 19 percent per capita reduction by 2035. The proposed Plan would exceed the GHG emission reduction targets for 2020 and 2035 established by CARB, as shown in Table 2-8.”

Regarding the use of 2016 as the baseline, the proposed Final Plan is unique, as it was developed over 6 years rather than 4 years. In October 2019, AB 1730 (Gonzalez) was signed into law, authorizing a 2-year extension for the Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) for the San Diego region and deeming the 2015 Regional Plan, its SCS, and Final EIR valid for State compliance, funding eligibility, and other purposes through 2021. Due to this extended timeframe, the proposed Plan has a baseline of 2016, which is two years older than would be typical in past Regional Plan EIRs. In general, physical conditions as they existed in 2016 were used as the baseline for the impact analysis of the proposed Final EIR, corresponding with the release of the NOP on November 14, 2016 and the start of EIR preparation. This is the case for the GHG emissions baseline data used for analysis in the proposed Final EIR.

#### **RESPONSE TO COMMENT 20-8**

The proposed Plan maximizes our existing roads using technology to manage how lanes are used, which reduces traffic congestion and delay. The proposed network of Managed Lanes also encourages carpooling, vanpooling, and taking transit, which creates more roadway capacity without adding additional lanes. This model is very similar to how the I-15 Express Lanes operate today.

The Managed Lanes concept is envisioned in the proposed Plan, providing a system that gives the opportunity to dynamically manage the lanes based on real time conditions, time of day, and vehicle occupancy, to make all lanes more efficient and provide benefits to the system as a whole.

It is also important to recognize that State laws have changed from requiring congestion relief (usually solved in the short term by widening roadways) to reducing vehicle miles traveled and greenhouse gas emissions (usually solved by people living closer to destinations and using alternative modes of transportation such as walking, biking, carpooling and taking public transit). These bold changes are necessary to address unprecedented challenges facing our region, and state. SANDAG understands the near-term need for congestion relief and is

working to find near-term ways to implement flexible fleet pilot projects and expand service and frequency of public transportation.

**RESPONSE TO COMMENT 20-9**

The proposed Plan includes managed lanes on Interstate 8 between I-5 and Greenfield Drive east of El Cajon and, as indicated in Figure 2-25 and Figure 2-30, the proposed Plan includes rural corridor technology and operational improvements from Greenfield Drive to the Imperial County line. The rural corridor improvements would include curve realignments or straightenings, shoulder widenings, intersection improvements, and other safety improvements.

**RESPONSE TO COMMENT 20-10**

In terms of the air regulations in California, regardless of their registration and plate, any truck operating in the state is subject to California in-use regulations (e.g., truck and bus rule, smoke opacity requirements, and CARB's drayage truck rule). For example, each vehicle operating in California, including those in transit from Mexico, Canada, or any other state, must have a label, called an Emission Control Label, showing that the engine met the required federal emission standards applicable for the model year of the engine (see regulation at <https://ww2.arb.ca.gov/resources/documents/heavy-duty-diesel-emission-control-label-ecl-inspection-program-regulation>). Even if these trucks are exchanging cargo near California-Mexico border with another truck, they are still subject to CARB's regulations, including the Drayage Truck Rule.

Relevant federal and State regulations are discussed in Appendix Y of the proposed Plan.

Additionally, the Plan includes numerous projects to improve mobility at the border by reducing truck queuing, reducing congestion, and thereby reducing idling emissions.

No changes to the analysis are required.

**RESPONSE TO COMMENT 20-11**

Figure 2-30 is not intended to be a comprehensive map of all rural roadways, but rather Rural Corridors. Rural Corridors provide rural towns and lands access and connectivity to the interstate system. Highway 80 and SR 1, as "alternate routes," are not Rural Corridors.

- 20-11 cont. closed to major accidents or fires. **Add Highway 80 and SR-1 to the rural corridor maps with an appropriate level of improvements.**
- 20-12 --Table 2-10 on page 2-53 states, "Commuter rail lends itself to longer travel distances and operates with speeds up to 110 MPH." Figure 2-34 on page 2-57 shows an expansion of several commuter rail lines which seem to parallel the existing light rail (trolley) lines. **Where is the mass transit usage data for those routes that would justify the need (and the expense) of duplicative rail services?**
- 20-13 --Table 2-11 on pages 2-59 to 2-61 provides a list of the proposed mobility hubs in the RTP. **Why aren't the communities of Lakeside and Spring Valley included as future mobility hubs?**
- 20-14 --Table 2-12 on page 2-64 lists a variety of "Flexible Fleet Services." The RTP states that San Diego population is becoming older and that an estimated 60 percent will be seniors who are 75 years or older. **How will seniors safely use the flexible fleet services included in the RTP such as e-scooters, bikes, and ride-hailing? Does the RTP really intend for seniors to pick up their packages at "smart lockers" at mobility hubs instead of receiving package delivery at their doors?**
- 20-15 --Table 2-13 on page 2-68 to 2-69 is an expensive "wish list" of programs that are part of the RTP. Not only are the costs for these programs listed in 2020 millions of dollars, the table does not indicate funding sources. Even with all the RTP's proposed increases in road user fees, VMT, ridesharing costs, etc., in 2050, the RTP has a stated funding shortfall of \$73 billion in 2020 dollars. **Update Table 2-13 to include funding sources.**
- 20-16 --On page 2-72 is a list of prioritized RTP implementation actions where the number one priority is to "apply the Social Equity Planning Framework" and the number ten priority is to "Advance a data science program to better understand travel behavior and issues in the region..." **These implementation priorities must be reversed.** Included on the implementation actions list should be a requirement to identify funding sources before the RTP is approved. If funding cannot be identified, then reduce the scope of the plan.
- 20-17 --Table 4.3-4 on page 4.3-12 provides criteria pollutant emissions inventory for 2016 in the San Diego Air Basin. **Why does the RTP use "old" 2016 data for its modeling? Update the EIR to include a similar inventory for the year 2020, so that a trend in air quality can be determined.**
- 20-18 --Page 4-3-13 identifies wood burning and natural gas consumption as two emission sources. Both of these energy sources are commonly used by low-income rural residents to heat their homes. Future plans that would curtail or eliminate these energy sources must avoided in the interests of social equity. Especially when mismanagement of forest resources continues to result in enormous wildfires that burn large swaths of the State.
- 20-19 --Page 4.3-20 addresses Executive Order N-79-20 which requires that 100 percent of new car sales in California are to be zero emission by 2035. With the shift to electric vehicles, the draw on our electrical grid must surely increase. Just last week, Elon Musk who knows a little bit about electric cars, stated that the State's electrical generation capacity will have to at least double to support the planned shift to electric vehicles. Yet, the regional energy predictions found in Appendix F, and in Table 4.6.1 (page 4.6-17) show an overall decrease in the region's electrical

**RESPONSE TO COMMENT 20-12**

The comment only addresses the data used to prepare the proposed Plan, not the EIR.

SANDAG developed the proposed Plan and the proposed transportation network based on a data driven process— analyzing where people live and work, how they get around, what transportation infrastructure exists, what is needed to serve future growth, and more. This data included census data and cellphone based data. SANDAG did not rely on data alone; the proposed Plan reflects the views of real residents from around the region, the professional judgments of a number of planning professionals at the agency, and extensive knowledge of diverse communities across our region. Appendix T of the proposed Plan includes the detailed methodology for network development and performance of the Plan related to improved access to basic needs (retail, parks, and medical), employment centers, and higher education.

**RESPONSE TO COMMENT 20-13**

The coverage area of each regional Mobility Hub represents a general area defined through a propensity analysis (detailed in Appendix T of the proposed Plan). The Mobility Hubs depict a framework that will be used to guide future collaborative planning efforts between SANDAG and local jurisdictions. In reviewing the County of San Diego's suggestions received through the proposed Plan comment period, SANDAG agrees that the areas identified, including Lakeside and Spring Valley, are appropriate to consider in future Mobility Hub planning. The areas identified also align with Transit Priority Areas. In the proposed Plan, Mobility Hub maps also reflect Transit Priority Areas to be more inclusive of these areas.

**RESPONSE TO COMMENT 20-14**

The comment only addresses the content of the proposed Plan, not the EIR.

The proposed Plan aims to improve access to a quality public transportation system for all San Diego residents, especially for seniors and other disadvantaged populations. These improvements include transit fare subsidies and on-demand Flexible Fleet services that are accessible to seniors. The proposed Plan projects a growth in senior access to parks and recreational facilities via walking, biking, and transit (see Appendix H of the proposed Plan for more information). In

every metric, senior access to transit, retail, medical facilities, and parks improves through 2025 and 2050.

SANDAG has a long history of working closely with senior community members, social service providers, non-profits, and community-based organizations to develop and fund specialized transportation services geared specifically towards the needs of seniors. The proposed Plan network includes a variety of modes that work together seamlessly to provide all San Diego residents, regardless of age or ability, access to multiple travel choices. Flexible Fleets are an example of an option that is particularly well suited for the senior population. Flexible Fleets options like ridehail, rideshare, and microtransit offer a range of mobility options and vehicles that can accommodate many types of trips and meet the needs of various users. They can make it easy for seniors to access medical appointments and other basic needs without relying on a car. Flexible Fleet vehicles and services are adaptable in nature and can offer personalized accommodations, such as wheelchair lifts, door-to-door services, and other options for people with physical limitations. SANDAG has conducted outreach and will continue to engage with seniors to ensure their mobility needs are met. In addition, SANDAG is developing a Flexible Fleets Implementation Strategic Plan that will address potential barriers to accessing Flexible Fleets, ensuring options for people without smartphones or internet, providing education about how to access Flexible Fleets, and more.

#### **RESPONSE TO COMMENT 20-15**

Table 2-13 includes costs for proposed programs of the proposed Plan. Specific funding sources have not been identified for each program; however, proposed Plan Appendix V, *Funding and Revenues* includes Table V.1 that shows eligible uses (including programs) for the various funding sources.

The comment incorrectly identifies a funding shortfall of \$73 billion. The proposed Plan is revenue constrained, as required by 23 CFR 450.324 (f) and the California Transportation Commission Regional Transportation Plan Guidelines for Metropolitan Planning Organizations (2017). In the proposed Plan, revenues total \$172 billion and costs total \$163 billion in 2020 dollars.

**RESPONSE TO COMMENT 20-16**

The implementation actions identified on page 2-72 of the Draft EIR are not listed in order of priority. Funding sources for the proposed Plan are detailed in proposed Final Plan Appendix V.

**RESPONSE TO COMMENT 20-17**

As discussed in Chapter 4, physical conditions as they existed in 2016 are used as the baseline for the impact analysis of the EIR. The 2016 base year for the air quality analysis is the same as the 2016 year used in other technical sections, such as *Greenhouse Gas Emissions* (Section 4.6) and *Transportation* (Section 4.16). As shown in Table 4.3-3, ambient air quality in recent years is generally similar to 2016 data. Moreover, as discussed in Section 4.16.1, differences in traffic conditions between 2016 and current conditions (2021) are minor, and the change does not affect findings in the transportation analysis. Similarly, for air quality, changes between 2016 and current conditions are minor, and changing the baseline would not affect the overall findings of the air quality analysis.

No changes to the analysis are required..

**RESPONSE TO COMMENT 20-18**

There are no measures in the proposed Plan that would curtail or eliminate residential wood burning and natural gas combustion. SDAPCD regulates stationary and area source emissions as part of its air quality responsibility, and develops rules and regulations to ensure federal and State air quality standards are met. SDAPCD periodically revisits and amends its rulebook as part of the State Implementation Plan (SIP) process. Regardless, no mitigation like this is proposed in the EIR, and no changes to analysis are required.

**RESPONSE TO COMMENT 20-19**

The energy consumption shown in Table 4.6-1 is based on the energy consumption projections used in the GHG inventory (Appendix X of the proposed Plan), which are based on the CEC Energy Demand 2020–2030 Revised Forecast. The CEC forecasts discussed in Section 4.6, *Energy*, and Chapter 5, *Cumulative Impact Analysis*, indicate an increase in energy demand between 2020 and 2030. Appendix O of the EIR provides information to support the alternatives analysis, but does not include information related to electricity or energy demand.

No changes to the EIR analysis are required.

- 20-19 cont. | consumption from 2016 to 2050. The decrease in electrical consumption will also occur while the region's population is increasing. The CEC California Energy Demand 2018-2030 revised forecast shows the continued increase in the demand for energy supplies over the next ten years (page 5-30). **Verify electrical energy usage figures in Appendix O and cite sources for these figures.**
- 20-20 | --Page 4.3-33 states the entire MTS fleet of buses will be transitioned to zero-emission vehicles by 2040. **How will the longer time it takes to charge bus batteries be accommodated?** MTS should really consider a transition to smaller busses as the current passenger usage does not appear to require the seating capacity provided by full-sized, 60-foot long buses. **Will school buses be required to transition to electric buses?** This may be impractical and unworkable in rural parts of the county where Santa Ana winds cause frequent and extended power outages, and bus replacement may cause a financial hardship for small school districts.
- 20-21 | --Page 4.3-43 states VMT is expected to increase by 6.7 percent in 2050. One of the RTP's stated goals is to reduce VMT and the associated GHG emissions.
- 20-22 | --Page 4.3-51 states the use of propane and natural gas generators is authorized for construction purposes when the power is not available from the electrical grid. Residents in the rural part of the county frequently rely on propane generators when their normal source of electrical power has been shut off. Therefore, the future use of propane generators and/or heaters must be allowed.
- 20-23 | --Many RTP figures such as Figures 4.4-2 to 4.4-14 are missing page numbers which make them easier to reference. **Add page numbers to all RTP figures.**
- 20-24 | --Figure 4.4-7 should indicate that tricolored blackbirds and golden eagles are in the Jacumba area. **Update.**
- 20-25 | --Page 4.4-20 should show that Golden eagle habitat includes Jacumba. Page 4.4-21 should show the Tricolored blackbird and Pacific Pocket mouse habitat includes Jacumba. **Add Jacumba in habitat comments.**
- 20-26 | --Page 4.8-5, Table 4.8.4 should show emission breakdowns for the year 2020 and not 2016. **Update.**
- 20-27 | --Page 4.8-34, Table 4.8-12 shows 2050 GHG emission reference point is 80 percent below 2016 levels. Elsewhere in the RTP, the 2050 reference point is described as 80 percent below 1990 emission levels. **Review DEIR for GHG consistency.**
- 20-28 | --Page 4.8-50 describes the need for building "low stress bicycle networks." **What are low stress bicycle networks and how do they differ from bicycle corridors?** It also recommends implementing a school bus program in areas not currently served by school buses. **Identify the areas where additional school bus service is needed based on a geographical need and not a social equity "want."** In urban areas where schools are located close to residences, children should walk to school. San Diego County has recently allocated funds to pay for programs that would reduce childhood obesity and walking a short distance to school would provide a health benefit for children.
- 20-29 | --Figure 4.9-2 emergency evacuations routes do not include rural communities. **Add Alpine, Jamul, Campo, Jacumba, etc.**

**RESPONSE TO COMMENT 20-20**

The proposed Plan supports the electrification of the region's transit buses and the State's Innovative Clean Transit regulation. Appendices A and B of the Plan include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 and 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans>. As discussed in the Rollout Plans, appropriate charging infrastructure will be installed on site to accommodate and support bus capacity. MTS and NCTD will consider forecasted passenger usage, among other factors, when making decisions regarding bus sizes prior to purchase of vehicles.

The MTS transition to zero-emissions vehicles is detailed in its transition plan. The transition plan takes into account daily mileage requirements and charging needs. See the transition plan here: [https://www.sdmts.com/sites/default/files/attachments/mts\\_fleet\\_transition\\_study\\_final\\_092220\\_reduced.pdf](https://www.sdmts.com/sites/default/files/attachments/mts_fleet_transition_study_final_092220_reduced.pdf). School buses are not part of MTS transition plan, but CARB has budgeted for 1,000 zero-emission school buses in its 2021-2022 budget.

No changes to the Draft EIR analysis are required.

**RESPONSE TO COMMENT 20-21**

This comment does not pertain to EIR adequacy. As shown in Tables 4.6-17 through 4.6-19, while overall VMT is expected to increase relative to 2016 conditions, VMT on a per capita basis is reduced 14.1 percent by 2050, consistent with the objectives of the EIR.

**RESPONSE TO COMMENT 20-22**

Mitigation measure AQ-3b allows for the use of propane or natural gas generators when grid power is not available, which includes the rural areas. No changes to the EIR analysis are required.

**RESPONSE TO COMMENT 20-23**

For ease of reference, electronic documents have been updated to link all figure references to the appropriate figure upon selecting the associated reference.



**RESPONSE TO COMMENT 20-24**

Figure 4.4-7 has been updated as requested to include the tricolored blackbird and golden eagle in the Final EIR.

**RESPONSE TO COMMENT 20-25**

The EIR relies on available data sources. All sensitive species from the data sources referenced in the EIR are included in Figure 4.4-7, and tricolored blackbird and golden eagle points were added to the figure in the Final EIR.

**RESPONSE TO COMMENT 20-26**

As stated in Chapter 4 of the EIR, SANDAG is required to update the Regional Plan every 4 years, in collaboration with the 18 cities and County of San Diego, along with regional, State, and federal partners. The proposed Plan is unique, as it was developed over 6 years rather than 4 years. In October 2019, AB 1730 (Gonzalez) was signed into law, authorizing a 2-year extension for the RTP/SCS for the San Diego region and deeming the 2015 Regional Plan, its SCS, and Final EIR valid for State compliance, funding eligibility, and other purposes through 2021. Due to this extended timeframe, the proposed Plan has a baseline of 2016, which is 2 years older than would be typical in past Regional Plan EIRs. In general, physical conditions as they existed in 2016 are used as the baseline for the impact analysis of this EIR, corresponding with the release of the NOP on November 14, 2016, and the start of EIR preparation. As such, no changes have been made to Table 4.8-4.

**RESPONSE TO COMMENT 20-27**

The comment asserts that the reference in Draft EIR Table 4.8-12 referring to the 2050 reference point as 80 percent below 2016 levels is inconsistent with other, unspecified references to the 2050 reference point as 80 percent below 1990 emissions levels.

Under Impact GHG-5 the Draft EIR evaluates whether the proposed Plan is inconsistent with the State's ability to achieve the EO S-3-05 goal of reducing California's GHG emissions to 80 percent below 1990 levels by 2050. To perform this analysis, the Draft EIR estimated an emissions reduction reference point for the region for 2050, based on EO S-3-05. Because there is not an available 1990 emissions inventory for the San Diego region that is comparable to the regional inventory and projections prepared for the proposed Plan, a reference point was developed for this analysis to show the level of GHG reductions needed between 2016 (the baseline year of the inventory and proposed Plan)

and 2050 that would be equivalent to the level of reductions needed when measured against 1990.

In 2016, total statewide emissions equaled 429 MMTCO<sub>2e</sub>, which was 2 MMTCO<sub>2e</sub> (less than 1 percent) lower than the statewide 1990 emissions level of 431 MMTCO<sub>2e</sub> (CARB 2018d). Because total statewide emissions in 2016 were essentially equal to the statewide 1990 level, for purposes of this analysis, total regional emissions in 2016 are assumed to be representative of total regional emissions in 1990. Therefore, to identify the reference point for 2050, an 80 percent reduction was applied to the total regional emissions in 2016.

This comment does not relate to the adequacy of the Draft EIR and no further response is required.

#### **RESPONSE TO COMMENT 20-28**

This comment addresses two of the measures included in Draft EIR mitigation measure GHG-5f that the County of San Diego and cities can and should implement to reduce VMT from development projects. Specifically, the comment asks for clarification on the difference between low stress bicycle networks and bicycle corridors; regarding the measure to implement school bus programs in areas not served by school buses, the comment requests that SANDAG identify areas where school bus programs are “needed based on geographical need and not a social equity ‘want’.”

Low stress bicycle networks refer to bicycle facilities like trails, paths, or lanes in which the user experiences a low amount of stress due to factors such as low vehicle speed, low vehicle volumes, and physical separation from vehicle traffic. Implementing a school bus program in areas not served by school bus service is included in mitigation measure GHG-5f because school bus service can reduce VMT and associated GHG emissions when students travel to and from school in a bus instead of in passenger cars and trucks. The request for SANDAG to identify areas with a geographic need for school bus service is noted but not required by CEQA. However, this comment is noted for the record and will be forwarded to the SANDAG Board of Directors for its consideration prior to making a decision on adoption of the proposed Plan.

#### **RESPONSE TO COMMENT 20-29**

Edits have been made to Figure 4.9-2 to include rural communities.

20-30 --Table 4.14-2 on page 4.14-4 projects population growth by jurisdiction. From 2016 to 2050, the unincorporated area of the county is expected (or allowed) to increase by 0.9 percent. This increase seems incongruent when compared to Table 4-14-4 on page 4.14-6 which projects the 2016 to 2050 job growth in the unincorporated areas to be 23.2 percent. On page 4.11-28, the RTP states that in 2025, "growth in the unincorporated areas would be focused within existing rural communities." However, the plan would actually restrict growth (development) in the rural areas through the implementation of Vehicle Miles Travelled (VMT) restrictions and fees.

20-31 --Table 4.15-2 on page 4.15-3 lists Fire Service providers in the unincorporated areas of the county. It currently omits a number of fire service providers such as Boulevard, Campo, Descanso, Jacumba, and others. **Update the Fire Service providers listing.**

20-32 --Page 4.15-58 describes certain mitigation measures for reducing construction waste. It currently reads: "prepare and apply a waste management plan that promotes solid waste reduction." Another measure reads: "Reuse and or recycle construction and demolition waste." Measures such as these should have an identified percentage specified. **Assign percentages to mitigation measures.**

20-33 --Page 4-16-2, Table 4.16-1 provides a summary of roadway miles for the years 2016 and 2020. It is unbelievable that during a 5-year period, just two freeway lane miles were added and lane miles added to state highways and local roadways were also minuscule. **The revenue generated by the 2004 TransNet Tax was directed for improving the efficiency of our roadway systems. It should be used for highway improvements including additional road lanes, etc., and not be consumed by mass transit improvements envisioned by SANDAG.**

20-34 --Page 4.16-7 states that the RTP uses 2019 transit data instead of the 2021 data because it better reflects current and typical ridership conditions when the county is not under a stay-at home order. That may be so, but even the 2019 transit figures showed a decline over 2016 figures, and the 2019 figures are pre-pandemic. During the pandemic, people not only shunned mass transit, many found that they could work from home. Because they are likely to continue to do so well into the future, the lingering effects of the pandemic on transit ridership need to be evaluated before billions of dollars in mass transit subsidies are used to increase the frequency of bus and tram service or to expand trolley, bus and commuter rail routes or to provide free or reduced transit fares. Mass transit cannot be considered to be a stand-alone transportation plan as there will likely be future pandemics. **Before the expansive mass transit expenditures proposed in the 2021 RTP can be approved, at least two years of current ridership data must be thoroughly scrutinized. Real data collected from the public should be used to predict future transit usage figures not models.**

20-35 --Page 4.16-9, Footnote 1 for Table 4.16-3: Year 2019 Transit Services in the Region appears to contain an error. The average daily passenger figures should be taken from the FY2019 National Transit Database and not from FY2016. **Correct footnote 1. To provide some meaningful data, this table should also show the annual and daily carrying capacity for each type of transit. That data would reflect actual transit usage. Then based on real usage data, the cost analysis for different types of transit passenger miles can be determined. This is information that must be provided in the RTP.** Cost analysis when combined when usage data must be applied to future transit decisions. BMPs for transit should identify cost efficiencies such as using a one-car trolley

**RESPONSE TO COMMENT 20-30**

For the San Diego region, population is expected to grow by nearly 437,000 people from 2016 to 2050. Prior forecasts projected more people in the San Diego region. The Series 14 Regional Growth Forecast includes assumptions of housing unit production that results in a subregional forecast that includes population decline or lower population growth in certain areas in the region. These housing assumptions, described in proposed Plan Appendix F, include an increase in the region's vacancy rate to 4% by 2040, an accounting of vacation rentals and second homes as "unoccupiable," and a decrease in household size from 2.75 persons per household in 2016 to 2.62 persons per household by 2036.

Forecasted job growth in the region is a result of the size and age/race/ethnicity/sex composition of the projected population as well as higher projected labor force participation rates in the future. The region is expected to grow by 440,000 jobs by 2050. Future jobs are allocated to existing employment centers and scheduled commercial development. To clarify, the quoted statement is intended to indicate that for the growth that would occur within the unincorporated areas (0.9 percent), that growth would be focused within existing rural communities, rather than in unincorporated areas that are not part of rural communities. It is acknowledged that VMT restrictions and fees encourage growth in urban areas and discourages growth in unincorporated areas.

**RESPONSE TO COMMENT 20-31**

Table 4.15-2 in the Final EIR has been updated in response to this comment to include additional County fire service providers, specifically, Campo Reservation Fire Protection District and Boulevard. The other two fire stations referenced are CAL FIRE stations and were already accounted for.

**RESPONSE TO COMMENT 20-32**

The percentage of waste reduction associated with the measures outlined in mitigation measure U-2b would be based on State legislation and local regulations. A specific percentage cannot be applied to each measure due to waste reduction policy variations across the various jurisdictions in the county and potential future regulatory updates at

the State level; however, a reference to State and local requirements has been added to the measure to ensure the goals established are achieved.

**RESPONSE TO COMMENT 20-33**

Experience and research have demonstrated that expanding roadways ultimately leads to more traffic and GHG emissions. For example, in the Houston area, a 26-lane, \$2.8 billion mega-freeway project was built to alleviate traffic congestion. Within a few years after construction was completed, congestion worsened and travel times increased 30 percent during the morning commute and 55 percent during the evening commute. The proposed Plan maximizes our existing roads using technology to manage how lanes are used, which reduces traffic congestion and delay. The proposed network of Managed Lanes also encourages carpooling, vanpooling, and taking transit, which creates more roadway capacity without adding additional lanes.

The TransNet measure approved by San Diego County voters in 2004 focused on congestion relief and included a set of transportation improvements, many of which have been completed. The remaining projects in the TransNet measure may not be constructed due to changes in regional needs, changes in State law, and technology advancements that would suggest a different transportation solution. The SANDAG Board of Directors may review the TransNet ordinance and discuss possible updates. This process is outside of the development of the proposed Plan.

**RESPONSE TO COMMENT 20-34**

Due to data/survey availability, ABM2+ largely relies on pre-pandemic survey (2016/17 household behavior, 2019 SB1 TNC, and 2015 transit onboard surveys); therefore, the pandemic impacts on behaviors such as transit/carpool usage and auto ownership are not reflected in ABM2+. Based on information from the National Household Travel Survey, California Household Travel Survey, 2016/17 Household Behavior Survey, and the ACS, SANDAG developed a telework trend to project future telework rates. Researchers from the Institute of Transportation Studies at UC Irvine reviewed and confirmed the telework assumptions used in proposed Plan.

SANDAG has a plan to update ABM2+ to ABM3 to reflect the “new normal” travel behaviors, once surveys conducted in a new normal year become available. The new normal condition is important for

creating a long-range planning model. It is unclear at this moment, when and if the new normal has arrived.

**RESPONSE TO COMMENT 20-35**

Please see response to comment JCSG 20-26 for rationale regarding the use of a 2016 baseline.

The performance of the proposed Plan is based on the best available data at this time. It will be important to continue to monitor trends and impacts on travel behavior as the Regional Plan is implemented and updated in the future. Priority Implementation Action 10 is to advance a data science program to better understand travel behavior in the region, update travel demand modeling tools, and improve transparency and reporting on program effectiveness and project delivery.

20-35 cont. Instead of a three-car trolley when passenger loads are low. This could save on routine trolley car maintenance which is likely based on actual trolley miles. Bus sizing and frequency of service should also be analyzed based on costs. **Smart transit operations save the taxpayers money!**

20-36 --Table 4.16-4 on page 4.16-11 shows that unlike roadway miles, bicycle paths/lanes/route mileage were significantly increased between 2016 and 2020. The expansion of safe bicycle lanes within urban areas has been met with mixed reactions. The few cyclists who are using them are happy but the merchants losing customer parking spaces are not. The bicycle coalition is a strong voice but in reality, bike lanes on both sides of a street are routinely underutilized by cyclists. The construction of additional urban bike facilities should not come at the expense of a reduction in handicapped parking, etc. Bike facilities could easily be expanded along the road shoulders of freeways. They would be especially useful along I-8 which could function as an important link in the cross-country southern bicycle route.

20-37 --Table 4.14-6 on page 4.14-18 identifies the potential displacement of the residential and commercial land uses if the RTP was implemented, including the loss of 1234-acres of land under military use in 2050. **It is unclear in the RTP where this proposed loss of military land would occur and how it would affect military readiness. Provide amplifying information.**

20-38 --Page 4.15-49 discusses the requirement for the appropriate level of telecommunications infrastructure be included with any forecasted new development. However, the RTP fails to address the outstanding need for broadband infrastructure in many of the county's rural communities. **In the interests of social equity, the RTP must address strategies for real connectivity within our rural areas that would allow low-income residents access to remote education programs and to work from home.** Both of these could reduce VMT for residents living well outside of mobility hubs.

20-39 --Page 4.16-13 states that SANDAG does not regulate public or private parking within the region. However, in an effort to promote mass transit usage, SANDAG has developed a Parking Strategies for Smart Growth guide which, if implemented by in cities, would make affordable parking in urban areas a thing of the past.

20-40 --Page 4.16-23 describes some of the requirements of SB 375 as it pertains to regional GHG targets. The California Air Resources Board (CARB) has established per capita regional GHG reduction target for passenger vehicles for 2020 and 2035. Updated CARB targets of 15 percent reduction GHG below 2005 levels in 2020, and 19 percent below 2005 levels in 2035. These do not appear to align with the RTP's GHG reduction goals on page 4.16-45 which are 80 percent below 1990 levels. **Verify GHG reduction goals to ensure consistency.**

20-41 --Table 4.16-14 on page 4.16-40 shows a **374-lane mile reduction** in General Purpose Freeway Lanes from the baseline year 2016 to 2050 while HOV/Managed Lanes in 2050 reflect a 705-mile increase over the baseline year. **The addition of new freeway HOV lane miles should not come at the cost of reducing general purpose lanes as they will contribute to overall traffic congestion on our freeways.**

20-42 --Table 4.16-13 on page 4.16-39 shows a comparison of baseline year 2016 transit miles of service with transit service of 2050. **Where is usage data that shows that transit service in 2050 will require 2.8 times the number of 2016 transit miles? Where does the RTP address a**

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### RESPONSE TO COMMENT 20-36

Build out of the Regional Bike Network along with investments in Complete Streets and Vision Zero programs are components of the proposed Plan that advance goals related to reducing GHG emissions, improving safety for all users, and advancing public health. SANDAG is unaware of any study indicating that it is either safe or effective to add bicycle lanes to freeway shoulders.

### RESPONSE TO COMMENT 20-37

Figure 4.11-3 in the Land Use section of the EIR identifies the military installations in the San Diego region. Table 4.14-6 identifies the potential loss of land uses with implementation of the proposed Plan (including a 500-foot buffer to provide a conservative estimate of impact). The potential impact on military lands that may occur with permanent ROW acquisitions from the proposed transportation projects would be addressed at the project-specific level of environmental analysis. As discussed in Appendix B of the proposed Plan, SANDAG is collaborating directly with Military Community Planning Liaison Officers to identify challenges, opportunities, and priority projects that support mission readiness and the region's transportation priorities.

### RESPONSE TO COMMENT 20-38

As discussed in detail in mitigation measure GHG-5d in Section 4.8, SANDAG will adopt a Regional Digital Equity Strategy and Action Plan that identifies and addresses gaps in accessing affordable, high-quality broadband service (Near-Term Action 6(c) in Appendix K). SANDAG will also participate in federal and State processes to support projects that increase access to broadband infrastructure, as well as pursue federal, State, and private partnerships to leverage additional dollars for these programs.

### RESPONSE TO COMMENT 20-39

Please note that the Parking Strategies for Smart Growth guide is referenced on page 4.16-13 of the Draft EIR.

SANDAG developed a *Parking Strategies for Smart Growth* guide as part of their *Planning Tools for the San Diego Region* (SANDAG 2010a). This guide provides a benchmark and compares the various parking regulations within the region, as well as how those regulations compare to national standards. Additionally, the guide provides example policies

on how jurisdictions can implement smart growth parking policies and programs. SANDAG also developed a regional parking management toolbox that provides jurisdictions within the San Diego region with a framework for evaluating, implementing, and managing parking management strategies that support their economic development, sustainability, and mobility goals.

**RESPONSE TO COMMENT 20-40**

This comment asserts that the per capita regional GHG reduction targets for passenger vehicles for 2020 and 2035 established for SANDAG by CARB “do not appear to align with the RTP’s GHG reduction goals,” which the commenter refers to as “80 percent below 1990 levels” by referencing Draft EIR page 4.16-45.

To clarify, Draft EIR page 4.16-45 is referring to the statewide goal established in EO S-3-05 for reducing GHG emissions from all emissions sectors in California to 80 percent below 1990 levels by 2050. The proposed Plan does not establish a reduction goal of reducing total regional emissions in the San Diego region to 80 percent below 1990 levels by 2050. The Draft EIR does provide an analysis of whether the proposed Plan would be inconsistent with the State’s ability to achieve the EO S-3-05 target of reducing emissions to 80 percent below 1990 levels by 2050 (Impact GHG-5, pages 4.8-31 to 4.8-35).

The proposed Plan is required by State law to include an SCS that will achieve the 2035 per capita regional GHG reduction targets for passenger vehicles, if it is feasible to do so. GHG reductions under SB 375 apply only to certain classes of passenger vehicles, are measured against a 2005 baseline, and are measured on a per capita basis. For these reasons GHG reductions required under SB 375 are not directly comparable to the statewide GHG reductions goals set forth in EO S-3-05.

**RESPONSE TO COMMENT 20-41**

Managed Lane investments are focused on making carpooling, vanpooling, and transit more time competitive with driving by ensuring these driving alternatives can use Managed Lanes to bypass congestion in general purpose lanes. Solo drivers who pay a fee will also have the opportunity to bypass traffic congestion. Conversion of general purpose lanes to create additional Managed/HOV lanes would be governed by federal and State laws and regulations. Increasing non-drive alone

travel choices such as carpooling/vanpooling and bicycle facilities is also important to the overall goal of reducing GHG emissions and VMT.

**RESPONSE TO COMMENT 20-42**

The performance of the proposed Plan is based on the best available data at this time. It will be important to continue to monitor trends and impacts on travel behavior as the Regional Plan is implemented and updated in the future. The proposed Plan's Priority Implementation Action 10 is to advance a data science program to better understand travel behavior in the region, update travel demand modeling tools, and improve transparency and reporting on program effectiveness and project delivery.



20-42 cont. | corresponding transportation benefit for rural residents who don't reside near mobility hubs who must use roadways as their primary method of travel?

20-43 | --Page 4.16-45 describes total VMT, household-generated VMT and light-duty VMT. (Hey fellas, can we make this more complicated?) The RTP uses "modeled" forecasts to develop transportation metrics and predict transportation requirements using 2016 as the baseline year. Complicated VMT models make assumptions that are unlikely to approach reality especially when models are used to make per capita VMT predictions that are 34-years out (2050). **2019 should be used as a baseline year and any VMT analysis predictions past 2035 are educated guesses at best.**

20-44 | --On page 5-65 in its description of the California-Baja California Border Master Plan, the RTP states that more than 30 million privately owned vehicles crossed the border from Mexico in 2015. This figure seems to be at odds with the figure of 2 million trucks crossing the border in 2019 that is found on page 2-49. **Clarify.**

20-45 | The JCSG and the residents of Jacumba reject the RTP for the following reasons:  
 --It is essentially an urban transportation benefits plan which residents in the rural area will be required to fund via VMT programs and road user fees which come on top of the gasoline taxes already paid at the pump. Road user fees should be only be applied to electric vehicles because they do not pay gasoline taxes. The vehicle registration program could include a flat fee for electric vehicle road usage and that would eliminate the need to require black boxes in vehicles to record VMT. Unfortunately, future increases to road user fees can be expected, as state and federal governments look for an easy source of revenue that can be thrown at a variety of programs. After all, history has proved there are no governmental "lock boxes." Even with the addition of many new transportation-related fees, the 2021 RTP acknowledges a funding shortfall of \$70 billion (2020 dollars) and this is real money.

20-46 | --The RTP uses outdated 2016 data to model many of its transportation predictions 34-years into the future (2050). It should at least be using 2019 data. SANDAG must do a better job of identifying the lasting impacts of the COVID-19 pandemic before shoveling billions of taxpayer dollars into an overly expensive plan that has been developed with faulty assumptions.

20-47 | --The RTP also seeks to institutionalize ever-increasing transportation fees and land use policies that would essentially raise the cost of renting, buying, or building a home in San Diego county. Additionally, the RTP would infringe upon the rights of residents to raise their families in the rural parts of the county.

20-48 | --Finally, the 2021 RTP admits that even if all the restrictive transportation programs described in the plan were approved it does not guarantee that local temperature and the sea levels won't rise. In fact, on page 4-8-35, the RTP states:  
 "Despite the transportation-related reductions under the proposed Plan implementation, total regional GHG emissions would exceed the reference points for 2050. Additional reductions would be needed in the transportation sector and in all other GHG sectors: energy; solid waste; water supply and wastewater; industrial processes; management of natural lands; etc. Achieving GHG

**RESPONSE TO COMMENT 20-43**

The data presented in this table are modeled results from SANDAG's Activity Based Model (ABM). This model can take into account several factors such as travel distance, speed, and network availability. The ABM is updated regularly with the latest available data and best practices to represent regional travel; please see Appendix S, *Travel Demand Modeling Tools*, of the proposed Plan for more information.

Regarding the assertion that VMT predictions past 2035 are educated guesses, the ABM is a state-of-the-art tool for analyzing the transportation network, land use pattern, and other policies of the proposed Plan; however, it is based on the information we know today. There are many emerging technologies and future behavior changes that could impact mode shift in the future. SANDAG will continue to use best available data and research on mobility to inform future updates of the ABM and estimated performance of the proposed Plan.

Please see response to comment JCSG 20-7 regarding the use of 2016 for the baseline year.

**RESPONSE TO COMMENT 20-44**

Page 5-65 of the Draft EIR references the total number of privately owned vehicles, including trucks, crossing the border, while page 2-49 references just trucks. These numbers are not conflicting, and no change has been made.

**RESPONSE TO COMMENT 20-45**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

Rural corridors, mostly located along state routes traversing the eastern two-thirds of the region, provide people access to rural towns and lands (including Jacumba), as well as connectivity to the interstate system. Rural corridors are economic lifelines for rural communities and the region's many tribal nations. Rural corridors provide access to jobs, education, and healthcare, as well as needed infrastructure for the movement of goods, deliveries, and emergency vehicles.

Along I-8 in East County, projects included in the proposed Plan benefit interchanges to this freeway with substantial safety improvements for SR 94, SR 76, and SR 79 and other state routes. Physical safety improvements are realized with a variety of projects including shoulder widening and curve straightening. Rural and tribal communities also

need new investments in broadband infrastructure. This infrastructure is an essential part of the transportation technology envisioned along rural corridors, by providing travelers with real-time travel information and enabling access to Flexible Fleet options such as shuttles and other on-demand transportation services. But it will not only improve mobility along rural corridors; it will enable residents to work remotely, learn online, and conduct other business over the internet.

Technology enhancements such as ATDM, as well as SIS, are also aimed at improving safety. These improvements provide people with a variety of benefits, including expediting the movement of goods to rural communities during disaster recovery efforts. Projects related to ATDM will provide motorists with real time roadway conditions, including speeds, roadway visibility conditions, and other tactical information. Smart sensors, closed circuit television cameras, changeable message signs, and traffic detection equipment will all help provide people with a safer environment to walk and bike, while also adding the capability to prioritize the movement of freight or emergency vehicles along a rural corridor.

Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like GHG emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle: the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently fund different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.

The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed

program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.

The road usage charge, which is being studied by both the federal and State governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.

The proposed Plan is revenue constrained, as required by 23 CFR 450.324 (f) and the California Transportation Commission Regional Transportation Plan Guidelines for Metropolitan Planning Organizations (2017). Funding sources for the proposed Plan are detailed in Appendix V of the Plan.

#### **RESPONSE TO COMMENT 20-46**

This comment addresses the proposed Plan and is not related to EIR adequacy.

The proposed Plan is unique, as it was developed over 6 years rather than 4 years. In October 2019, AB 1730 (Gonzalez) was signed into law, authorizing a 2-year extension for the RTP/SCS for the San Diego region and deeming the 2015 Regional Plan, its SCS, and Final EIR valid for State compliance, funding eligibility, and other purposes through 2021. Due to this extended timeframe, the proposed Plan has a baseline of 2016, which is 2 years older than would be typical in past Regional Plan EIRs. The COVID-19 pandemic is a very recent phenomenon that fell in the middle of the planning efforts related to the proposed Plan. The long-term effects of the pandemic on the region, specifically related to transportation, have yet to fully emerge. SANDAG is mandated by State law (AB 1730) to adopt the current iteration of its RTP/SCS by December 31, 2021. However, as noted under response to comment JCSG 20-43, the Regional Plan and its SCS are iterative planning documents that are typically updated every four years to account for new data, analysis, policy, and experience. The longer-term effects of the pandemic will be taken into account during the subsequent iterations of the Regional Plan.

**RESPONSE TO COMMENT 20-47**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

**RESPONSE TO COMMENT 20-48**

This comment accurately cites language in the Draft EIR stating that achieving GHG reductions “at the scale required would require major changes to government regulation, private sector activity, consumer behavior, and other facets of life. . .” However, it incorrectly implies that the proposed Plan outcome should guarantee that local temperatures and sea levels would not rise. The basic purposes of CEQA are to inform government decision makers and the public about potential significant environmental impacts of projects, identify ways the impacts can be reduced or avoided, prevent significant avoidable environmental damage through alternatives and mitigation, and disclose to the public the reason that decision makers approved a project that may result in unavoidable significant impacts. The lead agency is required to consider the information in the EIR, along with any other relevant information, in making its decisions on the project approval. The Draft EIR accomplishes the basic purposes of CEQA, and the SANDAG Board of Directors will consider the information in making its decision on the Plan.

20-48 cont. | reductions for these sectors at the scale required would require major changes to government regulation, private sector activity, consumer behavior, and other facets of life..."

20-49 | **It is for the reasons stated above and others, that the JCSG recommends the "No Project" RTP alternative outlined in the DEIR. We reject the Draft 2021 Regional Transportation Plan as it is written.** Attachment A provides some of our previous comments on the draft 2021 RTP.

Sincerely,

Cherry Diefenbach  
Chair, Jacumba Sponsor Group  
[csdiefenbach@sbcglobal.net](mailto:csdiefenbach@sbcglobal.net)  
619-743-5224

cc:  
County Board of Supervisors: Fletcher, Vargas, Anderson, Lawson-Remer, and Desmond  
Kathleen Flannery, Acting Director, Planning and Development Services  
Rami Talleh, Deputy Director, Planning and Development Services

Attachments:  
Attachment A: JSCG letter of August 6, 2021

### RESPONSE TO COMMENT 20-49

JCSG's support for the No Project Alternative is acknowledged and will be considered during the final decision-making process.

ATTACHMENT A

Jacumba Community Sponsor Group

To: Rami Talleh (via [rami.talleh@sdcounty.ca.gov](mailto:rami.talleh@sdcounty.ca.gov))  
San Diego County Department of Planning and Development Services (PDS)

Subject: Comments on the San Diego Association of Governments (SANDAG's) Draft 2021 Regional Plan

August 6, 2021

Dear Mr. Talleh,

20-50 On July 16, 2021, community planning/sponsor groups were asked to provide their comments on the draft May 2021 San Diego Forward-The 2021 Regional Plan and its thirty-one lengthy and detailed appendices. Although this was an exceptionally short review period, the Jacumba Sponsor Group has the following comments.

This draft plan identifies interdependent transformative strategies designed to address the greatest transportation and mobility challenges that the region faces: safety and traffic congestion; social inequities; and state and federal requirements to reduce greenhouse gas (GHG) emissions and air pollution—and they are noble goals. However, it makes many unsubstantiated assumptions based on inadequate data from which it then draws conclusions.

On page 10, the plan states that in 2019, greater than 90 percent of CA-MEX trade was moved by truck across the international border. A great fact to know, but where does your regional plan address and mitigate for the smoggy trucks registered in Mexico that are hauling those goods? Will the plan only regulate the emissions of vehicles registered in San Diego County (or California) while out-state and out-of-country (Mexican) vehicles get a “free pass?”

On page 12, the plan states: “from 2016 to 2050, nearly 60 percent of population growth will be among those who are 75 years and older.” Will this aging population (60 percent who are projected to be people of color), feel physically safe while using public transit (buses, trams, trolleys) during evening/night time? Will they all have smart phones and be able to navigate a smart phone application that gives them a choice of transportation modality based on a variety factors including CO<sub>2</sub> emissions?

On page 15, the plan states that if the 2021 plan was implemented, “By 2050, this could result in 13 percent of commuters using transit (up from 3 percent today) and that there would be a substantial decline in commuters driving alone to work (from 80 percent today to 62 percent in 2050). Those figures do not reflect any significant behavioral changes regarding transportation choices given that this plan would greatly expand mass transit frequency and routes. In 2021, many city busses are carrying just two to three passengers while trolleys carry more passengers depending on their routes. How realistic are the 2021 plan’s predicted increases? Were urban residents asked about factors that would actually make them leave their cars and use mass transit instead? Was the current trend of working remotely from home factored into these calculations? What if the public perceives that it is not in their best interests to share a bus or a trolley with a group of strangers who may or may not be healthy? What happens when the next pandemic

**RESPONSE TO COMMENT 20-50**

Thank you for including a copy of JCSG’s comments on the proposed Plan. For detailed responses to these comments, please refer to responses beginning on L217 in Appendix P.2.

impacts our region and mass transit shuts down for public safety reasons? Clearly more studies on the current trends in mass transit usage must be analyzed before the predictions contained in this plan can be validated. Also, additional studies on post-COVID mass transit usage figures are critical. Analysts should avoid using the data from any month when all mass transit ridership fares have been waived, as they will skew the data. (This will happen in September 2021.)

On page 25, the 2021 plan calls for providing a variety of transit riders with reduced fares (seniors, low-income, students, youth and the disabled). This is fiscally untenable. What is the actual cost per passenger mile on a bus, trolley, or light rail? **Appendix A predicts that in 2020 dollars, transit fare subsidies in 2035 will be \$982 million dollars and in 2050, subsidies will be \$4 BILLION dollars which means that the answer to the previous question about the cost per passenger mile must be too high to print!!!** This plan cannot seriously contemplate spending \$4 billion dollars to possibly achieve a 13 percent increase in mass transit ridership.

The 2021 plan which seeks to “reimagine” regional transportation strategies appears to be a huge and costly wish list of programs and government regulations directed primarily at changing residents’ driving behavior at a tremendous loss of personal freedoms. It envisions spending millions of dollars to create an expanded bike network with corridors by 2050. Again, where is the data that shows that kind of expenditure will get more people out of their cars and onto bicycles? A recent case in point: the removal of 400 parking spaces along the business district on 30<sup>th</sup> Street in the North Park area so that bike lanes, that are rarely used to commuting to and from work, could be installed. Not only are the merchants upset about the loss of customer parking and business, but delivery trucks are now blocking bike lanes to make their deliveries and handicapped parking has become confusing for those who need it. The 2021 plan will greatly expand on that unpopular and costly transportation strategy.

Under this plan, transportation in and around mobility hubs or areas of concentrated development (cities) would be highly regulated with curb management regulations/fees based on the time of day parking rates, and ride-hailing opportunities. Ride-hailing at mobility hubs is described as offering people on-demand vehicles for short and long-distance trips, possibly subscription-based services which would “allow people to reserve a vehicle that best serves the needs of their trip.” So, it is okay to rent/drive a vehicle but just not to personally own a vehicle?

On page 32, the plan states: “In the San Diego region, almost half of all trips are three miles or less, and most everyday trips are made within neighborhoods using local streets.” Where is the data to back up this statement? This page also states: “On average, one person is killed or seriously injured in traffic violence everyday in the region.” Everyone understands the safety risks that they take when they drive a car and they believe those risks to be acceptable. Again, no driving statistics are referenced, and of course, the plan does not provide data on the numbers of people who are mugged walking down the region’s streets or at trolley stations, etc.

Everyone agrees that climate change is real. On page 34, several climate strategies are listed. The blue pie chart at the top of the page lists “collecting rainwater” as one viable climate mitigation strategy. Why doesn’t this 2021 plan identify more impactful strategies such as building new reservoirs/expanding existing ones or building additional desalinization plants? It should be noted, that even if the 2021 plan is implemented, it will not stop the sea levels from rising.

This plan would require employers and developers to provide transportation benefits and on-site amenities to encourage people to use sustainable transportation choices. Does the County want even more businesses to flee California for a friendlier business climate? Employers can figure out how to use flexible work schedules and tele-work options to attract and sustain their workforce without unnecessary government intervention/regulation.

Of course, of the 2021 plan's proposed transportation management "strategies" come at a huge cost (\$163 billion dollars). The plan identifies \$90 billion dollars that will come from local funding sources: sales taxes, impact fees, fuel taxes, roads tolls, increased passenger fares, general funds, housing revenue, ride-hailing fees, value pricing, and road user charges also called vehicle miles travelled (VMT). Road usage fees or VMT, which have yet to be implemented through legislation, are needed to offset the reduction in gasoline taxes as more electric vehicles (EV) use our roadways. Under this plan, VMT fees would come on top of the existing federal, state, and local gasoline taxes, and they would unfairly penalize the drivers of gas-powered vehicles, who frequently are low-income and minority residents who live in the rural areas of the County. (VMT would not be collected on out-of-state vehicles.) Under the 2021 plan, fees of all kinds would be raised, including variable road tolls based on the time of day (congestion), fees for solo drivers using carpool lanes, and fees for ride-sharing services like Uber. The fees and regulations imposed by this plan will disproportionately impact low-income residents, while the plan claims to promote social equity. They are the ones who will not be able to afford to park/drive their own private vehicles while private transportation choices of more affluent residents will not be affected.

Figure 3.3 on page 50 shows the 2021 Regional Plan Expenditures with an estimated total of \$163 billion in 2020 dollars. There needs to be a similar pie chart within the 2021 plan that shows how much money will be spent on each transportation category: Transit Leap (mass transit), mobility hubs, complete corridors, bicycle network, highway improvements etc. Although there may be appendices that list all the funding for a specific category, it is unlikely that most people will wade through all of them to find that important information.

On page 53 of the 2021 Regional plan is a list of a priority implementation actions. Number 1 on the list is "Apply the Social Equity Planning Framework". Number 10 on this list is: "Advance a data science program to better understand travel behavior in the region." These priorities should be reversed. **You can't apply a framework or develop a meaningful plan until there is solid and recent (post COVID) transportation data!**

This very expensive "Lamborghini" transportation plan with its "woke" statements about social equity and its claims to "strengthen a sense of place," is a direct assault on the personal transportation choices of San Diego County residents. County leaders must choose a less expensive "Toyota" plan that will not transform "America's Finest City" into a third-rate economy where only the wealthy residents can still afford to own and drive a car.

Cherry Diefenbach  
Chair, Jacumba Community Sponsor Group  
619-743-5224



**COMMENT LETTER 21: CRAIG JONES**

Comment Letter 21

**From:** Craig Jones <[bananashke@sbccglobal.net](mailto:bananashke@sbccglobal.net)>  
**Sent:** Friday, September 17, 2021 10:10 AM  
**To:** Keith Greer <[Keith.Greer@sandag.org](mailto:Keith.Greer@sandag.org)>; Clerk of the Board <[ClerkoftheBoard@sandag.org](mailto:ClerkoftheBoard@sandag.org)>  
**Cc:** Masada Disenhouse <[masada.disenhouse@gmail.com](mailto:masada.disenhouse@gmail.com)>; Joyce Lane <[joycelane75@gmail.com](mailto:joycelane75@gmail.com)>; Bee Mittermiller <[beemitt@gmail.com](mailto:beemitt@gmail.com)>; Jack Shu <[jkshu52@gmail.com](mailto:jkshu52@gmail.com)>; [terra.lawsonremmer@sdcounty.ca.gov](mailto:terra.lawsonremmer@sdcounty.ca.gov)  
**Subject:** Questions re: dEIR for the regional plan

**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

Mr. Greer, these are the questions I raised during the Sept. 17 SANDAG joint committees hearing; I was disappointed that there was no response during the hearing; please provide responses in reply to this email:

- 21-1 • The dEIR analysis of GHG production: Is this analysis of production of GHGs from ALL sectors and operations in the San Diego region - not just from the transportation sector, but from all including land use, energy, agriculture, etc? If so, from the proposed project what is the analysis of GHG production from JUST the transportation sector?
- 21-2 • Given that the dEIR project alternative 3 is the environmentally superior alternative, and I assume including reduction in production of GHGs, why would this alternative not be the recommended alternative to adopt as the 2021 regional plan?

Craig Jones  
 858-354-1785  
[bananashke@sbccglobal.net](mailto:bananashke@sbccglobal.net)

**RESPONSE TO COMMENT 21-1**

The comment asks whether the Draft EIR analysis of “GHG production” includes only the transportation sector or also includes other sectors and operations in the San Diego, and also asks for “the analysis of GHG production from JUST the transportation sector.”

In Impacts GHG-1 and GHG-5, the Draft EIR analysis is based on GHG emissions projections from 15 emissions categories, including the on-road transportation and off-road transportation sectors (Draft EIR pages 4.8-19- to 4.8-26; pages 4.8-31 to 4.8-35). The analysis in Impacts GHG-1 and GHG-5 is based on the *2016 GHG Inventory and Projections for the San Diego Region* report (Draft EIR Appendix H). This report provides an estimate of 2016 GHG emissions for the San Diego region and GHG projections for the years 2025, 2030, 2035, 2045, and 2050.

In Impact GHG-3, the Draft EIR analysis is based on GHG emissions projections from the entire on-road transportation sector (Draft EIR pages 4.8-28 to 4.8-29). The on-road transportation sector is defined in Impact GHG-3 as passenger cars and light-duty trucks and heavy-duty trucks and vehicles (Draft EIR page 4.8-28).

The comment does not raise any issues with the adequacy of the Draft EIR and no further response is required.

**RESPONSE TO COMMENT 21-2**

CEQA does not require that lead agencies adopt the environmentally superior alternative. At the conclusion of the EIR process, the decision-makers (in this case the SANDAG Board of Directors) makes final determinations as to the feasibility of alternatives, considering information in the Draft EIR, additional information in the Final EIR and elsewhere in the administrative record, and policy factors. (See CEQA Guidelines Section 15091(a)(3).) Therefore, this comment will be provided to the Board of Directors and will be considered before it makes a decision on adopting a final Regional Plan.

**COMMENT LETTER 22: SAN DIEGO COUNTY LOCAL AGENCY FORMATION COMMISSION**

Comment Letter 22



**San Diego County**  
**Local Agency Formation Commission**  
 Regional Service Planning | Subdivision of the State of California

September 30, 2021

**Delivered Electronically:**  
[RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)

**TO:** SANDAG  
**FROM:** Priscilla Allen, Analyst I  
 San Diego County Local Agency Formation Commission

**SUBJECT:** SD LAFCO Comment Letter |  
 Draft Environmental Impact Report (EIR) for SANDAG's 2021 Regional Plan

22-1

The San Diego County Local Agency Formation Commission (LAFCO) appreciates the opportunity to review the program-level Draft Environmental Impact Report (EIR) prepared as part of SANDAG's 2021 Regional Plan. LAFCO's review is premised as potential responsible agency, and specifically exercising its separate planning and regulatory activities in response and/or in alignment to the Regional Plan. This includes addressing LAFCO's own task under Government Code Section 56668(g) to consider the merits of all jurisdictional changes relative to regional transportation plans.

With the preceding framing in mind, LAFCO has reviewed the DEIR and have no material comments to provide at this time. We will – nonetheless – continue to monitor the EIR process and are available to SANDAG staff to coordinate as appropriate.

Respectfully,  
  
 Priscilla Allen  
 Analyst I

<b>Administration</b> Keene Simmonds, Executive Officer 2350 Fifth Avenue, Suite 275 San Diego, California 92101-5614 T: (619) 221-1310 www.sdlafco.org	<b>Mike Clark, AIC, President</b> County of San Diego	<b>Mary Lindler Sales, LEED</b> City of Escondido	<b>Steve Cate</b> City of San Diego	<b>Joanna Knecht, Vice Mayor</b> City of San Diego	<b>Chris Arndt-Vanderhaar, General Public</b> General Public
<b>Dora Vargas</b> County of San Diego	<b>Paul McCannara</b> City of Escondido	<b>Adam van Wagoner, AIC</b> City of San Diego	<b>Henry Mills</b> San Diego Fire Protection	<b>Henry Mills, AIC</b> General Public	
<b>Neil Anderson, AIC</b> County of San Diego	<b>Kristi Becker, AIC</b> City of San Diego		<b>David A. Drake, AIC</b> City of San Diego		

**RESPONSE TO COMMENT 22-1**

Thank you for your review of the Draft EIR and participation in the environmental review process. Please continue to follow along in this process by visiting SDForward.com.

**COMMENT LETTER 23: LIBBY LUCAS**

Comment Letter 23

Libby Lucas  
4532 Chinook Court  
San Diego, CA 92117

October 11, 2021

San Diego Regional Plan EIR  
C/O Kirsten Uchitel, Associate Planner  
401 B Street, Suite 800  
San Diego, CA 92101  
Only via email to [RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)

Re: Comments on the Draft Program EIR for San Diego Forward: The 2021 Regional Plan

Dear Ms. Uchitel:

23-1 The focus of the comments herein on the subject DEIR is one of the proposed Regional Plan's Major Travel Corridors - Coast, Canyons, and Trails, specifically trail-related impacts on wildlife. Here, "trail-related impacts on wildlife" refers to negative indirect impacts / effects on wildlife from the construction and/or use of trails and bikeways for recreation, commuting, or local trips. The wildlife species of concern are those living in, passing through, or somehow relying on lands conserved for the perpetuation of viable populations of sensitive species pursuant to the approved and draft NCCPs/HCPs in San Diego County, and otherwise conserved lands such as CDFW's ecological reserves and USFWS's national wildlife refuges.

The construction and human use of such trails / bikeways is an admittedly minor component of the proposed Plan; and, this focus is in no way intended to minimize the importance of any other aspects of the proposed Plan, but rather only to highlight DEIR's inadequacies on this matter.

23-2 The DEIR identifies several trail / trail segments and bikeways among the projects of the proposed Plan.<sup>1</sup> The following two CEQA significance criteria in the DEIR are the most pertinent to the construction and use of trails and bikeways.

BIO-2 Have a substantial adverse effect, either directly or indirectly, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or listed by CDFW or USFWS, including their federally designated critical habitat, or species that are considered sensitive in CEQA Guidelines section 15380.

BIO-3 Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.

Please note the following four points.

<sup>1</sup> The following are the trail / trail segments among the projects of the proposed Plan: California Coastal Trail, Coastal Rail Trail, San Diego River Trail - Carlton Oaks Segment, San Diego River Trail - Mast Park to Lakeside baseball park, San Luis Rey River Trail, and Inland Rail Trail: Oceanside (tables on pages E-63 to E-77 in the DEIR's Appendix E - Biological Resources - <https://www.sandag.org/files/2021/09/2021-regional-plan-eir-appendix-e-biological-resources.pdf>).

**RESPONSE TO COMMENT 23-1**

Thank you for your participation in the environmental review process. Further responses to your comments are provided below. SANDAG appreciates and shares your concerns on the importance of wildlife protection from the effects of trails and bikeways.

**RESPONSE TO COMMENT 23-2**

SANDAG appreciates the summary of the EIR's biological mitigation measures that pertain to the construction and use of trails and bikeways.

- 23-3 1. The discussion in the DEIR of indirect impacts under Bio-3 mentions human disturbance from increased human presence, and the importance of riparian corridors to regional connectivity, describing corridors as often being the only connections left to large core habitat patches (page 4.4-98). However, the proposed mitigation measures for significant impacts to which the two above significance criteria apply are inadequate to address the need to provide perpetual adaptive management associated with the indirect impacts on wildlife from human disturbance.<sup>2</sup>
- 23-4 2. Not found (though possibly missed in review) in the EIR is evidence of consideration of a potential project-related increase in the human use of trails (on NCCP/HCP and other conserved lands) that lead to any of the trails and bikeways identified on the DEIR.
- 23-5 3. The analyses in the DEIR for direct impacts for years 2025, 2035, and 2050, state, “Bikeways would have relatively little impact on corridors as most are within or directly adjacent to developed areas.... The increased presence of humans in some riparian areas (e.g., Coastal Rail Trail, San Diego River Trail) may alter wildlife behavior, but these areas are already heavily disturbed by human presence.” The fact that the identified riparian areas are already heavily disturbed by human presence does not obviate the need to mitigate for added project-related levels of human disturbance.
- 23-6 4. The preceding three points are concerning with respect to wildlife species requiring sound management of the NCCP/HCP and other conserved lands in San Diego County. Consequently, please add the following to the final EIR.
- A. A discussion of the potential for project-related increase in the human use of trails (on NCCP/HCP and other conserved lands) that lead to any of the trails and bikeways identified on the DEIR, an analysis of the impacts on wildlife from increased levels of human use, and mitigation measures to address the increased levels.
- B. Mitigation measures to provide the following at project-specific levels.
- i. Site trails / bikeways outside of NCCP/HCP and other conserved lands wherever feasible.
- ii. Studies (e.g., BACI) should be designed and implemented by biologists well-grounded in recreation ecology<sup>3</sup> to assess the trail-related indirect impacts on wildlife for both (a) existing trails / bikeways that experience an increase in project-related use, and (b) new

<sup>2</sup> Indirect effects / impacts may have an effect later in time or are farther removed in distance, but are still reasonably foreseeable and attributable to project-related activities (DEIR page 4.4-61). Examples of such impacts from human disturbance of wildlife are (a) disruptions of animals' behavior, physiological processes, natural movement patterns used for foraging/hunting, and/or (b) rendering foraging/hunting/resting/feeding areas functionally inaccessible. Such impacts are most serious when long lasting and/or the affected wildlife don't have elsewhere to go to meet their needs (i.e., no other suitable habitat is available to them within a distance or linkage they could safely travel) – refer to sources in footnote 3.

<sup>3</sup> As reflected in studies conducted on NCCP/HCP-conserved lands in San Diego and Orange County, such studies should have been occurring regularly as part of the implementation of the NCCPs/HCPs in the region to inform adaptive management for public use of the conserved lands; two reasons they have not been done as needed are lack of sufficient funding and the fact that this issue is as yet inadequately recognized and addressed despite the documented evidence for it. Regarding the insufficient funding, refer, for example, to Appendix AA of the DEIR <https://www.sandag.org/sites/default/files/2021-08/Appendix%20AA%20-%20Sierra%20Club%20-%202021%20-%20Letter%20to%20SANDAG%20on%20the%20Regional%20Plan.pdf> and the Sierra Club's August 2, 2021, letter to SANDAG on the Regional Plan. The SDMMP provides related information at <https://www.sandag.org/sites/default/files/2021-08/SDMMP%20-%202021%20-%20Letter%20to%20SANDAG%20on%20the%20Regional%20Plan.pdf>. Also refer to <https://www.sandag.org/sites/default/files/2021-08/SDMMP%20-%202021%20-%20Letter%20to%20SANDAG%20on%20the%20Regional%20Plan.pdf> specifically the articles at <https://www.sandag.org/sites/default/files/2021-08/SDMMP%20-%202021%20-%20Letter%20to%20SANDAG%20on%20the%20Regional%20Plan.pdf> and <https://www.sandag.org/sites/default/files/2021-08/SDMMP%20-%202021%20-%20Letter%20to%20SANDAG%20on%20the%20Regional%20Plan.pdf>.

### RESPONSE TO COMMENT 23-3

Mitigation measure BIO-3, *Facilitate Wildlife Movement* (page 4.4-106), identifies measures for indirect impacts on wildlife movement corridors, including designing to avoid impacts on wildlife corridors and the preparation of wildlife movement studies where no data exist. In order to capture adaptive management and monitoring as suggested by the comment, the following text has been added to the first paragraph:

Conduct wildlife movement studies and Before-After-Control-Impact-Studies (BACI) where data are lacking, identify corridor widths and wildlife crossing structures, and consider balancing conservation and recreation (Mitrovich et al. 2020) in project design. Include adaptive management and monitoring measures in the CEQA review, mitigation measures, and project design.

### RESPONSE TO COMMENT 23-4

Page 4.4-83 (BIO-2) addresses potential impacts from human use on sensitive species resulting from land use changes and regional growth. Consistency with the HCPs is addressed in BIO-4, which assumes that the proposed Plan is consistent with all HCPs. Allowable uses, including recreational trails, are identified in the respective adopted NCCP Subarea Plans, and land use adjacency analyses conducted on the project-specific CEQA level would identify any conflicts with Subarea Plans and require mitigation.

### RESPONSE TO COMMENT 23-5

DAG appreciates your comment. In order to mitigate for added project-related levels of human disturbance, the following revisions have been made to mitigation measure BIO-3:

- Allow corridor buffer zones and wide movement corridors to remain or incorporate periodic larger habitat patches along a corridor's length.
- Where feasible, site linear projects, including pedestrian trails, away from wildlife corridors and conserved lands or NCCP lands.
- Where feasible, prohibit night-time trail use and enforce seasonal trail closure, and plan access points and infrastructure carefully to minimize the effects on biological resources and wildlife corridors.

- As feasible, within 200 feet of a wildlife corridor, use non-reflective glass or glass treated with non-reflective coating for all exterior windows and building surfaces.
- Use only native species for landscaping within at least 200 feet of identified wildlife corridors.
- Incorporate dimmed, shielded, and directed lighting in areas near corridors that only illuminate the project site; consider high pressure sodium or cut-off fixtures as feasible, and provide vegetative screening to reduce light pollution on corridors.
- Include permanent noise barriers and sound-attenuating features as part of the project design, and incorporate temporary noise barriers and noise-reduction devices on equipment during construction; require the use of hydraulically or electrically powered tools, as feasible. Barriers could be in the form of outdoor barriers, sound walls, buildings, or earth berms to attenuate noise at adjacent sensitive uses.
- Install physical barriers (e.g., wildlife fencing) that prevent human and/or domestic predator entry into the corridor and, if appropriate, limit the amount of noise and lighting that enters the corridor. Use techniques such as grade separation, buffer zones, landscaped berms, dense plantings, sound walls, reduced-noise paving materials (i.e. rubberized asphalt), and traffic calming measures.

#### **RESPONSE TO COMMENT 23-6**

Thank you for identifying potential indirect impacts on wildlife species and corridors. As addressed in the response to the preceding comments, and as correctly stated, increase of human use would be addressed on the project-specific level; see also response to comments Lucas 23-3 and 23-4. Informed by studies on the recreational impacts on wildlife (i.e. M. Mitrovich, C. L. Larson, K. Barrows, M. Beck, and R. Unger. 2020. *Balancing Conservation and Recreation*. California Fish and Wildlife, Recreation Special Issue; 11–28), the following bullets were added to the BIO-3 mitigation paragraph:

- Where feasible, site linear projects, including pedestrian trails, away from wildlife corridors and conserved lands or NCCP lands.
- Where feasible, prohibit night-time trail use and enforce seasonal trail closure, and plan access points and infrastructure carefully to minimize the effects on biological resources and wildlife corridors.

With regards to funding and Appendix AA (see Footnote 3), please refer to Master Response 1 for discussions regarding including a regional habitat conservation fund.



23-8 cont. trails and bikeways. For "a," the studies will inform adaptive management. For "b" the studies must be conducted and the data analyzed during initial planning of contemplated trails, prior to CEQA or any environmental review. Until data are gathered and analyzed, it is infeasible to defensibly determine whether such impacts are significant and, if they are, whether an existing level of use continue or a new project should proceed, and, if so, what management / mitigation should be provided.

23-7 C. A requirement to set aside transportation dollars for the studies in B(ii) and associated resulting mitigation / perpetual adaptive management with realistic alternatives to select from to adaptively manage effectively. This funding should be at least at a level commensurate with the reliance on commuting by bike (including e-bikes) and foot to meet the VMT and GHG emission reductions. This required set-aside should be possible with (a) \$40 million by 2025 to be allocated to projects that reduce GHG emissions and for updates to CAPs or GHG reduction plans and (b) an additional \$40 million by 2025 to be allocated to the implementation of nature-based climate solutions to remove CO<sub>2</sub> from the atmosphere.<sup>4</sup>

23-8 In closing, climate change has and will continue to negatively affect most wildlife species. The degree to which the use of trails / bikeways in San Diego County diminishes the rate of climate change will factor into weighing the relative importance of protecting wildlife from trail-related impacts. However, in efforts to address climate change by increasing use of trails and bikeways, please do not jeopardize the decades of effort, time, energy, and funding dedicated to conservation in the region by burdening the conserved lands with new trails and bikeways or higher level of human use of existing trails and bikeways. There is a perpetual need to uphold the conservation achieved and meet the associated regulatory obligations. And, it is well documented that trail-related disturbance of wildlife on lands conserved expressly for them must be taken seriously.

Thank you for the opportunity to comment on the DEIR.

Libby Lucas



<sup>4</sup> This assumes that the funding is realized and that, for example, carbon sequestration projects may occur within lands conserved for wildlife species and there will be existing or new trails in some of these areas.

**RESPONSE TO COMMENT 23-7**

To meet the region’s habitat conservation goals, the proposed Plan identifies approximately \$3 billion for habitat-related efforts. This includes \$2,087 million for an enhanced habitat conservation, management, and monitoring program (see Land Use and Habitat programs in Appendix B of the proposed Plan), a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (see Climate Adaptation and Resilience programs in Appendix B of the proposed Plan), and \$300 to \$500 million of land acquisition and restoration for habitat mitigation of transportation projects (incorporated in project costs presented in Appendix A of the proposed Plan).

**RESPONSE TO COMMENT 23-8**

SANDAG appreciates the commenter’s concerns. The proposed Plan includes a Climate Adaptation and Resilience Program that takes into consideration the potential effects of and solutions to climate change. Climate change has been a key topic throughout the Draft EIR and is discussed in detail in Appendix C, *Climate Change Projections, Impacts, and Adaptation*.

**COMMENT LETTER 24: JAMES MARPLE**

Comment Letter 24

From: JAMES MARPLE <jamesmarple66@yahoo.com>  
Sent: Friday, September 3, 2021 8:15:38 AM (UTC+00:00) Monrovia, Reykjavik  
To: RegionalPlanEIR  
Subject: Regional Plan EIR

24-1 | CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.

**RESPONSE TO COMMENT 24-1**

Thank you for participating in the environmental review process. Please continue to follow along in this process by visiting [SDForward.com](http://SDForward.com).

(Note that since this comment was received blank, SANDAG subsequently followed up with the commenter and received a follow up comment letter on November 11, 2021.).



**From:** JAMES MARPLE <jamesmarple66@yahoo.com>  
**Sent:** Thursday, November 11, 2021 11:11 PM  
**To:** Kirsten Uchitel  
**Cc:** Kelly McFlea; TomMarple@comcast.net; Mary Beth Sheets  
**Subject:** Re: San Diego Forward Draft EIR Comment

Kirsten

24-2 Many thanks for your thoughtful reminder. Becoming ancient has brought on constant overload as my colleagues decline in number and/or acuity. Our favorite Editor is on leave so please bear with my stumbling verbiage, not meant to offend.

Citizens for Responsible Watershed Management  
comment to 2021 SANDAG Regional Plan

24-3 The focus of this plan on improving effectiveness of previous plans reveals limitations of information and/or education on the part of authors who did not factor in the publicly beneficial effects of compliance with the 1945 CA Water Code.

What does this have to do with transit planning?

24-4 That Landmark State Law specifically and repeatedly

**RESPONSE TO COMMENT 24-2**

This comment is an explanation of the previously submitted blank email SANDAG received. SANDAG appreciates your feedback on the Draft EIR. Please see responses below for the comments provided in this letter.

**RESPONSE TO COMMENT 24-3**

Section 4.10.2 of the *Hydrology and Water Quality* section in the EIR, includes all of the applicable federal, State, and regional and local laws, regulations, plans, and policies applicable to the proposed Plan. Applicable sections of the California Water Code were included and analyzed to determine if implementation of the proposed Plan would result in a significant hydrology and water quality impact. The analysis in Section 4.10.4 of the EIR concluded that with compliance with regulatory requirements the proposed Plan’s impacts on hydrology and water quality are less than significant.

**RESPONSE TO COMMENT 24-4**

Please see response to comment Marple 24-3.

24.4  
cont. instructed all Southern CA agencies to;  
“guide all or any stormwaters into soils of the District”

24.5 We need no civil engineering expertise to recognize beneficial alternatives to ‘traditional’ transit planning that would become open to present planners if this simple instruction was complied with.  
- If all San Diego landscapes are managed like the USEPA mode of Phoenix to retain rainfall so that it soaks into the soil, no runoff of water would occur.  
- If there is no runoff then storm drains would not dump rainfall into canyons so these could become ‘secondary transit’ routes, as in Phoenix.

24.6 If planners find these concepts confusing then we may reasonably assume they’ve not ‘done their homework’ well enough to recognize public benefit from providing a convenient, safe, economical alternative to riding a bike in traffic or owning an automobile.

24.7 Public servants who manage transit systems should be aware of all costs/benefits of non-auto travel routes and produce a comprehensive study of these from National and Worldwide models. Only then will San Diego citizens be able to vote wisely for candidates who will demand multi-layered transit planning.

If residents have convenient paths-trails-travelways simple economics would reduce car ownership and thereby bring an overall improvement in traffic flow.

24.8 Has the scope of benefits from this reduction been identified? Have results of reduced auto traffic been

**RESPONSE TO COMMENT 24-5**

Please see response to comment Marple 24-3. As discussed in additional detail in Section 4.10, through the various regulatory requirements to incorporate hydromodification and low impact development (LID) measures, projects implementing the proposed Plan would maintain pre-development hydrology, and would reduce, infiltrate, and properly manage stormwater runoff such that on- or offsite flooding would not occur.

**RESPONSE TO COMMENT 24-6**

For further information, refer to the proposed Plan, which discusses in additional detail the Plan’s strategy for creating an integrated transportation system, including one with Complete Corridors that prioritize access to roadways for public transit, active transportation, and shared mobility services. The Active Transportation Network is a critical part of the proposed Plan that represents critical connections needed to get people around and is more than just bike facilities. As is the case with current SANDAG Active Transportation projects, each of these facilities also includes safety and connectivity enhancements for people walking, riding micromobility or transit, and driving. That said, this comment is not a comment about the content or analysis of the Draft EIR, and, as such, no further response is required.

**RESPONSE TO COMMENT 24-7**

SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms.

**RESPONSE TO COMMENT 24-8**

The proposed Plan includes a number of investments in active transportation including the regional bike network, local bike projects through local streets and road funding as well as complete street investments in mobility hubs, mobility hub amenities (including secure bike parking and e-bike charging), an e-bike incentive program, and Vision Zero programs. In addition, Appendix B describes implementation actions for the proposed Plan, which includes a Regional Active Transportation Plan (including updated Regional Bike

Plan), Comprehensive Multimodal Corridor Plans, Regional Vision Zero Action Plan (including Regional Safety Policy), updating SANDAG grant programs, a quick build program for complete streets, and transportation demand management grants and incentives.

Also, as discussed in comment Marple 24-7, SANDAG will conduct a study that will focus on calculating the true cost of driving. Equity will be a very important component of that study. That said, this comment does not appear to provide a specific comment about the content or analysis of the Draft EIR and no further response is required.

24-8  
cont. evaluated and illustrated to the public?  
It is obvious that the less wealthy population would benefit most from a dense network of non-auto trails, but so too would drivers, due to reduced traffic.

A fully developed web of travelways for those who would benefit most from not owning a car would be a proper goal for officials seeking equitable plans.

24-9 SANDAG planning has been focused on expanding vehicular travel systems and creating bike lanes.  
Forming a network of non-auto travel routes would give all residents the free or inexpensive option of walking, biking, ‘scooters’ or using minibus units to reach local destinations.

24-10 For these reasons, addressing the issue of failure to comply with CA Law intended to prevent flooding of canyons would be a major step toward restoring the public’s right to convenient, safe, free pedestrian passage throughout all communities.

24-11 Has SANDAG performed a fully comprehensive study of ‘secondary transit’ that uses canyons, highway ROWs and ‘back streets’ to form a web of safe paths-trails-travelways along these routes?

24-12 To summarize:  
San Diego residents have shown minimal interest in working with SANDAG because it presents choices between its preferred plans, does not fully illustrate all transit planning options for public consideration.

**RESPONSE TO COMMENT 24-9**

Please see response to comment Marple 24-6.

**RESPONSE TO COMMENT 24-10**

Please see response to comment Marple 24-3.

**RESPONSE TO COMMENT 24-11**

Many of the Complete Corridor projects in the proposed Plan utilize existing right-of-way and, in many cases, existing roadway shoulders without encroaching into any additional land. This will greatly reduce environmental impacts, speed project delivery, and reduce costs. Where this is not an option additional project-specific outreach and engagement will be conducted with affected residents and stakeholders. This process aims to develop projects with minimal impacts.

In addition, as referenced in comment Marple 24-8, SANDAG will prepare a Regional Active Transportation Plan that will revisit future active transportation investments, including the feasibility of investments along travel ways such as those listed in the comment.

Thank you for your comment and consideration of the proposed Plan. Please see response to comment Marple 24-3

**RESPONSE TO COMMENT 24-12**

This comment appears to assert that the Draft EIR does not analyze a reasonable range of alternatives.

As the Draft EIR explains (page 6-1), SANDAG considered public input provided during the EIR scoping process, and used this input develop the reasonable range of alternatives. Public input requested alternatives that reduce GHG emissions, air quality impacts, and VMT. The alternatives selected for detailed consideration incorporate many of the major transportation investments and policy options that commenters suggested.

Notably, alternatives do not need to be environmentally superior in all respects to the proposed Project. Courts have noted that for complex projects with a wide scope, “it is practically impossible to imagine an alternative that would provide substantial environmental advantages in all respects” (*Sierra Club v. City of Orange* (2008) 163 Cal. App. 4th 523).

Please see Master Response 1 for additional discussion of alternatives evaluated in the EIR. Please see response to comment Marple 24-5 regarding stormwater management planning.

24-12  
cont.

Integrating its planning with that of every community to maximize rainwater management in keeping with the spirit and intent of the CA Water Code would be a major step toward upgrading the planning process.

James H. Marple  
for CRWM and its associates

On Nov 5, 2021, at 10:34 AM, Kirsten Uchitel <[Kirsten.Uchitel@sandag.org](mailto:Kirsten.Uchitel@sandag.org)> wrote:

Dear Mr. Marple,

I received an email from you on the San Diego Forward: 2021 Regional Plan Draft EIR, however, there was no text in the body of your email. I wanted to reach out to you to see if you had a comment that you wanted to submit for response and inclusion in the Final EIR. If yes, please email it to me by the close of business next Friday, November 12, 2021.

Thank you very much,

Kirsten Uchitel  
Associate Planner

401 B Street, Suite 800, San Diego, CA 92101

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**COMMENT LETTER 25: CITY OF OCEANSIDE**

Comment Letter 25



**CITY OF OCEANSIDE**  
OFFICE OF CITY MANAGER

October 11, 2021

Mr. Hasan Ikhtrata  
Executive Director  
San Diego Association of Governments (SANDAG)  
401 B Street, Suite 800  
San Diego, CA 92101

RE: Draft Environmental Impact Report for the 2021 Regional Plan

Dear Mr. Ikhtrata:

25-1 The City of Oceanside ("City") appreciates the opportunity to comment on the Draft Environmental Impact Report (EIR) for the 2021 Regional Plan ("the proposed Plan"), which combines the Regional Transportation Plan, Sustainable Communities Strategy, and Regional Comprehensive Plan. The proposed Plan looks ahead to 2050, with the purpose of addressing many systematic transportation challenges faced by the entire San Diego region. The City acknowledges SANDAG's bold vision for a transformed mobility network that promotes convenient and cost-effective transportation options, smart growth, environmental justice, social equity, and Greenhouse Gas emissions reduction. However, the City would like to take this opportunity to identify significant concerns regarding 1.) the proposed Plan and Draft EIR's growth projections and land use assumptions for Oceanside, and 2.) SANDAG's continued lack of funding allocation, support, or implementation of two important regional transportation projects identified and relied on in the proposed Plan. These inadequacies effectively result in miscalculated environmental impacts and insufficient analysis pursuant to the California Environmental Quality Act (CEQA). The City's comments on these two issues are detailed below:

The proposed Plan and associated environmental analysis inadequately address Oceanside's growth and land use assumptions, forecasts, and planning efforts.

25-2 In a letter to SANDAG on the proposed Plan from the City's Development Services Department, dated August 6, 2021, City staff raised concerns about the proposed Plan's significant underestimation and inconsistent acknowledgement of Oceanside's growth assumptions and land use projections, which should form the basis of the Draft EIR analysis. As such, the Draft EIR's land use analysis is incomplete. Further details are provided below:

- 25-3 • The proposed Plan projects roughly 300,000 fewer new residents in the San Diego region compared to the prior (2016) forecast; however, SANDAG projects the region's population will grow by nearly one million people by 2050. The growth in population will drive job growth and housing demand within the region – adding 500,000 jobs and more than 330,000 housing units by 2050 (Series 13: 2050 Regional Growth Forecast).

300 NORTH COAST HIGHWAY • OCEANSIDE, CA 92054-2885 • TELEPHONE (760) 435-3065 • FAX (760) 435-3078

**RESPONSE TO COMMENT 25-1**

SANDAG would like to thank the City of Oceanside for participating in the environmental review process and for acknowledging support for SANDAG's vision of the proposed Plan. Please see below for detailed responses to the concerns listed by the City.

**RESPONSE TO COMMENT 25-2**

The proposed Plan and associated land use analysis use the most recent planning assumptions considering local general plans and other factors consistent with Government Code Section 65080(b)(2)(B). The SCS must also "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the GHG emission reduction targets approved by the state board." The SCS included in the proposed Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the proposed Plan. The proposed Plan forecasts development through 2050 consistent with projections from the California Department of Finance but does not represent buildout capacity of jurisdictions' general plans. The analysis in the EIR is complete and based on planning assumptions provided to SANDAG by local jurisdictions as of 2018. SANDAG acknowledges that Oceanside is working on a General Plan Update and has completed other planning efforts since 2018 that will inform development of the next forecast.

The Regional Plan and its SCS are iterative planning documents that are typically updated every 4 years to account for new data, analysis, policy, and experience.

**RESPONSE TO COMMENT 25-3**

The Series 14 Regional Growth Forecast uses the January 2020 vintage of the Department of Finance populations projections, which shows less growth over the next 30 years than previously anticipated in the population projections used for the Series 13 Regional Growth Forecast.

- 25-4 • The proposed Plan and associated land use analysis insufficiently assumes Oceanside will accommodate less than three percent (3%) of this total regional growth through 2050. Oceanside is the San Diego region's Interstate (I)-5 gateway. With Oceanside remaining one of the region's more affordable communities, and with the City looking to incentivize higher and better use of underutilized properties in its major corridors, the proposed Plan disregards Oceanside's land use potential to accommodate a greater share of the regional growth. Housing demand in Oceanside remains strong, and the City is still one of the most affordable markets in the San Diego region, particularly along the coastline. Moreover, the local employment base continues to grow, especially in the manufacturing, health care, and hospitality sectors. Oceanside has the potential to accommodate significant growth through infill and redevelopment, and the revitalization of the City's urban corridors will draw new residents and employers. In order to sufficiently allocate transportation funding where it is most needed in the region and ensure that Oceanside receives its fair share, it is imperative that Oceanside's growth is correctly reflected in both the proposed Plan and Draft EIR. Otherwise, this persistent underestimation of the City's population will only exponentially adversely affect the San Diego region's transportation network and directly impact Oceanside, beyond year 2050.
- 25-5 • The Draft EIR provides an inaccurate analysis of existing land use/zoning and local land use plans, policies, and regulations. Most specifically, Appendix F: Regional Growth Forecast and Sustainable Communities Strategy Land Use Pattern is inconsistent with the City's General Plan Update and current planning efforts, including the City's endeavors to accommodate the Regional Housing Needs Assessment. The Draft EIR relies on data provided in an outdated June 2002 General Plan rather than establishing assumptions based on the City's General Plan Update and associated Smart and Sustainable Corridors Plan (SSCP), currently in process. In fact, SANDAG's continued use of the City's outdated General Plan has likely contributed to low growth projections over the past three forecast periods (2008, 2012, and 2016). Moreover, the proposed Plan and Draft EIR fails to recognize the Coast Highway Vision and Strategic Plan, adopted by Oceanside City Council in 2009. The adopted plan is expected to generate significant jobs and housing growth along the Coast Highway corridor.
- 25-6 Since early 2020, the City has made significant progress on updating its General Plan and associated technical studies. Slated for City Council adoption in spring 2023, the General Plan Update establishes a long-range vision for the community and plans for important community issues, such as new growth, housing needs, public services, and environmental protection. The City's General Plan Update includes policies to incentivize infill and redevelopment through new zoning standards, a streamlined review process, CEQA clearance, and targeted infrastructure improvements. The SSCP establishes a framework for developing future housing and employment growth into the City's commercial corridors, while maintaining the integrity of adjacent residential neighborhoods. The SSCP will identify ways to facilitate infill and redevelopment along Mission Avenue, Oceanside Boulevard, and Vista Way. Another relevant planning document is the approved Coast Highway Vision and Strategic Plan, which re-envisioned the historic highway and its surroundings based on Livable Communities and Smart Growth principles and transforms it into a pedestrian-friendly and transit-oriented place that attracts and serves both visitors and residents. It is imperative that the proposed Plan and Draft EIR accurately consider these important planning efforts going forward. Rather than relying on outdated information, the City is confident that these policies and projections provide more reliable data demonstrating Oceanside's true growth and land use potential.

**RESPONSE TO COMMENT 25-4**

Please see response to comment Oceanside 25-2.

**RESPONSE TO COMMENT 25-5**

The proposed Plan and associated land use analysis use the most recent planning assumptions considering local general plans and other factors consistent with Government Code Section 65080(b)(2)(B). Consistency of the proposed Plan with relevant general plans and LCPs is analyzed in Section 4.11, *Land Use*, of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions' general plans, LCPs, or other local planning documents. Consistency of individual second-tier projects with these policies would be considered during project-specific CEQA reviews.

As noted in the comment, the City's General Plan Update has not been adopted and is currently in process and will inform development of the next forecast. The proposed Plan is an iterative planning document that is typically updated every 4 years to account for new data, analysis, policy, and experience. In 2016–2018, local jurisdictions, including the City of Oceanside, provided data to SANDAG on housing capacity based on their adopted plans to inform the Series 14 forecast development. The proposed Plan forecasts development through 2050 consistent with projections from the California Department of Finance but does not represent buildout capacity of jurisdictions' plans.

**RESPONSE TO COMMENT 25-6**

The comment describes the City's progress on updating its general plan and associated technical studies. As noted in the comment, the City's General Plan Update is currently in process and anticipated for consideration by the City Council in Spring 2023. The proposed Plan is an iterative planning document that is typically updated every 4 years to account for new data, analysis, policy, and experience. SANDAG looks forward to coordinating with the City on future Regional Plan updates. Consistency of the proposed Plan with relevant general plans and LCPs is analyzed in Section 4.11 of the Draft EIR. Due to the programmatic nature of the EIR analysis, the Draft EIR does not call out specific policies from local jurisdictions' general plans, LCPs, or other local planning documents. Consistency of individual second-tier projects with

these policies would be considered during project-specific CEQA reviews.

In 2016–2018, local jurisdictions, including the City of Oceanside, provided data to SANDAG on housing capacity based on their adopted plans to inform the Series 14 forecast development. The proposed Plan forecasts development through 2050 consistent with projections from the California Department of Finance but does not represent buildout capacity of jurisdictions' plans.



- 25-7 • The Draft EIR fails to account for the City's long-standing allowances for mixed-use residential development in commercial districts, which have the strong potential to dramatically affect residential growth projections. Many of the City's largest mixed-use residential projects have been developed on, or are planned for, commercially-designated sites.
  - 25-8 • SANDAG has the responsibility to analyze the proposed Plan for inconsistencies with each jurisdiction's land use assumptions, which in this case is specific to Oceanside. Consequently, these inconsistencies could result in the underestimation of proposed environmental impacts and associated mitigation measures.
  - 25-9 • Overall, the Draft EIR insufficiently addresses these important land use factors and trends for determining potential environmental impacts. Ultimately, the City is concerned that the most recent iteration of the regional population forecast may significantly underestimate Oceanside's capacity for additional population, housing, and employment. As such, the Draft EIR lacks sufficient environmental analysis pursuant to CEQA.
- The proposed Plan and associated environmental analysis identify and rely on two important regional transportation projects, yet fail to demonstrate how SANDAG will fund, support, or implement such projects consistent with the Draft EIR analysis.
- As previously expressed, the City is concerned with the detrimental and persistent ramifications associated with the proposed Plan and Draft EIR's significant underestimation of growth in Oceanside. This inaccurate depiction of future growth in the northern San Diego region could eventually result in lost funding for traffic alleviation projects with potential to provide relief to all local San Diego residents and its visitors. The City is already enduring serious adverse traffic safety and mobility impacts along the State Route (SR)-76 corridor due to lack of SANDAG and CALTRANS funding and jurisdictional coordination. This is particularly experienced at the College/SR-76 interchange, which per recent reports is one of the most congested areas in the State. The City is extremely concerned, however, with the proposed Plan and Draft EIR's identification and reliance on two such regional transportation projects: 1.) I-5 HOV Lanes, from SR-78 to Vandergrift ("I-5 HOV Lanes"), and 2.) I-5 and SR-78 Interchange ("I-5/SR-78 Interchange"). Further details are provided below:
- 25-11 • The Draft EIR states that the proposed I-5 HOV Lanes project will be implemented by year 2025; however, to date SANDAG has yet to allocate funding or support on this major freeway improvement's project design. It is imperative that the proposed project not only remain on the proposed Plan's list of projects, but also receive adequate funding and commitment from SANDAG to bring the project to fruition, especially if the Draft EIR analysis relies on it. With the year 2025 nearly three years away, it is unrealistic and disingenuous for SANDAG to continue stating that the project will be delivered on-time.
  - 25-12 • The proposed I-5/SR-78 Interchange project would establish a much-needed connection between the west and east side of I-5 at the SR-78 interchange. Under existing conditions, there is no safe access for bicyclists and pedestrians across I-5 in this area. Similar to the I-5 HOV Lanes project, the Draft EIR identifies and relies on the proposed I-5/SR-78 Interchange project; however, SANDAG has not formally appropriated the funding needed to implement it.
  - 25-13 • While the City is encouraged by SANDAG's inclusion of these projects in the proposed Plan and associated environmental analysis, there are considerable concerns about the lack of project funding allocation and commitment provided by SANDAG at this time. These are integral traffic-

**RESPONSE TO COMMENT 25-7**

In 2016–2018, local jurisdictions, including the City of Oceanside, provided data to SANDAG on housing capacity based on their adopted plans to inform the Series 14 forecast development. The SCS land use pattern proposed in the proposed Plan focuses growth and development in the Mobility Hub areas to facilitate access to transit and improved jobs-housing balance. The allocation of housing units to subregional areas represents general areas projected for future growth in Mobility Hub areas, not specific parcels, for future housing development or housing unit type. A number of land uses at the parcel level, aggregated up, comprise these general areas. The exercise of land use authority is reserved for local jurisdiction.

**RESPONSE TO COMMENT 25-8**

Chapter 4.11 of the Draft EIR evaluates the land use impacts of the proposed Plan, including a consistency analysis with jurisdictions' land use plans. Please also see Draft EIR Appendix L, *Subregional Plan Consistency Analysis*. Environmental impacts of any such inconsistencies are considered throughout the Draft EIR as part of the proposed Plan impact analysis.

**RESPONSE TO COMMENT 25-9**

In 2016–2018, local jurisdictions, including the City of Oceanside, provided data to SANDAG on housing capacity based on their adopted plans to inform the Series 14 forecast development. The forecasted development pattern in the SCS does not represent buildout capacity of jurisdictions' general plans. Rather, the SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan consistent with SB 375. The Draft EIR's population forecasts are based on substantial evidence using the best-available data, specifically, the Series 14 Regional Growth Forecast and the regional forecast from the California Department of Finance.

**RESPONSE TO COMMENT 25-10**

SANDAG looks forward to continuing to coordinate with the City of Oceanside to incorporate its latest planning assumptions into future updates of the Regional Plan so that they are included. To the extent this comment refers to the comments above alleging the proposed Plan's population modeling undercounts growth in Oceanside, see response to

comment Oceanside 25-09. See below responses regarding the two specific transportation projects mentioned in the comment.

**RESPONSE TO COMMENT 25-11**

The Build NCC I-5 HOV lane project is being constructed from south to north and includes the northern segment as part of its project-level environmental analysis (to Harbor/Vandegrift [https://www.keepsandiegomoving.com/Documents/NCC\\_doc/I-5\\_Final\\_EIR-EIS.pdf](https://www.keepsandiegomoving.com/Documents/NCC_doc/I-5_Final_EIR-EIS.pdf)). Although funding has not yet been identified or programmed, SANDAG continues to pursue funding for implementation of this project consistent with the proposed Plan.

**RESPONSE TO COMMENT 25-12**

The I-5/SR 78 project (Interchange and Arterial Operational Improvements) is included in the proposed Plan by 2035. The regional transportation network does not include details regarding the types of bicycle and pedestrian facilities to be included with specific corridor projects, and the analysis of those projects will require future planning and coordination with local jurisdictions, community members, and other stakeholders to determine those details; all to be conducted at the project level.

**RESPONSE TO COMMENT 25-13**

SANDAG will continue to pursue State and federal funding for these (and other) future projects identified in the proposed Plan.

Page 4 of 4

25-13  
cont. | alleviating projects that affect the San Diego region, and every effort must be made to  
implement them in accordance with statements made in the proposed Plan and Draft EIR.

Summary

25-14 | The City of Oceanside again thanks SANDAG for the opportunity to comment on the Draft EIR for the  
proposed Plan. Staff look forward to collaborating with SANDAG as the draft environmental analysis is  
revised to more accurately reflect Oceanside's more realistic growth and land use projections. The City  
will continue reaching out to SANDAG staff to express the importance of allocating funding for  
implementation of the I-5 HOV Lanes and I-5/SR-78 Interchange projects with the goal of realizing their  
timely construction.

Sincerely,



Deanna Lorson  
CITY MANAGER  
[dlorson@oceansideca.org](mailto:dlorson@oceansideca.org)

cc: Jonathan Borrego, Deputy City Manager/Development Services Director  
Hamid Bahadori, Interim Public Works Director/City Traffic Engineer  
Darlene Nicandro, Development Services Deputy Director  
Jeff Hunt, City Planner  
Russ Cunningham, Principal Planner

**RESPONSE TO COMMENT 25-14**

SANDAG would like to thank the City of Oceanside for the feedback submitted and looks forward to future collaboration.

**COMMENT LETTER 26: CITY OF POWAY**

Comment Letter 26

**From:** David De Vries <DDeVries@poway.org>  
**Sent:** Monday, October 11, 2021 6:28:28 PM (UTC+00:00) Monrovia, Reykjavik  
**To:** RegionalPlanEIR <RegionalPlanEIR@sandag.org>  
**Cc:** Andy Loperena <ALoperena@poway.org>; Scott Post <SPost@poway.org>; Melody Rocco <MRocco@poway.org>; Bob Manis <BManis@poway.org>; SDFORWARD <sdforward@sandag.org>  
**Subject:** Draft EIR for the 2021 Regional Plan Comments - City of Poway

**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

Thank you for allowing us to submit comments on the Draft EIR for the 2021 Regional Plan.

26-1 Regarding Scripps Poway Parkway, the City of Poway would like to see vehicle, bike, pedestrian and transit infrastructure improvements and connections to be added from the Highway 67 through Scripps Poway Parkway to the I-15 Freeway. Please note that the majority of the City of Poway and areas east of the City of Poway are in the Very High Fire Severity Zone. Evacuation routes for the region should consider alternative routes and not only highway routes. Figure 4.9-2 of the EIR shows that there are no evacuation routes through the City of Poway. Providing vehicle, bike, pedestrian and transit infrastructure improvements along Scripps Poway Parkway and establishing it as an Evacuation Route will provide better access for emergency vehicles and sufficient routes for persons evacuating through the City of Poway. I have spoken to several property and business owners within the South Poway Business Park (SPBP) including Geico and parking is a constant issue. There is currently no public transit route into the SPBP. Having public transit, bike, pedestrian and highway/road improvements/connections providing more efficient access to the SPBP is essential for future employment growth and public safety in the area. Many workers in the Poway area live in Ramona and East County and this is a vital connection for the City and the Region. SANDAG has also identified the SPBP as a Tier 3 employment center in their draft Employment Center analysis. Construction is also underway to add thousands of more employees in the SPBP. To be clear, we are recommending that Scripps Poway Parkway be shown as a critical connection, a multimodal corridor, and an evacuation route in the San Diego region ([https://www.sandag.org/uploads/publicationid/publicationid\\_4730\\_28341.pdf](https://www.sandag.org/uploads/publicationid/publicationid_4730_28341.pdf)).

26-2 Regarding the Hwy 67, please note that the City of Poway's General Plan Transportation Element includes a multi-use path on the west side of SR-67 (reference p. 3 <http://docs.poway.org/weblink/0/doc/50446/Electronic.aspx>). This multi-use path would include a separated two-way bike path and a fenced DG equestrian trail. The multi-use path provides a critical and safe pathway for hikers, bikers, runners, walkers, children, and equestrians. A multi-use path also creates a necessary loop between the City's Iron Mountain trailhead and other destinations (e.g., Mt. Woodson, Lake Poway) which is also a goal within the Transportation Element. We recommend the San Vicente corridor plan be consistent with the City's plans. Also, for public safety, please recall that there are considerable traffic collisions along the Hwy 67 and we recommend that traffic safety improvements be considered along the Hwy 67 corridor.

State Route 67 is also designated as a scenic roadway by the Poway General Plan. As a part of the General Plan requirements, a 50-foot wide landscape open space easement is required from adjacent property owners from the ultimate right-of-way line along State Route 67 when development is proposed. This easement shall be landscaped and modified as needed to enhance the scenic quality of the area as discussed in the General Plan Transportation Element Policy B – Scenic Roadways. Providing scenic roadway elements to the design will also help the corridor be more compatible with surrounding open space. To contribute to the General Plan goals, we would suggest that the right-of-way incorporate design elements consistent with a scenic roadway (e.g., naturalized decorative solid walls, native landscaped medians and shoulders, additional landscape areas and trees where feasible, earthen berms). Also, the EIR

**RESPONSE TO COMMENT 26-1**

This comment is related to the proposed Plan and does not address the adequacy of the Draft EIR.

The San Vicente Comprehensive Multimodal Corridor Plan (CMCP) effort is currently underway, and Scripps Poway Parkway is included in the study area for that CMCP. The CMCP will include a suite of solutions for consideration in future planning, implementation, and improvement activities along the corridor, including SR 67 connections with Poway Road and Scripps Poway Parkway. The CMCP will include active transportation, clean transportation, transit, resilience and environment, ROW and utilities, equity, and evacuation considerations. The CMCP stakeholder working group includes representation from the City of Poway, which is intended to integrate jurisdictional priorities into the suite of solutions within the boundaries of the CMCP planning area.

**RESPONSE TO COMMENT 26-2**

The San Vicente CMCP will consider all relevant and related plans and projects, in collaboration with City of Poway staff, to ensure there is cohesion and consistency between the CMCP and the communities within and adjacent to it, including active and multi-modal transportation considerations.

The CMCP study identifies ways to improve roadway safety, enhance the urban-rural transportation interface (with special consideration given to limiting impacts on surrounding environmental habitats and wildlife), engage with tribal nations, and create greater trip reliability and efficiency throughout the study area while supporting climate action initiatives. The suite of solutions will include active transportation, clean transportation, transit, resilience and environment, ROW and utilities, equity, and evacuation considerations. The City of Poway is an integral member of the stakeholder working group and in the development of the CMCP.

This comment also applies only to the content of the proposed Plan and not the adequacy of the Draft EIR's contents.

for the 2021 Regional Plan Table 4.1-1 and Figure 4.1-1 shows Highway 67 as not an Officially Designated or an Eligible State Scenic Highway, however, the Caltrans Scenic Highway System Lists (<https://dot.ca.gov/programs/design/lap-landscape-architecture-and-community-livability/lap-liv-l-scenic-highways>) notes Highway 67 as an Eligible State Scenic Highway and the EIR needs to be revised to show Highway 67 as an Eligible State Scenic Highway.

As a part of the San Diego Forward Plan and the 5 Big Moves Plan, SANDAG established the SR-67 corridor as a Comprehensive Multimodal Corridor Plan (CMCP) calling for a multimodal road along the SR-67 ([https://www.sdforward.com/docs/default-source/default-document-library/appendix-june-5-2020.pdf?sfvrsn=891afe65\\_4](https://www.sdforward.com/docs/default-source/default-document-library/appendix-june-5-2020.pdf?sfvrsn=891afe65_4)). As stated on p. 6-2 of the 2050 RTP, “Our region has consistently supported a multimodal approach to transportation that looks at the overall system and improvements that benefit all modes, rather than prioritizing one over the other. This approach gives all of the transportation system users choices traveling within and through the region.” Further, “A well designed and thoughtfully integrated multimodal transportation system will give people choices, allowing them to select the transportation mode that is best suited for a particular trip. In an area as large and diverse as the San Diego region, this approach is necessary to make the best use of our limited transportation resources.” As discussed, a multi-modal transportation system provides users transportation options and choices and thereby reduces traffic congestion and ghg emissions. Regional multi-use paths have been a great asset to communities across the country. Here in San Diego, the SR-56 Bike Path is separated from the highway and is often used by runners, walkers, and equestrians. In contrast, it is uncommon to see bikers, walkers, and equestrians in a bike route adjacent to a highway (for instance, SR-76). A multi-use path is also kid friendly because of the separation from the highway and kids are often seen on the SR-56 Bike Path and not commonly seen within bike routes adjacent to a Highway. The multi-use path also accommodates a more rural aesthetic and is safer for users. Multi-use paths have become a critical component to the transportation system and are treasured by the communities they are a part of. The addition of the multi-use path along Hwy 67 is more consistent with the goals and policies of the 2050 RTP. We recommend the San Vicente corridor plan provides a separated mixed-use path throughout the full length of the corridor.

Regarding unique geological features or landforms, page 4.7-30 of the EIR for the 2021 Regional Plan notes that the City of Poway General Plan “does not contain policies or regulations specific to unique geological features or landforms.” This is incorrect, the General Plan and Habitat Conservation Plan notes unique geological features and landforms and related policies that include the preservation of rock outcroppings, open space, hillsides, ridgelines, and cultural, historical, and paleontological resources. Please update this in the EIR to be accurate.

Regarding Poway’s General Plan, page 4.11-16 of the EIR for the 2021 Regional Plan notes that the City of Poway Comprehensive Plan was adopted November 1991 and that the Housing Element update is in the process of being updated. Please update the EIR as follows: “Poway General Plan November 1991 (Transportation Element updated March 2010; Housing Element updated August 2021; Public Safety Element being updated as of October 2021).”

Lastly, during the workshop portion for the Draft 2021 Regional Plan, workshops were provide by area (North, East, Central, etc.). Based on the mapped areas shown, Poway residents and community stakeholders were not represented as a part of any region and that outreach with appropriate comment period should be provided prior to moving forward with Draft. I'd be happy to assist you with what an appropriate outreach should be.

Thank you for considering our comments. Please feel free to reach out to me with any questions.

Thank you,

**David De Vries, AICP**  
 City Planner  
 Development Services  
 City of Poway | 13325 Civic Center Drive | Poway, CA 92064  
 Phone (858) 668-4604 | Fax (858) 668-1211  
[ddevries@poway.org](mailto:ddevries@poway.org)

**RESPONSE TO COMMENT 26-3**

Table 4.7-4 in the Final EIR has been updated to reflect correct notes in the General Plan and Habitat Conservation Plan as provided in the comment.

**RESPONSE TO COMMENT 26-4**

Table 4.11-5 in the Final EIR has been updated to reflect the General Plan element updates as provided in the comment.

**RESPONSE TO COMMENT 26-5**

This comment addresses the proposed Plan public outreach process, and is not related to the adequacy of the Draft EIR.

To support the development of the proposed Plan, SANDAG implemented a comprehensive public outreach and involvement program consistent with State and federal requirements. Early in the planning process, SANDAG developed a Public Involvement Plan (PIP) to guide the public outreach program, which was updated in mid-2019. The PIP identifies public engagement techniques to involve the public and collect input for the proposed Plan, including public workshops, social media, visualizations, and other means. It describes how to connect with hard to reach communities such as tribal nations and low-income and minority populations. A detailed description of the PIP can be found in Appendix G of the proposed Plan. As part of outreach on the Draft Plan, a virtual open house was held on June 16, 2021, entitled “County Unincorporated,” which included connections to adjacent cities, including Poway.

There will be a further opportunity for public participation on December 10, 2021, at the SANDAG Board of Directors meeting discussing adoption of the proposed Plan and certification of the EIR



**From:** David De Vries <DDeVries@poway.org>  
**Sent:** Thursday, August 5, 2021 10:34 AM  
**To:** San Diego Association of Governments - San Diego Association of Governments (<sdforward@sandag.org>  
 <sdforward@sandag.org>  
**Cc:** Bob Manis <BManis@poway.org>  
**Subject:** 2021 Regional Plan Comments - City of Poway

Thank you for allowing us to submit comments on the Draft 2021 Regional Plan.

Regarding Scripps Poway Parkway, the City of Poway would like to see vehicle, bike, pedestrian and transit infrastructure improvements and connections to be added from the Highway 67 through Scripps Poway Parkway to the I-15 Freeway. I have spoken to several property and business owners within the South Poway Business Park (SPBP) including Geico and parking is a constant issue. There is currently no public transit route into the SPBP. Having public transit, bike, pedestrian and highway/road improvements/connections providing better more efficient access to the SPBP is essential for future employment growth in the area. Many workers in the Poway area live in Ramona and East County and this is a vital connection for the City and the Region. SANDAG has also identified Scripps Poway as a Tier 3 employment center in their draft Employment Center analysis. Construction is also underway to add thousands of more employees in the SPBP. To be clear, we are recommending that Scripps Poway Parkway become a critical connection and a multimodal corridor ([https://www.sandag.org/uploads/publicationid/publicationid\\_4720\\_28341.pdf](https://www.sandag.org/uploads/publicationid/publicationid_4720_28341.pdf)).

Regarding the Hwy 67, please note that the City of Poway's General Plan Transportation Element includes a multi-use path on the west side of SR-67 (reference p. 3 <http://docs.poway.org/web/Link/0/doc/50446/Electronic.aspx>). This multi-use path would include a separated two-way bike path and a fenced DG equestrian trail. The multi-use path provides a critical and safe pathway for hikers, bikers, runners, walkers, children, and equestrians. A multi-use path also creates a necessary loop between the City's Iron Mountain trailhead and other destinations (e.g., Mt. Woodson, Lake Poway) which is also a goal within the Transportation Element. We recommend the San Vicente corridor plan is consistent with the City's plans.

State Route 67 is also designated as a scenic roadway by the Poway General Plan. As a part of the General Plan requirements, a 50-foot wide landscape open space easement is required from adjacent property owners from the ultimate right-of-way line along State Route 67 when development is proposed. This easement shall be landscaped and modified as needed to enhance the scenic quality of the area as discussed in the General Plan Transportation Element Policy B – Scenic Roadways. Providing scenic roadway elements to the design will also help the corridor be more compatible with surrounding open space. To contribute to the General Plan goals, we would suggest that the right-of-way incorporate design elements consistent with a scenic roadway (e.g., naturalized decorative solid walls, native landscaped medians and shoulders, additional landscape areas and trees where feasible, earthen berms).

As a part of the San Diego Forward Plan and the 5 Big Moves Plan, SANDAG established the SR-67 corridor as a Comprehensive Multimodal Corridor Plan (CMCP) calling for a multimodal road along the SR-67 ([https://www.sdforward.com/docs/default-source/default-document-library/agenda-june-5-2020.pdf?sfvrsn=891afe65\\_4](https://www.sdforward.com/docs/default-source/default-document-library/agenda-june-5-2020.pdf?sfvrsn=891afe65_4)). As stated on p. 6-2 of the 2050 RTP, "Our region has consistently supported a multimodal approach to transportation that looks at the overall system and improvements that benefit all modes, rather than prioritizing one over the other. This approach gives all of the transportation system users choices traveling within and through the region." Further, "A well designed and thoughtfully integrated multimodal transportation system will give people choices, allowing them to select the transportation mode that is best suited for a particular trip. In an area as large and diverse as the San Diego region, this approach is necessary to make the best use of our limited transportation resources." As discussed, a multi-modal transportation system provides users transportation options and choices and thereby reduces traffic congestion and ghg emissions. Regional multi-use paths have been a great asset to communities across the country. Here in San Diego, the SR-56 Bike Path is separated from the highway and is often used by runners, walkers, and equestrians. In contrast, it is uncommon to see bikers, walkers, and equestrians in a bike route adjacent to a highway (for instance, SR-76). A multi-use path is also kid friendly because of the separation from the highway and kids are often seen on the SR-56 Bike Path and not commonly seen within bike routes adjacent to a

**RESPONSE TO COMMENT 26-6**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. See Appendix P.2 for the responses to comments on the proposed Plan. The San Vicente CMCP effort is currently underway. The CMCP will include a suite of solutions for consideration in future planning, implementation, and improvement activities along the corridor, including Highway 67 connections with Poway Road and Scripps Poway Road. The CMCP will include active transportation, clean transportation, transit, resilience and environment, ROW and utilities, equity, and evacuation considerations. The CMCP stakeholder working group includes representation from the City of Poway, which is intended to integrate jurisdictional priorities into the suite of solutions within the boundaries of the CMCP planning area.

Your comment has been forwarded to San Diego Metropolitan Transit System (MTS).

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

Please see responses L124 through L128 in Appendix P.2.

26-6

26-6  
cont.

Highway. The multi-use path also accommodates a more rural aesthetic and is safer for users. Multi-use paths have become a critical component to the transportation system and are treasured by the communities they are a part of. The addition of the multi-use path along Hwy 67 is more consistent with the goals and policies of the 2050 RTP. We recommend the San Vicente corridor plan provides a separated mixed-use path throughout the full length of the corridor.

Lastly, during the workshop portion for the Draft 2021 Regional Plan, workshops were provide by area (North, East, Central, etc.). Based on the mapped areas shown, Poway residents and community stakeholders were not represented as a part of any region and that outreach with appropriate comment period should be provided prior to moving forward with Draft. I'd be happy to assist you with what an appropriate outreach should be.

Thank you for considering our comments. Please feel free to reach out to me with any questions.

Thank you,

**David De Vries, AICP**  
City Planner  
Development Services  
City of Poway | 13325 Civic Center Drive | Poway, CA 92064  
Phone (858) 668-4604 | Fax (858) 668-1211  
[ddevries@poway.org](mailto:ddevries@poway.org)

**COMMENT LETTER 27: CITY OF SAN DIEGO**



Comment Letter 27

October 11, 2021

SANDAG Regional Plan EIR  
C/O Kirsten Uchitel  
401 B Street, Suite 800  
San Diego, CA 92101

**Subject: City of San Diego Comments on the Draft Environmental Impact Report for San Diego Forward: The 2021 Regional Plan**

Dear Ms. Uchitel:

The City of San Diego (City) Planning Department has received the Draft Environmental Impact Report (EIR) for San Diego Forward: The 2021 Regional Plan (2021 Regional Plan) prepared by the San Diego Association of Governments (SANDAG) and distributed it to applicable City departments for review. The City has reviewed the Draft EIR and appreciates this opportunity to provide comments to SANDAG.

27-1

The 2021 Regional Plan represents a major step forward in reducing vehicle miles traveled by single occupant vehicles and greenhouse gas (GHG) emissions in the region by incorporating five transformational strategies which will be critical to enabling the City to implement its Climate Action Plan. The City applauds SANDAG's commitment to making infrastructure and technological investments in the mobility system with a greater emphasis on transit, bicycling, and walking as well as innovative and bold strategies to manage demand on regional roadways prioritizing safety and aligning with the City's commitments to Vision Zero. The City's General Plan is consistent with the 2021 Regional Plan as both focus development within vibrant mixed-use centers served by high frequency transit, and the City supports the 2021 Regional Plan's intent to preserve open space from non-sustainable development. The City Planning Department looks forward to closely working with SANDAG to implement the strategies described in the 2021 Regional Plan.

In response to the request for public comment, the City has the following comments on the Draft EIR for your consideration.

• • •

27-2

**MOBILITY DEPARTMENT – EMANUEL ALFORJA, ASSOCIATE TRAFFIC ENGINEER – [EALFORJA@SANDIEGO.GOV](mailto:EALFORJA@SANDIEGO.GOV), (619) 446-5372**

In chapter 4.16, Transportation, please consider the following edits and comments:

9485 Aero Drive, MS 413  
San Diego, CA 92123  
[sandiego.gov/planning](http://sandiego.gov/planning)

T (619) 235-5200  
[sandiego.gov](http://sandiego.gov)

**RESPONSE TO COMMENT 27-1**

Thank you for your comments and consideration of the proposed Plan.

**RESPONSE TO COMMENT 27-2**

Table 4.16-4 has been revised to reflect this comment and now shows 20.9 Class IV lane miles under year 2020 conditions.

Table note #2 for Tables 4.16-5 through 4.16-16 has been updated to read "Mode Share" instead of "More Share."



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- 27-2 cont. • **Table 4.16-4:** shows a decrease in class IV mileage from 20 to 13 between 2016 and 2020. Per coordination with SANDAG staff it is understood that this was due to a misclassification of some facilities and will be corrected.
  - Mode Share typo in footnote 1 “more share”.
- 27-3 • **Table 4.16-1 Existing Roadway Facilities:** it appears State Highways may be mislabeled in this table and should be tollways. This causes inconsistencies in subsequent tables Roadway Network Analysis for years 2025, 2035 and 2050.
- 27-4 • **Table 4.16-4 Existing Bicycle Facilities in the Region:** It is understood that the mileage was extracted from the transportation network used in ABM 2+, recommend additional clarification on how the mileage is reported from the ABM (i.e. is it centerline mileage, lane mileage, etc.)
  - Recommend disaggregating Class IV Cycle Track into one-way cycle track and two-way cycle track mileages.
- 27-5 • **Pg. 4.16-13 Pedestrian Facilities:** The Draft EIR states, “It should be noted that trail facilities are also considered part of the pedestrian network.” The document should state if these facilities would or would not be ADA compliant either partially or wholly.
- 27-6 • **Table 4.16-9 Transit System Analysis – Year 2035:** Please include a footnote on how Miles of Transit Service is generally calculated.
- 27-7 • **Table 4.16-14 Roadway Network Analysis – Year 2050:** Please clarify the cause of the significant decrease in Tollway mileage in 2050 when previous analysis years showed increases.
- 27-8 • **Page 4.16-47:** Typo in bottom paragraph states, “the proposed Plan would reduce the regional VMT per capita by 7.8%...” this should be “7.2%” per Table 4.16-7.
- 27-9 • **Alternative Analysis:** SANDAG has identified Alternative 3 as the environmentally superior alternative. Specifically, for Transportation, VMT is reduced more than the proposed plan. SANDAG should evaluate and analyze the features that reduce VMT in Alternative 3 for feasibility in inclusion on the proposed plan as a project feature or further mitigation for the project, such as subsidized transit fares and microtransit.

PLANNING DEPARTMENT – MYRA HERRMANN, SENIOR PLANNER –  
[MHERRMANN@SANDIEGO.GOV](mailto:MHERRMANN@SANDIEGO.GOV), (619) 446-5372

In chapter 4.5 Cultural Resources, please consider the following edits and comments:

- 27-10 • **Pg 4.5-24:** This paragraph requires a minor edit which should be corrected in the Final EIR as shown in underline below:
  - **2035 Conclusion:** Implementation of the proposed Plan would result in regional growth and land use change and transportation network improvements and programs that would cause a substantial adverse change in the significance of a historical resource or unique archaeological resource. Therefore, this impact (CULT-1) in between 2026 and 2035 is significant.
- 27-11 • **Pg 4.5-28:** Recommend that the following language be added at the end of the second bullet point in Mitigation Measure CULT-1.b to include the provision for consultation with local government agency qualified staff. This is especially important for local

### RESPONSE TO COMMENT 27-3

Table 4.16-1 has been updated to reflect this comment.

### RESPONSE TO COMMENT 27-4

Tables 4.16-4, 4.16-7, 4.16-11, and 4.16-15 have been updated to clarify that the total miles of bicycle facilities reported in the table are the total centerline miles.

The Class IV Cycle Track improvements contained within the proposed Plan are still at the higher level planning stages. Therefore, the form of cycle track (one-way or two-way) has not yet been determined for any of the identified improvements. This level of analysis will need to be conducted at the individual project level, during the design process. As such, this level of information cannot be provided at this time.

Please note that this information can be provided for the existing facilities outlined in Table 4.16-1; however, to maintain consistency with Tables 4.16-7, 4.16-11, and 4.16-15 of the Draft EIR, the same level of facility summary is maintained throughout all tables.

### RESPONSE TO COMMENT 27-5

All trail facilities included within the proposed Plan will be designed and constructed based on the trail design standards of the Member Jurisdiction in which they are located. The trail design standards for each Member Jurisdiction should incorporate all relevant ADA standards, thereby resulting in ADA compliant trails. Please note that the United States Access Board has identified four Conditional Exceptions for when ADA standards do not need to be applied to trail facilities, as identified in the *Accessibility Standards for Federal Outdoor Developed Areas* (May 2014). The four exceptions are as follows:

- Compliance is not practicable due to terrain.
- Compliance cannot be accomplished with the prevailing construction practices.
- Compliance would fundamentally alter the function or purpose of the facility or the setting.
- Compliance is limited or precluded by any of the following laws, or by decisions or opinions issued or agreements executed pursuant to any of the following laws:
  - Endangered Species Act (16 USC 1531 et seq.)
  - National Environmental Policy Act (42 USC 4321 et seq.)
  - National Historic Preservation Act (16 USC 470 et seq.)

- Wilderness Act (16 USC 1131 et seq.)
- Other federal, State, or local law, the purpose of which is to preserve threatened or endangered species; the environment; or archaeological, cultural, historical, or other significant natural features

Further detail is provided through the following link:

<https://www.access-board.gov/files/aba/guides/outdoor-guide.pdf>

Because the trail facilities included within the proposed Plan are only conceptual at this time, and have not yet been designed, it is not known if the proposed trail facilities, or a portion of the trail facilities, will need to utilize the ADA exceptions outlined above. Individual trail facilities will be required to go through the CEQA review process, at a project level, and will be subject to design review through the Member Jurisdiction prior to their construction. The level of ADA compliance each trail facility will be able to achieve will be identified, reviewed, and disclosed during this process. This information has been summarized as a footnote on page 4.16-13 of the EIR.

**RESPONSE TO COMMENT 27-6**

A table note has been added to Table 4.16-9 to describe the methodology used to calculate Miles of Transit.

**RESPONSE TO COMMENT 27-7**

The decrease in tollway mileage under the Year 2050 conditions is due to the expiration of the SR 125 tollway franchise agreement, which ends in 2042. After Year 2042 SR 125, south of SR 54, will be reverted to Caltrans control and the tolls will no longer be issued to the public.

**RESPONSE TO COMMENT 27-8**

The bottom paragraph of page 4.16-50 has been revised to correct 7.8% to 6.8%..

**RESPONSE TO COMMENT 27-9**

As the Draft EIR explains (page 6-1), SANDAG considered public input provided during the EIR scoping process, and used this input develop the reasonable range of alternatives. Public input requested alternatives that reduce GHG emissions, air quality impacts, and VMT. The alternatives selected for detailed consideration incorporate many of the

major transportation investments and policy options that commenters suggested.

Regarding reduction of fares, mitigation measure GHG-5f provides that during project-level planning, design, and CEQA review of development projects, responsible agencies can and should implement measures including “[s]ubsidizing transit service expansion by increasing service hours, decreasing fares, and adding additional transit fleets” (Draft EIR pages 4.8-49 and 4.8-50). In addition, one of the Implementation Actions listed in Appendix B of the proposed Plan is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a 1-year pilot that may provide free fares for youth under age 19. See Master Response 1 for further information on the role of subsidized fares and microtransit as an alternative.

**RESPONSE TO COMMENT 27-10**

The date has been corrected on page 4.5-24 of the EIR as requested.

**RESPONSE TO COMMENT 27-11**

Mitigation measure CULT-1b on page 4.5-28 of the EIR has been updated to include the requested language that acknowledges consultation/collaboration with local agencies that have qualified cultural resources staff:

...and/or when applicable, qualified local agency staff with technical expertise in archaeological and cultural resources management.

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- agencies that have established Historical Resources Regulations and Guidelines and qualified staff that assist other planning staff with such issues during the ministerial or discretionary review process, as well as during grading and construction implementation:
- Should an archaeological deposit and/or feature be encountered during construction activities that is determined to be a historical resource or unique archaeological resource by a qualified archaeologist, stop ground-disturbing activities and prepare and/or implement an Archaeological Data Recovery Program (ADRP) in consultation with SHPO and/or when applicable, qualified local agency staff with technical expertise in archaeological and cultural resources management.
- In chapter 4.17 Tribal Cultural Resources, please consider the following edits and comments:
- **Pg 4.17-8:** Please make the following revisions in the 2<sup>nd</sup> paragraph, lines 2 & 3 as follows: University ~~Center~~.
  - **Pg 4.17-10:** In the 2<sup>nd</sup> to last paragraph on the page, please insert a “hyphen” between Midway\_Pacific Highway.
  - **Pg 4.17-12:** In the last paragraph on the page, please insert “San Diego” after “Downtown”, insert a “hyphen” between Midway\_Pacific Highway, add “Mesa” after the word “Otay” and delete “City” from the 3<sup>rd</sup> line. These should be corrected throughout the chapter.
  - **Pg 4.17-13:** In the 2<sup>nd</sup> paragraph, 3<sup>rd</sup> line, insert “San Diego” after “Downtown” and add “Mesa” after the word “Otay” in the 4<sup>th</sup> line. These should be corrected throughout the chapter to clarify the correct Downtown and the correct “Otay” community in the region. Please also insert a “hyphen” between Midway\_Pacific Highway.
  - **Pg 4.17-15:** In TCR-1a, line 8, remove the “period” after the word “should” and replace with a “comma” to reconnect the two sentences. The last line in the last paragraph should be revised as shown: “...mitigation measures as set forth...”
  - **Pg 4.17-16:** Under standard mitigation measures for TCRs number “3”, the word “Record” should be inserted before “Permanent”. Recommend that Mitigation Measure 4. Protecting the resource., should be expanded to describe how the resource would/could be protected and/or include the following statement “as agreed upon during the tribal consultation process”
  - **Pg 4.17-16:** TCR-1b, 2<sup>nd</sup> bullet, line 2 should be revised to read the qualified archaeologist and or tribal monitor of an archaeologist is not present, shall direct the contractor to temporarily divert all stop ground-disturbing activities in the area of the discovery and prepare and implement a mitigation plan consistent with standard mitigation measures set forth in PRC Section 21084.3(b), in cooperation with a qualified archaeologist (if applicable) and in consultation with Native American tribes.
  - **Pg 4.17-16:** TCR-1b, 3<sup>rd</sup> bullet should be revised as follows: The qualified archaeologist shall be responsible for ensuring that all artifacts integrate curation of archaeological artifacts and associated records associated with the survey, testing,

**RESPONSE TO COMMENT 27-12**

The community name “University Center” is correct; therefore, no change has been made.

**RESPONSE TO COMMENT 27-13**

Midway Pacific” has been changed to “Midway-Pacific” on page 4.17-10 of the EIR as requested.

**RESPONSE TO COMMENT 27-14**

The community name “Downtown” is correct and adding “San Diego” after “downtown” is not necessary; therefore, no change has been made. The terms “Otay,” “Otay Mesa,” and “East Otay Mesa” have been reviewed and corrected where applicable. “Midway Pacific” has been changed to “Midway-Pacific” as requested on page 4.17-12 and throughout the section.

**RESPONSE TO COMMENT 27-15**

The community name “Downtown” is correct and adding “San Diego” after “downtown” is not necessary; therefore, no change has been made. The terms “Otay,” “Otay Mesa,” and “East Otay Mesa” have been reviewed and corrected where applicable. “Midway Pacific” has been changed to “Midway-Pacific” as requested throughout the section.

**RESPONSE TO COMMENT 27-16**

The minor corrections on page 4.17-15 of the EIR have been made as requested.

**RESPONSE TO COMMENT 27-17**

The comment aligns with the intent of the mitigation measure. The minor corrections have been made as requested. Mitigation measure TCR-1a has been revised on page 4.17-16 of the EIR to state:

3. Permanent Record permanent conservation easements or other interests in real property, with culturally appropriate management criteria for the purposes of preserving or utilizing the resources or places.
4. Protecting the resource as agreed upon during the tribal consultation process.

**RESPONSE TO COMMENT 27-18**

The comment aligns with the intent of the mitigation measure. Mitigation measure TCR-1b has been revised on page 4.17-16 to

incorporate the comments in order to clarify the process and intent of the measure. The revisions are as follows:

- Should a previously undiscovered cultural resource be encountered during construction activities that is determined to be a TCR by the CEQA lead agency in consultation with Native American tribes, the qualified archaeologist, or tribal monitor if an archaeologist is not present, shall direct the contractor to temporarily divert all stop ground-disturbing activities in the area of the discovery and prepare and implement a mitigation plan consistent with standard mitigation measures set forth in PRC Section 21084.3(b), ~~in cooperation with a qualified archaeologist (if applicable) and~~ in consultation with Native American tribes.

#### **RESPONSE TO COMMENT 27-19**

The comment aligns with the intent of the mitigation measure.

Mitigation measure TCR-1b has been revised on page 4.17-16 to

incorporate the comments in order to clarify the process and intent of the measure. The revisions are as follows:

- ~~Integrate curation of archaeological~~ The qualified archaeologist shall be responsible for ensuring that all artifacts and ~~associated~~ records associated with the survey, testing, data recovery and/or monitoring of future projects are permanently curated with an appropriate ~~in a~~ regional center focused on the care, management, and use of archaeological collections ~~if the artifacts must be excavated~~. This shall be completed in consultation with the Native American representative and does not include Native American human remains and associated burial items, the disposition of which should be determined in consultation with the designated Most Likely Descendants (MLDs).

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27-19 cont. data recovery and/or monitoring of future projects are permanently curated with an appropriate in-a regional center focused on the care, management, and use of archaeological collections if the artifacts must be excavated. This shall be completed in consultation with the Native American representative. This and does not include Native American human remains and associated burial items, the disposition of which should be determined in consultation with the designated Most Likely Descendants (MLDs).

27-20 • **Pg 4.17-16:** A fourth bullet should be added that requires preparation and submittal of a draft and final monitoring report which describes the results, analysis, and conclusions of all phases of the Monitoring Program, including the provisions for curation and/or repatriation, if applicable, and copies of any signed curation agreements to verify completion of the required monitoring program.

27-21 **STORMWATER DEPARTMENT – MARK G. STEPHENS, ASSOCIATE PLANNER – MGSTEPHENS@SANDIEGO.GOV, (858) 541-4361**

The City Stormwater Department is responsible for operation and maintenance of stormwater facilities located within the public right-of-way and drainage easements dedicated to the City; reducing flood risks; and leading the City's efforts to protect and improve stormwater quality by identifying and abating sources of pollution through public education, employee training, water quality monitoring, pollution source identification, code enforcement, watershed management, and development and implementation of best management practices (BMPs).

27-22 Please consider the following comments:

- **BIO-3, on pages 4.4-95 through 4.4-106, Tables 4.4-13 through 4.4-15:** show forecasted encroachment into wildlife movement corridors and linkages in the Multiple Species Conservation Program (MSCP). Development of transportation projects adjacent to or near MSCP lands has the potential to impact habitat integrity if a project casts a shadow or introduces artificial light or noise. These impacts may limit areas where the City of San Diego is able to successfully establish mitigation sites. Where possible, transportation network improvements should be located and designed in such a way that they minimize any potential impact on habitat integrity in MSCP lands.
- **Page 4.10-15 Under Areas of Special Biological Significance:** correct the last sentence identifying the Scripps Institution of Oceanography.
- **Under San Diego Regional Municipal Stormwater Permit on page 4.10-34,** change the reference to "County of San Diego Regional Airport Authority" to "San Diego County Regional Airport Authority," since the organization isn't part of the County of San Diego government.
- **Page 4.10-22:** please confirm the following statement is correct, or make any revisions needed to ensure its accuracy: "No areas in the San Diego region are in a levee flood protection zone." Corridor, light rail, and bikeway improvements are mentioned

**RESPONSE TO COMMENT 27-20**

The comment aligns with the intent of the mitigation measure. A fourth bullet has been added to mitigation measure TCR-1b on page 4.17-16 that requires the preparation and submittal of a draft and final monitoring report, per the comment. This addition will ensure and signify the completion of the monitoring program described in mitigation measure TCR-1b. The added language is as follows:

- Upon completion of all ground-disturbing activity, the qualified archaeologist shall prepare and submit a draft and final monitoring report to the CEQA lead agency that describes the results, analysis, and conclusions of all phases of the monitoring program, including the provisions for curation and/or repatriation, if applicable, and copies of any signed curation agreements to verify completion of the required monitoring program.

**RESPONSE TO COMMENT 27-21**

Thank you for your comment. The responsibilities of the City's Stormwater Department are understood.

**RESPONSE TO COMMENT 27-22**

nk you for your comment. Figure 4.4-15 has been revised to include the transportation network footprint in the Final EIR.

In regards to development of transportation projects adjacent to or near MSCP lands, direct and indirect impacts from the proposed Plan's land use change and transportation network on the County's adopted MSCP are programmatically addressed under Impact BIO-4 of the EIR. Indirect impacts are assessed qualitatively. Tables 4.4-16 through 4.4-19 quantitatively assess impacts on the County's MSCP Preserve. Consistent with the County's adopted MSCP, the County would be consulted prior to any design of projects that could potentially have an effect on the County's MSCP Preserve. Furthermore, consistent with the EIR, any such projects would be required to be consistent with the County's MSCP, and no impacts on hardline preserve are expected. Should impacts on the MSCP be unavoidable, boundary line adjustments would be required as mitigation for such impacts, pursuant to the County's guidelines and in consultation with the County of San Diego. In addition, please see response to comment USFWS 38-4.

**RESPONSE TO COMMENT 27-23**

"Scripps Institute of Oceanography" has been revised to "Scripps Institution of Oceanography" on page 4.10-15 of the EIR.

**RESPONSE TO COMMENT 27-24**

Text has been revised according to the comment to "~~County of San Diego~~ County Regional Airport Authority" on page 4.10-34 of the EIR.

**RESPONSE TO COMMENT 27-25**

Based on the Department of Water Resource's most recent available data, this statement is correct. No part of the County falls within a levee flood protection zone.



Page 5  
Ms. Kirsten Uchitel  
October 11, 2021

27-25  
cont. throughout the Draft Program EIR at locations that either neighbor or cross a levee along the San Diego River.

• **General Comments:**

- 27-26 ○ As a general comment applicable to 4.10 Hydrology and Water Quality, federally constructed levees along the San Diego River and Tijuana River are regulated by the U.S. Army Corps of Engineers. Improvements that encroach on the levee prism must obtain a Section 408 Permit from the Army Corps. The floodplain is regulated by the Federal Emergency Management Agency (FEMA), and improvements that encroach on the floodplain must obtain approval from the City of San Diego for areas within its jurisdiction to ensure floodplain regulations are met.
- 27-27 ○ Because this Draft Program EIR is a programmatic level document, with many project specifics still under development, please include the City Stormwater Department in future subsequent or tiered project level reviews that could have potential impacts on areas within our purview.
- 27-28 ○ Please note that effective July 1, 2021, the former City of San Diego Transportation and Stormwater Department was reorganized into individual departments, the City Stormwater Department (using the “stormwater” as a single word spelling convention) and the City Transportation Department.

• • •

27-29 Thank you for the opportunity to provide comments on the Draft EIR. Please feel free to contact me directly via email at [RMalone@sandiego.gov](mailto:RMalone@sandiego.gov) or by phone at (619) 446-5371 if there are any questions regarding the contents of this letter.

Sincerely,



Rebecca Malone, AICP, Environmental Policy Program Manager  
Planning Department

RM/ta

cc: Reviewing Departments (via email)  
Review and Comment online file

**RESPONSE TO COMMENT 27-26**

Thank you for your comment. The proposed Plan provides a framework for meeting its stated goals with coordinated land use and transportation planning strategies. Implementation actions related to projects, policies, and programs will confirm SANDAG’s commitment to fully realizing the strategies in the proposed Plan. Individual projects under the proposed Plan are subject to environmental review and will follow applicable laws and regulations, including coordination and permitting requirements of the local jurisdictions within which future development and transportation improvements fall.

**RESPONSE TO COMMENT 27-27**

The EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the proposed Plan include site-specific transportation network improvements and development projects. Many individual transportation projects in the RTP would be implemented by Caltrans and local governments. It is the responsibility of these implementing agencies to include the City Stormwater Department in their reviews. SANDAG will contact the City Stormwater Department for second-tier projects it approves or carries out.

**RESPONSE TO COMMENT 27-28**

Thank you for your comment. It is acknowledged that the former City of San Diego Transportation and Stormwater Department was reorganized into individual departments.

**RESPONSE TO COMMENT 27-29**

Thank you for your comments and consideration of the proposed Plan.



**COMMENT LETTER 28: CITY OF SAN MARCOS**



**RESPONSE TO COMMENT 28-1**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Appendix F of the proposed Plan includes the assumptions used to develop the Series 14 Regional Growth Forecast and the SCS land use pattern. Among other requirements set forth by SB 375, the SCS must "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board." The SCS included in the proposed Plan projects development that would achieve the State GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the Plan.

See below responses to specific comments mentioned in this general comment.

28-1  
cont.

Please find the City's specific comments on these topics below. City staff would be happy to meet with the SANDAG Regional Plan team to discuss these comments in greater detail and to learn more about SANDAG's modeling and funding projections.

**SERIES 14 REGIONAL GROWTH FORECAST MODEL ASSUMPTIONS**

**Land Use Assumptions**

The Regional Plan DEIR states that "Adopted general plan land use assumptions are used as input to develop SANDAG's regional growth forecast. The forecast is based on the most recent planning assumptions, considering local general plans and other factors, as required by SB 375 (Government Code Section 65080(b)(2)(B))" (p. 4.11-16). The City would like to better understand the "other factors" and model inputs that interact with the local general plan land use data.

City staff reviewed SANDAG's Series 14 Regional Growth Forecast GIS data. The forecast for San Marcos reflects a 28% population increase between 2016 (baseline) and 2050 (horizon year) (Table 2-2). The total projected population in 2050 is 120,247 persons. The San Marcos General Plan has capacity for 41,843 units (including existing units), which would support a population of more than 128,000 based on the 2019 average persons per household for San Marcos of 3.06. In theory, the City's general plan can support the projected future population through 2050.

28-2

We recognize that some redistribution of the development capacity may need to occur in the future in order to comply with State mandates related to housing, reduction of greenhouse gas (GHG) emissions and vehicle miles traveled, as well as to meet economic and other goals. For these reasons, the City is currently updating our General Plan. However, the current General Plan should serve as the baseline for land use assumptions in San Marcos for the purposes of the Regional Plan. The Regional Plan appears to redistribute future population within the City in a way that differs from what is in the General Plan. The City would like clarity regarding the land use and population growth assumptions underlying the Regional Plan.

The City recognizes that certain high-level criteria must be input to produce a regional forecast model, and that because of the dynamics between the various inputs, these models do not always produce linear results. We appreciate that apparent inconsistencies and anomalies may appear at a granular (parcel/ MGRA/ TAZ) level that don't necessarily represent the overall patterns generated by the model. However, we felt it was important to review the data at a parcel level throughout the City to understand where the forecast may be inconsistent with existing land use plans and reasonably foreseeable local growth patterns. Numerous or significant inconsistencies could lead to inaccuracy in the overall forecasts.

28-3

Below are several examples of land use or population projections that appear to conflict with the City's General Plan for specific areas, or otherwise seem counterintuitive based on staff's knowledge of local conditions (i.e., "local assumptions"). Overall, the SANDAG Series 14 Growth Forecast reflects future growth

**RESPONSE TO COMMENT 28-2**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Appendix F of the proposed Plan includes the assumptions used to develop the Series 14 Regional Growth Forecast and the SCS land use pattern, which considered local general plans and other factors. Among other requirements set forth by SB 375, the SCS must "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board." The SCS included in the proposed Plan projects development that would achieve the State-mandated GHG emissions reduction target when integrated with the transportation investments, programs, and policies in the Plan by focusing growth and development in Mobility Hub areas. The allocation of housing units to Mobility Hub areas represents general areas projected for future growth, not precise parcel locations, for future housing development or housing unit type. A number of land uses at the parcel level, aggregated up, comprise these general areas. The precise zoning at the parcel level is within local jurisdictions' land use authority.

Priority areas for future housing growth were identified through a scoring process applied to all Master Geographic Reference Areas (MGRAs) in the San Diego region. Each MGRA received a score based on Mobility Hub propensity analysis results and a land use mixing criterion. MGRAs associated with conserved lands or military installations were identified as "constraints" and excluded from the scoring. The Mobility Hub propensity analysis is described in proposed Plan Appendix T: Network Development and Performance, and considered the number of local street intersections per square mile, vehicle miles traveled in 2016, employment counts, population density, and proximity to "activity centers" such as hospitals, schools, airports, hotels, military installations, shopping centers, and universities and colleges. The land use mix score was calculated based on the percentage of MGRA acreage associated with land use types that are complementary to residential uses. In general, higher scored areas are more favorable to future housing development, and parcels without existing capacity that had both eligible land uses and high scores were assigned additional capacity for the purpose of developing the SCS land

use pattern. Within high-scoring MGRAs, SANDAG selected land use codes that could be considered for future residential uses (e.g., low-density office, vacant/undeveloped, arterial commercial, surface parking, hotel/resort, and other public services). Details on this methodology are described in the Series 14 Regional Growth Forecast and SCS Land Use Pattern Subregional Allocation Documentation: <https://sdforwarddata-sandag.hub.arcgis.com/documents/SANDAG::series-14-regional-growth-forecast-and-scs-land-use-pattern-subregional-allocation-oct-2021-draft/about>.

The Regional Plan and its SCS are iterative planning documents that are typically updated every four years to account for new data, analysis, policy, and experience.

### **RESPONSE TO COMMENT 28-3**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Appendix F of the proposed Plan includes the assumptions used to develop the Series 14 Regional Growth Forecast and the SCS land use pattern.

Regarding “areas where Series 14 Growth Forecast Households is higher than local assumption,” SANDAG relied upon local general plans and other factors to allocate housing units to subregional areas. Priority areas for future housing growth were identified through a scoring process applied to all MGRAs in the San Diego region. Each MGRA received a score based on Mobility Hub propensity analysis results and a land use mixing criterion. MGRAs associated with conserved lands or military installations were identified as “constraints” and excluded from the scoring. The Mobility Hub propensity analysis is described in proposed Plan Appendix T: Network Development and Performance, and considered the number of local street intersections per square mile, vehicle miles traveled in 2016, employment counts, population density, and proximity to “activity centers” such as hospitals, schools, airports, hotels, military installations, shopping centers, and universities and colleges. The land use mix score was calculated based on the percentage of MGRA acreage associated with land use types that are complementary to residential uses. In general, higher scored areas are more favorable to future housing development, and parcels without existing capacity that had both eligible land uses and high scores were assigned additional capacity for the purpose of developing the SCS land use pattern. Within high-scoring MGRAs, SANDAG selected land use

codes that could be considered for future residential uses (e.g., low-density office, vacant/undeveloped, arterial commercial, surface parking, hotel/resort, and other public services). Details on this methodology are described in the Series 14 Regional Growth Forecast and SCS Land Use Pattern Subregional Allocation Documentation: <https://sdforwarddata-sandag.hub.arcgis.com/documents/SANDAG::series-14-regional-growth-forecast-and-scs-land-use-pattern-subregional-allocation-oct-2021-draft/about>.

Regarding “areas where Series 14 Growth Forecast Population is lower than local assumptions,” the Series 14 Regional Growth Forecast includes assumptions of housing unit production that results in a subregional forecast that includes population declines or lower population growth in certain areas in the region. These housing assumptions, described in proposed Plan Appendix F, include an increase in the region’s vacancy rate to 4 percent by 2040, an accounting of vacation rentals and second homes as “unoccupiable,” and a decrease in household size from 2.75 persons per household in 2016 to 2.62 persons per household by 2036.

The SCS land use pattern advanced in the proposed Plan focuses growth and development in the Mobility Hub areas, which represent general areas projected for future growth and not precise parcel locations. A number of land uses at the parcel level, aggregated up, comprise these general areas. The precise zoning at the parcel level is within local jurisdictions land use authority.

The Regional Plan and its SCS are iterative planning documents that are typically updated every four years to account for new data, analysis, policy, and experience.

28-3  
cont.

areas roughly consistently with the City's General Plan in key locations (i.e., University District and Creek District Specific Plan Areas). However, the projected changes are tied to parcels in the vicinity but not the same as what is in the City's land use plan. There are some forecasted household or population increases or decreases within individual MGRAs that are directly inconsistent with the City's plan. The City has questions regarding the assumptions and model dynamics that create these apparently random projections.

*Areas where Series 14 Growth Forecast Households is higher than local assumptions (Attachment A)*

- A1. Single-family developments Coronado Hills and Rancho Tesoro (off of Twin Oaks Valley Road south) are accurately forecast to have an increase in households, but why a reduction in population?
- A2. San Marcos Boulevard mixed use shows significant population increases that would not be supported by the levels of development allowed in this land use designation.
- A3. Residential units are assigned to some individual MGRAs with industrial and commercial land uses. These areas are not currently planned for residential units (i.e., off of Las Posas and Armordite). Does the model assume that these areas will redevelop as mixed use?
- A4. Residential units are also assigned to areas designated for passive and recreational open space.

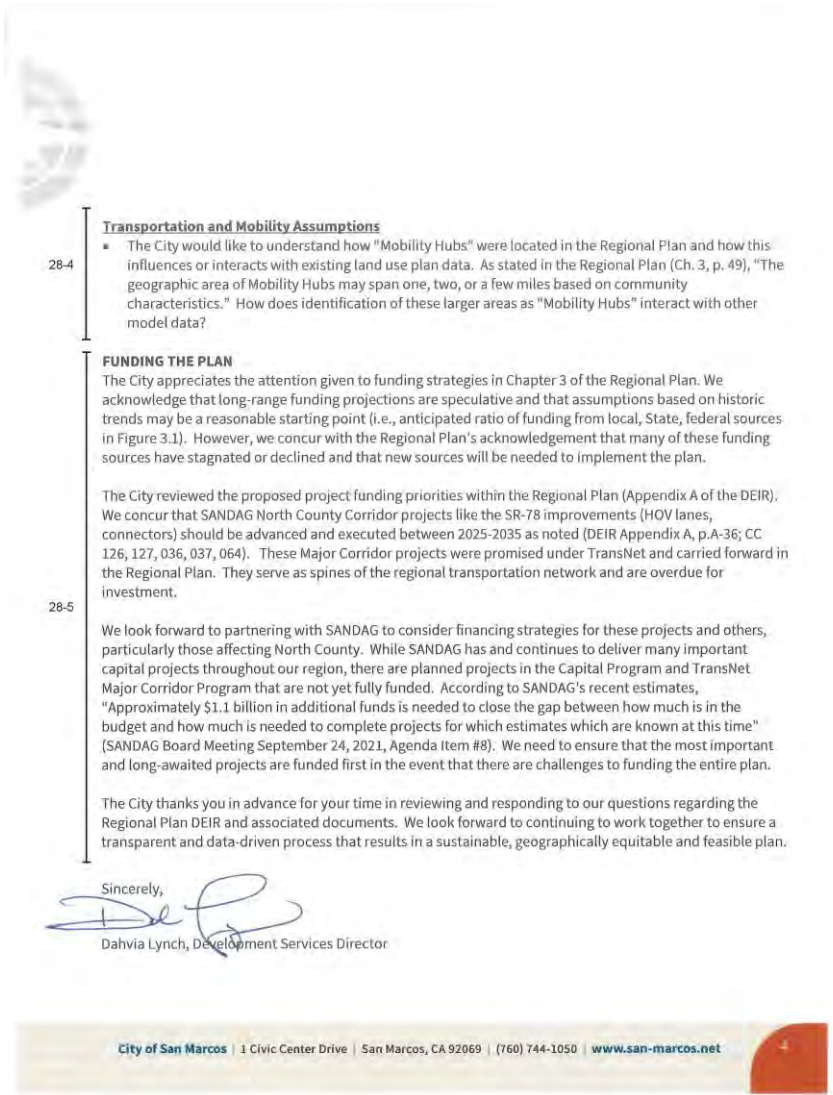
*Areas where Series 14 Growth Forecast Population is lower than local assumptions (see Attachment B)*

- B1. Population estimates for areas of San Marcos currently under development (i.e., Highlands off of northern Las Posas, Rancho Tesoro area off of Twin Oaks Valley Road) and Santa Fe Hills, as well as large developments like San Elijo Hills (over 3,000 units), seems to assume that populations in these and similar suburban areas will decrease. New units are being constructed in some of these areas and families continue to move into existing suburban homes. While future urbanizing centers will draw population from many places, we do not necessarily expect a major shift from suburban areas.

We understand the concept that suburban household size may decrease as children leave the home and parents stay in place through middle age. However, regional trends show that household size has increased in San Marcos over the past twenty years, from 3.03 to 3.06 persons per household (U.S. Census American Community Surveys 2010-2019). Anecdotally, given housing prices and demand for larger homes in quality school districts, it seems that turnover of suburban housing to younger families will occur within the Regional Plan horizon. We also anticipate more multi-generational households as children stay in the home through young adulthood or aging parents move in with their children. Additionally, it seems that new State laws streamlining construction of Accessory Dwelling Units and redevelopment of single-family lots will lead to higher, if not at least sustained, populations in suburban neighborhoods. What is the basis for these assumed population decreases?

Staff speculate that some of these inconsistencies could be due to reliance on an amalgamation of land use data combined with TAZ level data, or traffic and development assumptions generated for private project analyses (whether or not these came to fruition). We look forward to discussing further with SANDAG staff and/or receiving written feedback regarding these questions.





**RESPONSE TO COMMENT 28-4**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. Please see proposed Plan Appendix F, Regional Growth Forecast and SCS Land Use Pattern, for the assumptions used to develop the SCS land use pattern and Appendix T, Network Development and Performance, for information about Mobility Hub network development.

**RESPONSE TO COMMENT 28-5**

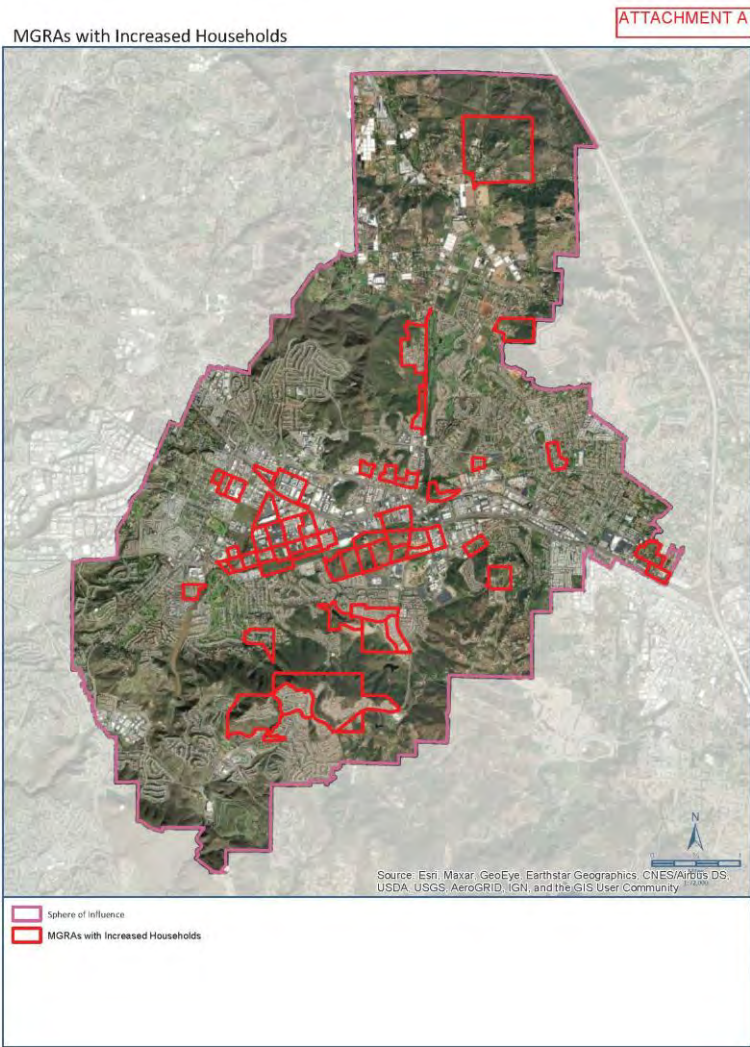
This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.



CC: Jack Griffin, City Manager  
Isaac Etchamendy, City Engineer  
Joseph Farace, Planning Manager

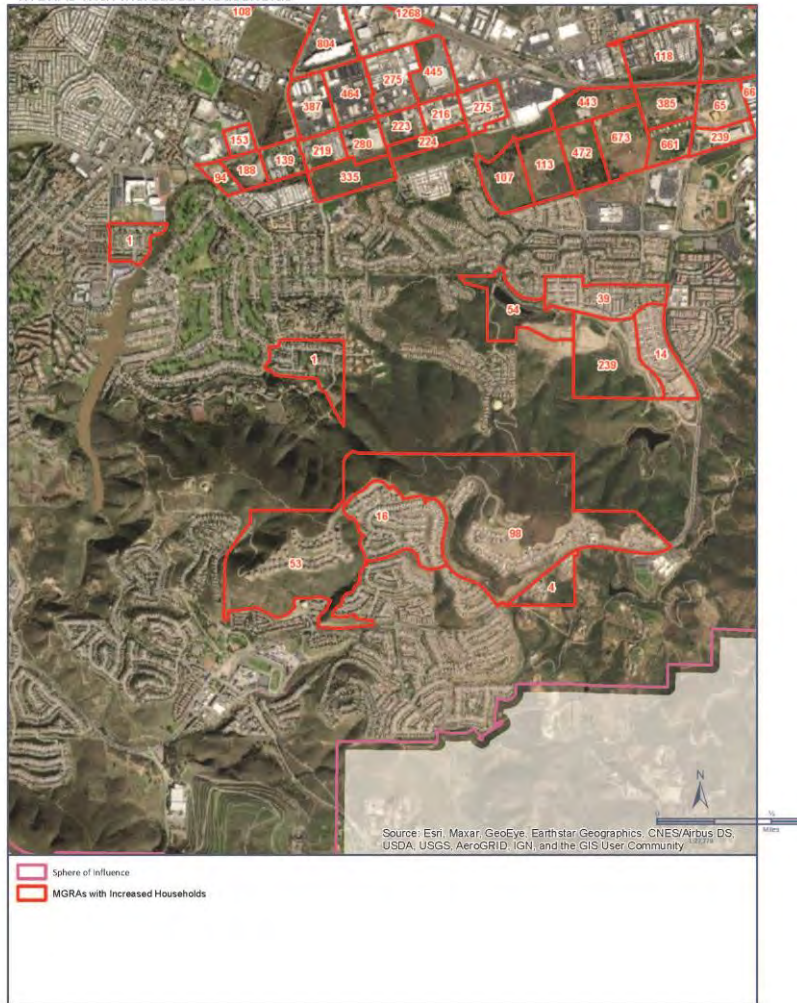
Attachments:

- Attachment A- MGRAs with Increased Households
- Attachment B- Change in Population

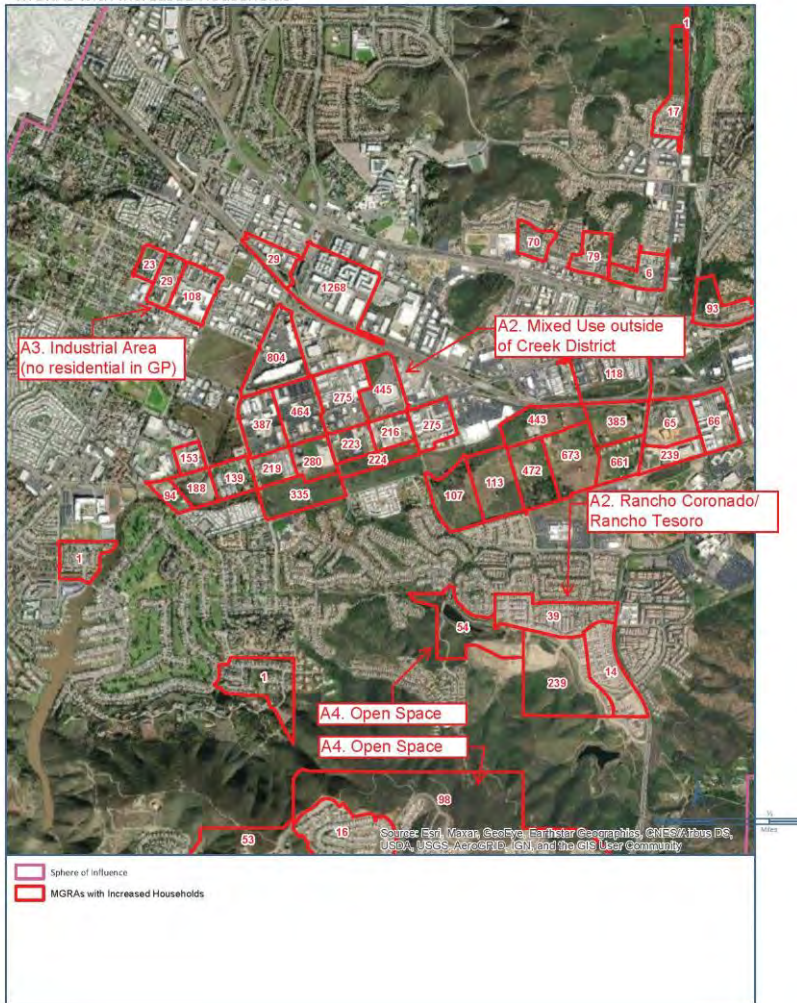




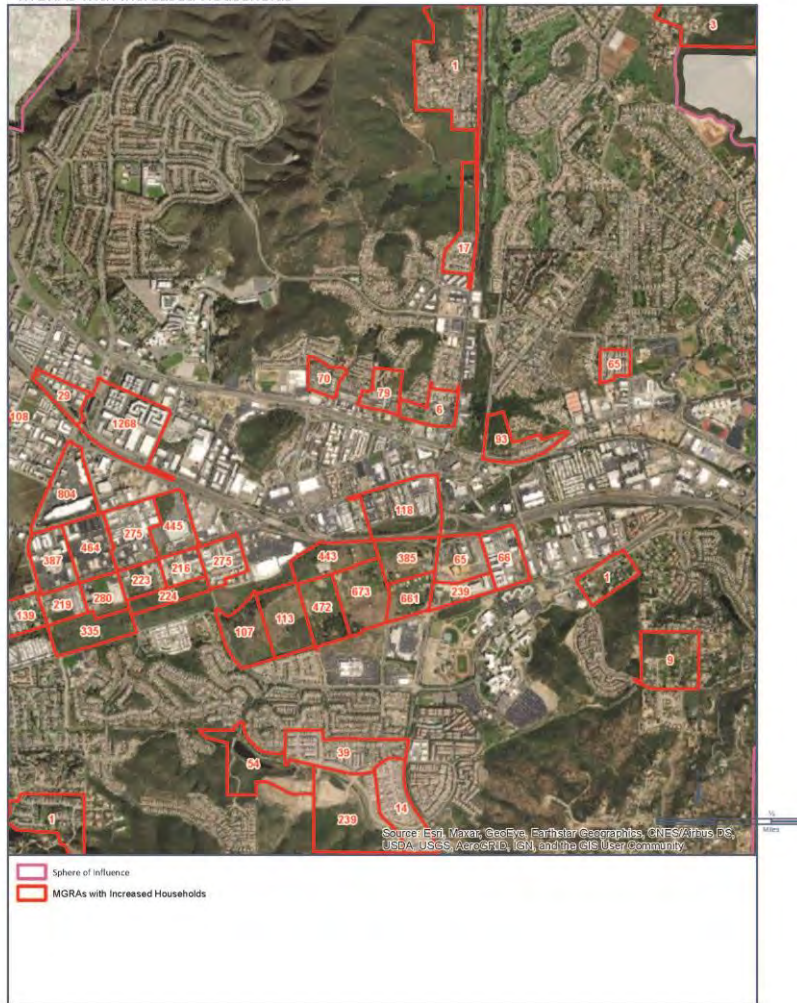
MGRAs with Increased Households



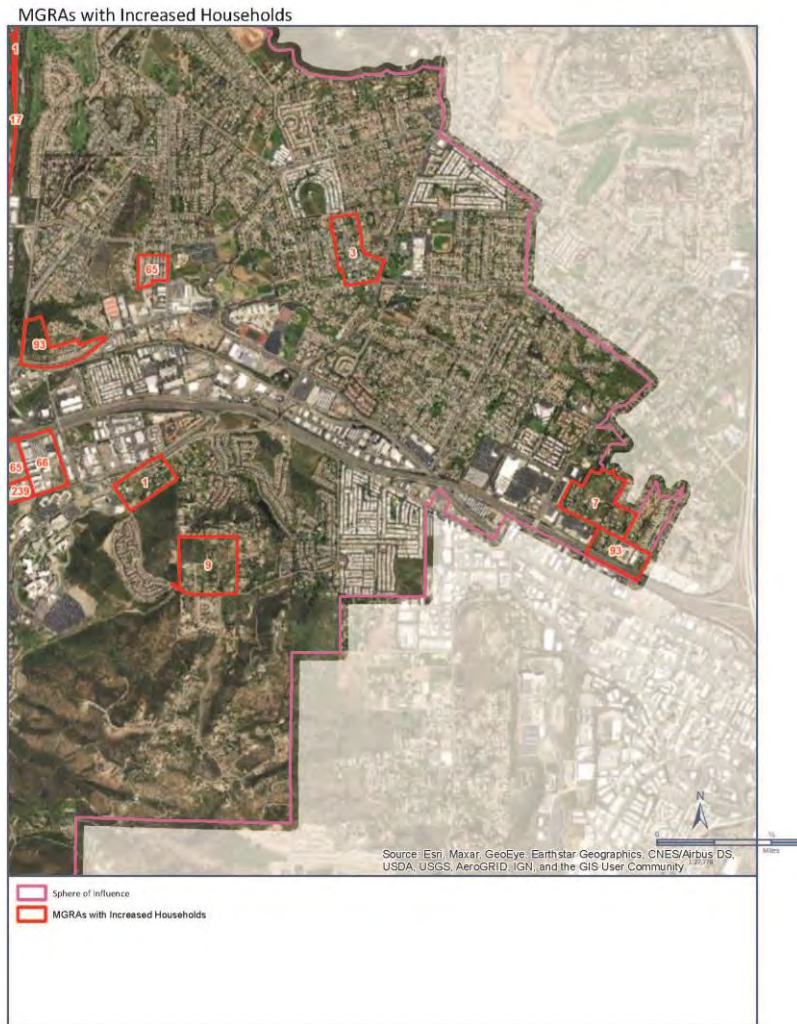
MGRAs with Increased Households



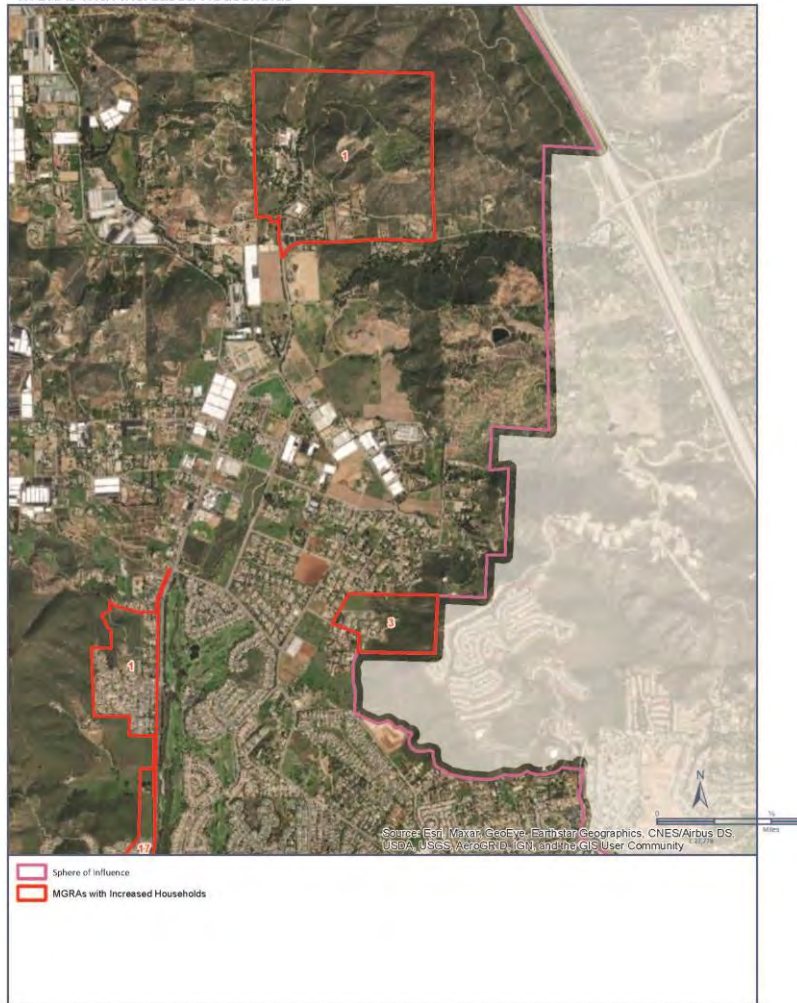
MGRAs with Increased Households

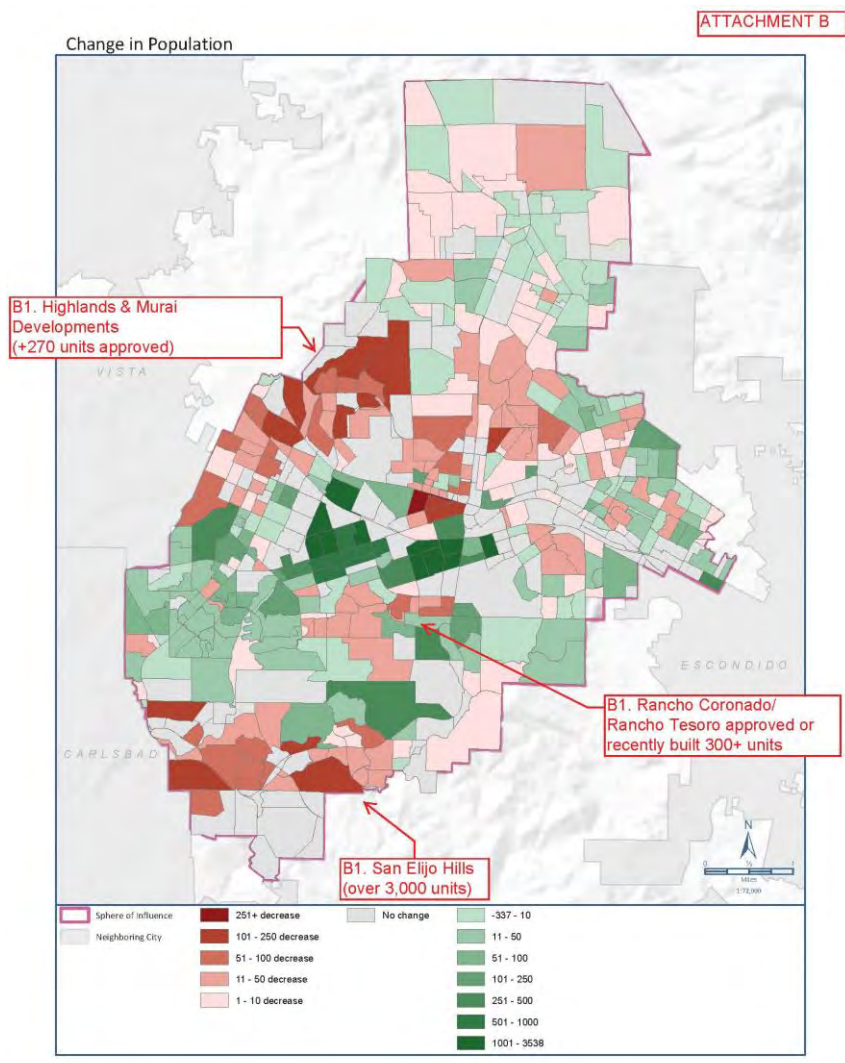






MGRAs with Increased Households





**COMMENT LETTER 29: SOUTHERN CALIFORNIA TRIBAL CHAIRMEN'S ASSOCIATION**

Comment Letter 29

**From:** Erik De Haro <edeharo@sctca.net>  
**Sent:** Wednesday, September 8, 2021 3:38:04 PM (UTC+00:00) Monrovia, Reykjavik  
**To:** RegionalPlanEIR <RegionalPlanEIR@sandag.org>  
**Subject:** Re: online comments

**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

29-1 This new plan seems to be incredibly beneficial for the county as a whole. It not only seems appropriate but long overdue, particularly because it will reduce noise pollution, greenhouse emissions and traffic collisions.

--

Thank you

*Erik De Haro  
Case Worker  
SCTCA Tribal TANF*

350 E Grand Avenue Suite 100  
Escondido, CA. 92025  
(760)746-0901 ext. 109  
(760)747-4560 fax  
[edeharo@sctca.net](mailto:edeharo@sctca.net)

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This information is private and confidential and intended solely for the person or persons addressed herein. If you have received this communication in error, immediately notify the sender and destroy/delete any copies of this transmission. Thank you for your compliance.

**RESPONSE TO COMMENT 29-1**

Thank you for your support and for participating in the environmental review process. Please continue to follow along in this process by visiting SDForward.com.



**COMMENT LETTER 30: SAN DIEGO COUNTY AIR POLLUTION CONTROL DISTRICT**

Comment Letter 30



October 11, 2021

Hasan Ikhrata  
San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92101

Re: San Diego Forward 2021 Regional Plan Draft Environmental Impact Report Comments

Dear Mr. Ikhrata:

The San Diego County Air Pollution Control District (APCD) would like to commend the time and effort invested in the creation of the Draft 2021 San Diego Forward Regional Plan and accompanying environmental document. Together, APCD and SANDAG share common goals, which include improving air quality throughout San Diego County in an equitable manner, supporting the transition to a zero-emission transportation system, and supporting alternatives to single occupancy vehicles. APCD believes that the Draft 2021 Regional Plan will move San Diego County in that direction and result in San Diego County being a leader in innovative transportation planning.

30-1

APCD also appreciates our collaborative relationship with SANDAG in other regional planning efforts that support the Draft 2021 Regional Plan and further improve air quality. Such efforts include participation in the Community Air Protection Program (AB 617) Portside Community Steering Committee, the San Diego County Incentive Project to install electric vehicle charging stations (CALeVIP), and the recently launched "Accelerate to Zero Emissions" collaborative to encourage zero-emission vehicles. Our strong collaboration in transportation conformity will also ensure that on-road motor vehicle ozone precursor emissions (VOC and NOx) will be reduced in San Diego County by 30% by 2026, and 40% by 2032, compared to 2020 levels. APCD looks forward to continuing these efforts and others with SANDAG well into the future.

Thank you for the opportunity to provide feedback on the Draft 2021 Regional Plan Draft EIR. APCD staff has reviewed the document and enclosed you will find our comments for your consideration.

Once again, we appreciate your partnership in ensuring that we all work collectively to improve the air quality in the region.

Respectfully,

Nora Vargas, Chair of the Governing Board  
San Diego County Air Pollution Control District

**Paula Forbis**  
Paula Forbis, Interim Air Pollution Control Officer  
San Diego County Air Pollution Control District

10124 Old Grove Rd. San Diego California 92131-1649  
(858) 586-2600 Fax (858) 586-2601  
www.scdapcd.org

**RESPONSE TO COMMENT 30-1**

SANDAG appreciates the San Diego County Air Pollution Control District's (APCD) expressed support for the proposed Plan and feedback. SANDAG also appreciates the collaborative relationships between our two agencies and looks forward to continued collaboration towards further improving air quality. Please refer to subsequent responses for detailed responses to APCD's comments.





Cc: Michael Watt, SDAPCD Deputy Director  
 Kathy Keenan, SDAPCD Supervising Air Resource Specialist

**Technical Notes**

30.2 **Attainment Status**  
 As of July 2, 2021, San Diego has been designated a Severe Nonattainment Area for the 2008 and 2015 ozone National Ambient Air Quality Standards (NAAQS). This should be reflected in Table 4.3-1 and first sentence of Attainment Status on page 4.3-11.  
**AQ-5 Mitigation Strategies**  
 Since some of the toxic air contaminant (TAC) exposure discussed in section AQ-5 is from rail lines, SANDAG should consider including AQ-2b Zero Emission Trains in Section AQ-5 mitigation strategies (page 4.3-80).

**Comments Regarding Chapter 4.3, Air Quality**

30.3 **Support for Planned Zero-Emission and Electric Vehicle Programs and Policies**  
 Mitigation measures including GHG-5b, AQ2-b (Establish New Funding Programs for Zero-Emissions Vehicles and Infrastructure) that encourage the adoption of zero-emission vehicles are crucial for the region to meet our air quality and GHG reduction goals. As a partner APCD is fully supportive of SANDAG's substantial near-term and long-term investment commitments and looks forward to continuing to work with SANDAG and other regional agencies on future programs that further encourage zero-emission technologies.

30.4 **More active transportation and zero-emission transit-lead projects completed, and more frequent service by 2025 in disadvantaged and low-income communities**  
 The Regional Plan provides a blueprint for a cleaner transportation system for our region. To the maximum extent feasible, SANDAG should consider bringing forward and scheduling additional active transportation and zero-emission transit-lead projects for completion by 2025 that transit through or benefit low-income (as defined in AB 1550) or disadvantaged communities (as defined in SB 535) in San Diego County. For example, the Draft 2021 Regional Plan includes only two transit-lead projects scheduled for completion by 2025: (1) Project ID #TL21 in the South Bay to Sorrento corridor, and (2) Project ID #TL19 in the I-8 corridor. Additional Rapid or bus improvement projects should be scheduled for completion and prioritized for these communities prior to 2025, and (to the maximum extent feasible) only with zero-emission equipment. SANDAG should also prioritize any projects in these same communities that would result in increased frequency of service on bus or trolley lines. These suggested improvements would urgently improve existing transit access in neighborhoods that rely most on transit service, and encourage residents to seek alternatives to older, high-polluting vehicles as their primary mode of transportation.

30.5 **Phase trolley and commuter rail projects to be open for service as early as possible and find creative ways to improve transit service in the near term.**  
 For example, the existing Blue Line trolley route connects the Border to Downtown San Diego via the San Ysidro Transit Station. The Draft 2021 Regional Plan does include future high speed commuter rail service along the same corridor, planned for operation by 2050 (Project ID #TL04). As an interim step to further  
 10124 Old Grove Rd, San Diego California 92131-1649  
 (858) 586-2600 Fax (858) 586-2601  
 www.sdapcd.org

**RESPONSE TO COMMENT 30-2**

The attainment designation for the 2008 ozone standard has been changed to Serious Nonattainment in Table 4.3-1 and within the in-text references on page 4.3-11 of the EIR.

**RESPONSE TO COMMENT 30-3**

This comment agrees with an EIR mitigation measure, and no further response is required.

**RESPONSE TO COMMENT 30-4**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. The proposed Final Plan includes additional Rapid bus projects in the 2025 plan phase compared to the Draft Plan that were selected considering equity, system operations, and performance criteria (TL32 in the Coast, Canyons, and Trails corridor, and TL37 in the North County corridor). Frequency and span of service improvements for the transit system have also been added to the proposed Final Plan in Attachment 1 to Appendix A. The proposed Final Plan also supports the electrification of the region's transit buses and the State's Innovative Clean Transit regulation. Appendices A and B of the proposed Plan include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 and 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans>.

**RESPONSE TO COMMENT 30-5**

This comment is related to the proposed Plan and is not related to the adequacy of the Draft EIR. A near-term implementation action (Appendix B) of the proposed Plan includes a Blue Line Trolley study to assess the ability to operate express and 24-hour service along the corridor. The results of this study will help inform decisions regarding express Blue Line trolley service and non-rail operational improvement options. High-Speed Commuter Rail from the vicinity of National City to Kearny Mesa is included in the proposed Plan in the 2035 phase. Subsequent plans will revisit the timeline for extending this rail service to the border.



30-5  
cont. reduce emissions in the near-term, APCD recommends adding an express Blue Line trolley (or RAPID) service along the existing Blue Line route between the San Ysidro Transit Station to a major downtown transit station (e.g., 12<sup>th</sup> and Imperial) as soon as possible, but no later than 2035. Such service could potentially be discontinued once high-speed commuter rail service is fully operational by 2050. Another possible consideration would be to prioritize the High-Speed Commuter Rail projects between the Border and Kearny Mesa for completion by 2035.

30-6 **Consideration of additional measures to reduce vehicle miles traveled (VMT) and Particulate Matter emissions between 2035 and 2050**  
Table 4.3-7 in the 2021 Regional Plan Draft EIR projects that emissions from ozone precursor pollutants (VOCs and NOx) as a result of the Plan will be substantially reduced by 2050. However, the Draft EIR also notes total VMT will increase by 6.7% by 2050 compared to 2016 baseline conditions. The increased VMT is presumed to result in more road dust overall, as well as brake and tire wear from on-road sources; both in turn are projected to result in an increase of 0.19 tons per day of particulate matter of 10 microns or less ("PM10") after mitigation. The mitigation SANDAG has proposed for anticipated PM10 increases includes working with APCD to procure more regional incentive funding, as well as a commitment to purchase zero-emission commuter trains from 2035 onward. These proposed mitigation measures are significant and stand to reduce at least some PM10 throughout the region. That being said, in order to avoid any potential future localized impacts along transportation corridors or regional air quality impacts, and to address the root cause of anticipated PM10 emission increases, which is increased regional VMT from motor vehicle use by 2050, APCD strongly encourages SANDAG to explore additional measures in the final 2021 Regional Plan that would reduce regional VMT enough to result in no projected PM10 increases by 2050. Such measures that could be further explored to reduce VMT and PM10 projection emissions include but are not limited to enhanced implementation of already implemented Transportation Control Measures (TCM's) identified in the Clean Air Act (§108(f)), or adoption and implementation of identified TCM measures that have not been implemented to date.

30-7 **Reconsider funding for Desert Line Reliab (Project ID #GM41)**  
Approximately \$253 million is noted as an unconstrained goods movement project in the Draft 2021 Regional Plan for "basic service" and "rehabilitation" of the MTS-owned Desert Line railroad track. Low-emission locomotives can play a critical role in reducing the number of heavy-duty trucks on the road. However, this project would require substantial funding in order for locomotives to even begin using the track decades from now. Furthermore, freight locomotives remain one of the highest emitters of ozone precursor emissions in San Diego County after on-road transportation. As on-road transportation moves toward zero-emission technologies, freight locomotive emissions will comparatively grow larger. Locomotives today also do not have any state or federal obligation to operate the lowest polluting equipment available. If ever completed and operational, the Desert Line could also add additional railroad traffic between the Border and Downtown San Diego from the Desert Line. To ensure such a scenario does not further burden impacted communities along this corridor, APCD recommends this funding be allocated to the project only if there is an enforceable commitment to only operate zero-emission locomotives along this corridor.

30-8 **Collaborate with APCD and other regional agencies on improving transit experience and expanding no-cost transit pass pilot project to residents 24 years and younger**  
10124 Old Grove Rd, San Diego California 92131-1649  
(858) 586-2600 Fax (858) 586-2601  
www.sdapcd.org

**RESPONSE TO COMMENT 30-6**

This comment is related to the proposed Plan and is not related to the adequacy of the Draft EIR. Total VMT is expected to increase by 2050 as a result of increased regional population, resulting in additional transportation-related particulate matter. This increase occurs despite the decrease in VMT per capita achieved under the proposed Plan. SANDAG looks forward to additional coordination with APCD and CARB as increases in PM10 emissions are not isolated to the San Diego region. The additional TCMs included in the Clean Air Act are substantially advanced with the proposed Plan including public transportation, bicycling and walking encouragement, traffic signalization, reduced congestion through transportation infrastructure, incident management, and ITS. The proposed Plan also identifies funding for partnering with local jurisdictions and other stakeholders on measures that could enhance VMT reduction, including Vision Zero programs, Complete Streets in Mobility Hubs, and Flexible Fleet pilots.

**RESPONSE TO COMMENT 30-7**

This comment is related to the proposed Plan and is not related to the adequacy of the Draft EIR. The Rehabilitation of the Desert Line is an unconstrained project in the proposed Plan with MTS as the implementing agency. Improvements would be funded by MTS, potentially in partnership with a leaseholder that would operate the freight rail line. SANDAG encourages its regional partners to develop and implement sustainable and innovative freight solutions that reduce emissions while still facilitating trade. In addition, CARB is developing measures aimed at reducing locomotive and railyard emissions in California

**RESPONSE TO COMMENT 30-8**

One of the Implementation Actions listed in Appendix B of the proposed Plan is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.



30-9  
1091  
Regional transit agencies today offer discounted daily and monthly fares for youth riders. However, the cost of discounted fares remains a significant barrier for increased ridership, especially those living in low-income households. Alongside infrequent transit service, youth riders today may not be incentivized to use public transit even at a discounted rate. As such, many youths may be forced or inclined to purchase low-cost, older, and higher-polluting vehicles to serve as their primary means of transportation. In recognition of this, APCD was pleased to see SANDAG's Transportation Committee pursuing an \$8 million pilot project to provide fare subsidies to residents 18 years and younger and supports full approval of this pilot program by the SANDAG Board of Directors. To further encourage youth transit ridership, APCD recommends expansion of the pilot project to all residents 24 years and younger as envisioned in Alternative 3 of the Draft EIR should additional funding become available.

**Continue to ensure the Regional Plan is consistent and aligns with the EPA Border 2025 Environmental Program.**

30-9  
The Draft EIR notes that the Regional Plan considered and relied on analyses from many plans, including the US EPA Border 2025 Program. Goal #1 of that program is to reduce air pollution in the Border region through efforts to prioritize environmental justice, address disproportionate air quality impacts, and focus on activities in or near vulnerable communities such as the San Diego/Tijuana binational airshed. When implemented, SANDAG should ensure the final 2021 Regional Plan and its respective projects are consistent with and align with strategies in the latest version of that plan, "EPA Border 2025 United States – Mexico Environmental Program", found here: [https://www.epa.gov/sites/production/files/2021-05/documents/final\\_us\\_mex\\_border\\_2025\\_final\\_may\\_6.pdf](https://www.epa.gov/sites/production/files/2021-05/documents/final_us_mex_border_2025_final_may_6.pdf)

**Include California Air Resources Board (CARB) and Environmental Protection Agency (EPA), in addition to APCD, as potential data sources for air quality performance**

30-10  
Table 3.1 on page 54 of the Draft 2021 Regional Plan states that APCD will be the primary data source for the "air quality" performance indicator of the 2021 Regional Plan. APCD stands ready to work with SANDAG in the fulfillment of this metric. However, should additional data be needed that goes beyond the capability or resources that APCD currently offers, APCD would recommend that CARB and EPA also be listed as potential agencies that could assist in data collection.

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**RESPONSE TO COMMENT 30-9**

he cumulative impacts of the proposed Plan are discussed in in the Draft EIR in consideration of proposed plans such as the U.S. Border Environmental Program: Border 2025, in Chapter 5, *Cumulative Impact Analysis*, of the EIR. Because cumulative air quality impacts throughout Southern California and northern Baja would be significant, it was determined that the proposed Plan's incremental air quality impacts are also cumulatively considerable.

The proposed Plan emphasizes continued collaboration between SANDAG and partners on both sides of the U.S.-Mexico border to plan for improved mobility in the border region. This collaboration builds on years of partnerships and active participation in binational programs that advance these goals, including the EPA and SEMARNAT-led Border 2025 program. SANDAG staff regularly participate in groups such as the San Diego-Tijuana Air Quality Task Force and the AB 617 Steering Committee, and have advocated for air quality measures in border communities. In California, regulation of vehicle emissions is managed by CARB. CARB conducts inspections of heavy-duty trucks traveling in California, including those registered out of state and from foreign countries. At border ports of entry CARB inspects heavy-duty trucks for excessive smoke and engine certification label compliance. SANDAG partners with CARB and the San Diego Air Pollution Control District on air quality conformity (see Appendix C) and emission reduction strategies across the region.

In addition, SANDAG has worked with CARB on updates to the CalEnviroScreen tool to provide data and improve how this tool captures various environmental impacts felt on either side of the border. SANDAG will continue participating in such border and environmental focused programs to support coordination of activities to reduce impacts on the binational community

SANDAG is committed to pursuing programs and projects to further policies focused on electrification of fleets, and EO N-79-20 related to sales of zero-emission personal and medium/heavy-duty vehicles; planning for goods movement strategies that reduce border congestion that exacerbates emissions resulting from vehicle delay; and continuing coordination on strategies identified in the 2021 California-Baja California Border Master Plan.

**RESPONSE TO COMMENT 30-10**

This comment addresses the proposed Plan and does not relate to the adequacy of the EIR. SANDAG intends to use similar data as prior Performance Monitoring Reports, which included Air Quality Index data from APCD. However, as noted in Chapter 3, *Environmental Setting*, of the proposed Plan, the data sources listed in Table 3.1 are the best sources identified as of the completion of the proposed Plan and are subject to change if new data sources are identified prior to the completion of the Performance Monitoring Report.



**COMMENT LETTER 31: SAN DIEGO COUNTY REGIONAL AIRPORT AUTHORITY**



Comment Letter 31

October 11, 2021

San Diego Association of Governments  
 401 B Street, Suite 800  
 San Diego, CA 92101.  
 Attn: Coleen Clementson

**RE: Airport Authority Comments on Draft EIR for Proposed 2021 Regional Plan**

Ms. Clementson:

The San Diego County Regional Airport Authority (Airport Authority) is pleased to submit this comment letter on the Draft Environmental Impact Report (Draft EIR) for the proposed 2021 Regional Plan (Proposed Plan) released by the San Diego Association of Governments (SANDAG) for public review on August 27, 2021. This letter supplements comments on the Proposed Plan that the Airport Authority sent to SANDAG on August 4, 2021, which are also attached for inclusion and consideration in the 2021 Regional Plan's Final EIR.

31-1

Created in 2003, the Airport Authority is responsible for operating San Diego International Airport (SAN) and planning for the region's long-term air transportation needs. SAN is the only major commercial airport in the region, connecting San Diego to over 70 domestic and international markets and generating over \$12 billion annually in local economic benefit. In addition, the Airport Authority acts as the Airport Land Use Commission in the County of San Diego, pursuant to the California State Aeronautics Act, to help ensure compatibility between all 16 public-use and military airports in the region and future land use development in the surrounding areas.

As SANDAG finalizes the EIR for the 2021 Regional Plan, the Airport Authority requests that the following items be included in the analyses and documentation:

31-2

- 1. Central Mobility Hub (CMH) Assumptions in Navy OTC Revitalization Draft EIS**  
 On page 2-63, the Draft EIR states that a "CMH at OTC is included in two of the development scenarios evaluated in the Navy's Draft EIS" for its proposed OTC Revitalization Project. The Navy's Draft EIS, however, specifically lists the Central Mobility Hub as an action that exceeds the scope of the analysis in the EIS. As such, the Airport Authority requests that SANDAG clarify and, if needed, correct in the Final EIR the relationship between the Central Mobility Hub in the proposed 2021 Regional Plan and the Navy OTC Revitalization Project's Draft EIS.

**RESPONSE TO COMMENT 31-1**

Thank you for your comments on behalf of the San Diego County Regional Airport Authority (SDCRAA). SANDAG appreciates SDCRAA's input on the EIR and the proposed Plan as well as the background information about the SDCRAA.

**RESPONSE TO COMMENT 31-2**

Proposed clarifications regarding assumptions related to the Central Mobility Hub in the Navy OTC Revitalization Draft EIS have been made to Chapter 2, *Project Description*, on page 2-64 of the EIR.



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31-3

**2. Airport Taxicab Replacement Program**

On page 4.3-25, the Draft EIR lists the San Diego Air Pollution Control District's (SDAPCD) "Airport Taxicab Replacement Program" as a regional incentive program to reduce emissions of ozone precursors. This program was concluded on June 30, 2015 based on information available on the SDAPCD's website. As such, the Airport Authority requests that the Final EIR notes that this incentive program is no longer available.

31-4

**3. Updated Alquist-Priolo Earthquake Fault Zone Maps**

On page 4.7-3, the footnote in the Draft EIR states that the California Geologic Survey is in the process of updating fault zone maps for the region. It should be noted that the new fault zone maps were officially finalized by the State on September 23, 2021. As such, the Airport Authority requests that the Final EIR be updated accordingly.

31-5

**4. Adopted Airport Land Use Compatibility Plans**

The Draft EIR on page 4.9-7 lists all of the Airport Land Use Compatibility Plans (ALUCPs) and their adoption year. However, the Draft EIR includes an incorrect statement that "ALUCPs have been adopted for 14 of the 16 public-use and military airports in the region." As such, the Airport Authority requests that the Final EIR recognizes that ALUCPs for all 16 public-use and military airports in the San Diego region have been formally adopted by the Airport Authority, acting in its role as the County's Airport Land Use Commission.

31-8

**5. Table of San Diego Region Airports**

The title for Table 4.11-4 (on page 4.11-10) should be revised to "San Diego Region's Public and Military Airports."

31-7

**6. Airport Development Plan Summary**

The Airport Authority requests that the following revisions be made on page 5-5 in the Final EIR's Cumulative Impacts section to more accurately describe the scope of the SDIA Airport Development Plan:

"San Diego ~~County~~ International Airport Development Plan

Each year, more than ~~1.917~~ 25 million air passengers use the San Diego International Airport (SDIA). ~~The air cargo capacity at SDIA is currently constrained by limited infrastructure.~~ To maximize the airport's operational efficiency and make the most of the airport's 661-acre footprint, SDIA is moving forward with its next master planning phase, the Airport Development Plan (ADP). The ADP provides a development framework to



**RESPONSE TO COMMENT 31-3**

Reference to Airport Taxicab Replacement Program on page 4.3-25 of the EIR now includes the caveat that the Airport Taxicab Replacement Program ended in 2015.

**RESPONSE TO COMMENT 31-4**

The footnote on page 4.7-3 of the EIR has been updated to reflect the September 23, 2021, finalization of the fault zone maps by the State.

**RESPONSE TO COMMENT 31-5**

Suggested edits have been implemented on page 4.9-7 of the EIR to indicate that ALUCPs have been adopted for all 16 public-use and military airports in the region.

**RESPONSE TO COMMENT 31-6**

Table 4.11-4 of the EIR has been updated to include "Military" in the title.

**RESPONSE TO COMMENT 31-7**

Suggested edits related to the San Diego International Airport Development Plan have been implemented on page 5-5 of the EIR.



Page 3 of 4

31-7  
cont.

implement improvements that will enable the San Diego County Regional Airport Authority (SDCRAA) to accommodate future demand for air travel that is anticipated to occur at SDIA with more modern, efficient, and comfortable facilities. The ADP is considered a probable future project for the cumulative impact analysis. The primary components of the project are the replacement of the existing Terminal 1, ~~modifications to Terminal 2~~, a new administration building, and a new airport access roadway with new bicycle and pedestrian infrastructure. As part of the Terminal 1 replacement, a new ~~access road and~~ parking structure would ~~also~~ be constructed. ~~Other improvements include infrastructure upgrades and the removal/relocation of other airport support facilities to accommodate the terminal improvements.~~ Ultimately, the number of gates at SDIA would increase from 51 to 62~~1~~ (SDCRAA 2019a)."

31-8

**7. 2019 Airport Development Plan vs. 2008 Airport Master Plan**  
In section 5.2.13, the Draft EIR cites SDIA's 2008 Airport Master Plan as the source document to inform its cumulative noise impact assessment. The 2008 Airport Master Plan is outdated and has been superseded in terms of the number of current and forecasted aircraft operations. A new aviation activity forecast was formally approved by the FAA and is included in the 2019 Airport Development Plan. As such, the Airport Authority requests that the 2019 Airport Development Plan be used in all cumulative impact analyses and discussions in the Final EIR.

The Airport Authority appreciates the opportunity to provide formal comments on the Draft EIR for the proposed 2021 Regional Plan. Please feel free to contact me at [breed@san.org](mailto:breed@san.org), if you have any questions or need additional information.

Sincerely,

**Brendan Reed**  
Director of Airport Planning & Environmental Affairs

Attachment: August 4, 2021 Airport Authority Letter to SANDAG on Draft 2021 Regional Plan

cc: Dennis Probst, Airport Authority, Vice President - Development  
Ted Anasis, Airport Authority, Airport Planning Manager



**RESPONSE TO COMMENT 31-8**

Text has been revised in Section 5.2.13 on page 5-52 of the EIR to reflect the updated 2019 Airport Development Plan.





Page 4 of 4

Ralph Redman, Airport Authority, Airport Planning Manager  
Michelle Brega, Airport Authority, Senior Director of External Relations  
Matt Harris, Airport Authority, Director of Government Relations





**ATTACHMENT**

August 4, 2021

San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92101.  
Attn: Coleen Clementson

**RE: Airport Authority Comments on Draft 2021 Regional Plan**

Ms. Clementson:

On behalf of the San Diego County Regional Airport Authority (Airport Authority), I am submitting this comment letter in response to the Draft 2021 Regional Plan (Draft Plan) released by the San Diego Association of Governments (SANDAG) for public review on May 28, 2021. The Airport Authority acknowledges SANDAG's hard work over the last 3 years in developing a new vision for the region's surface transportation system and appreciates the opportunity to provide productive feedback on it.

Created in 2003, the Airport Authority is responsible for operating San Diego International Airport (SAN) and planning for the region's long-term air transportation needs. SAN is the only major commercial airport in the region, connecting San Diego to over 70 domestic and international markets and generating over \$12 billion annually in local economic benefit. In addition, the Airport Authority acts as the Airport Land Use Commission in the County of San Diego, pursuant to the California State Aeronautics Act, to help ensure compatibility between all 16 airports in the region and future land use development in the surrounding areas.

As SANDAG further refines the 2021 Regional Plan, and completes its environmental review under the California Environmental Quality Act, the Airport Authority requests that the following items be considered:

- 1. Aligning Air & Surface Transportation Planning**  
In 2011, the Airport Authority and SANDAG led the development of a Regional Aviation Strategic Plan (RASP) and Airport Multimodal Accessibility Plan (AMAP), respectively, to ensure a seamless and efficient connection between the region's air and surface transportation infrastructure. The Draft 2021 Regional Plan's Appendix BB (page BB-1) states that "routes included in the 2011 AMAP continue to be identified in the 2021 Regional Plan." However, the following

31-9



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**RESPONSE TO COMMENT 31-9**

Thank you for providing SDCRAA's letter providing comments on the Proposed Plan. Responses to these comments can be found beginning from ID L343 in Appendix P.2.



Page 2 of 6

31-9  
cont.

ground access improvements, which were prioritized in the 2011 AMAP, do not appear to be programmed into the Draft Plan:

*San Diego International Airport*

- Heavy Rail Grade Separation (Whitherby St. to Laurel St.)
- I-5 Direct Access Ramps

*McClellan-Palomar Airport*

- Palomar Airport Road Widening (I-5 to Hidden Valley Rd.)
- Additional Airport Access at Owens Ave.
- Modification of Future Route 445

*Gillespie Field*

- Gillespie Field Trolley Station Relocation
- New Bus Rapid Transit (BRT) Station
- Marshall Avenue Intersection Improvements
- BRT Routes (90, 870, & 890) Modifications

*Cross Border Xpress*

- SR 905/Britannia Interchange Capacity Increase
- Britannia Road Widening
- Siempre Viva Road Widening
- Local Bus Route (661) Modifications

As such, the Airport Authority requests that the 2021 Regional Plan clarify whether these AMAP-identified priorities will be implemented or have been substituted with alternative implementation options.

**2. Connecting Regional Transit Network to SAN**

The Airport Authority has been working closely with SANDAG and other public agency partners to identify opportunities to better connect SAN to the regional transit network. As noted in the Draft 2021 Regional Plan, one of the concepts is a fixed-rail transit connection, such as an Automated People Mover (APM), between a Central Mobility Hub at the Old Town Campus and the SAN terminal area. This airport transit connection is anticipated in the Draft Plan to be built in 2035. The Airport Authority looks forward to continuing its collaboration with SANDAG to further refine the APM's alignment and station location concepts.

The 2016 Airport Transit Plan, which was developed in partnership between the Airport Authority, Metropolitan Transit System (MTS), and SANDAG, identified more near-term opportunities for increasing ridership on public transit to and





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from SAN. As recommended in the Airport Transit Plan, the Airport Authority will be launching a new all-electric shuttle service to Old Town Transit Center this fall, in conjunction with the start of the Mid-Coast Trolley Extension operations and increased Coaster service frequency.

Another recommendation in the Airport Transit Plan is the transition of MTS Bus Route 992, which is currently the main transit connection to the Airport, to a Rapid Bus service. It also suggested that combining the new Rapid 992 with other Rapid bus routes, such as the 215 along the El Cajon Boulevard corridor and 235 along the Interstate 15 corridor, could improve airport transit ridership by better linking to major regional destinations and by increasing single-seat access to the San Diego International Airport.

As such, the Airport Authority requests that the 2021 Regional Plan assess the potential ridership benefits from upgrading MTS Bus Route 992 to a Rapid service and extending other existing and planned Rapid routes to serve the SAN terminal areas.

**3. Considering Airport Compatibility in New Development Siting**

All 16 public-use and military airports in the San Diego region now have an adopted Airport Land Use Compatibility Plan (ALUCP), which provides guidance on appropriate land uses surrounding them to protect the health and safety of people and property within their vicinity. The Draft 2021 Regional Plan states in Chapter 1 (Page 12) that 3.7 million people will be living in the San Diego region by 2050 (13% greater than 2016 levels), creating a need for 440,000 more jobs and 274,000 more homes. Figure 2.4 (Page 27) in the Draft Plan identifies regional mobility hub areas that could accommodate this increased demand for jobs, housing, shopping, and recreation, while being served by expanded transit networks. In the Airport Authority's initial review, it appears that many of these hub areas are in close proximity to airports.

As such, the Airport Authority requests that the 2021 Regional Plan ensure that new incompatible land uses are not introduced near airports, as outlined in each ALUCP. The Draft Plan's Environmental Impact Report should also formally assess any land use conflicts with the applicable ALUCPs. Important factors include:

- Limiting new noise-sensitive development within an airport's noise contours and ensuring that any new noise-sensitive development includes sound insulation

31.9  
cont.





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31-9  
cont.

- Prohibiting certain sensitive land uses within an airport's safety zones and limiting the number of people in areas subject to the highest risk of aircraft accidents
- Assuring aircraft safety and preserving airport operations by limiting the height of new structures and objects

**4. Clarifying SAN Air Cargo Information**

The Draft 2021 Regional Plan acknowledges the importance of air cargo in moving goods into and out of the region. Specifically, Appendix Y of the Draft Plan discusses freight movement between the region's highways and arterials, rail corridors, land ports of entry, maritime port, and the San Diego International Airport. The Airport Authority has identified the following inaccuracies in the presented narrative and data:

- Page 21 in Appendix Y states that "when combined with the rate at which trucks produce emissions per day, neighborhoods in close proximity to the airport are put at a higher [air quality] risk" without citing any environmental impact study to substantiate this conclusion.

The Airport Authority has ensured that current and future emissions from the San Diego International Airport's activities are included in the most recent 2020 State Implementation Plan (2020 SIP) for attaining air quality standards in the San Diego region under the federal Clean Air Act. The 2020 SIP determined that SAN's emissions can be accommodated without causing the region to experience additional exceedances of criteria pollutant standards.

- Figure 2.10 in Appendix Y is an outdated map of SAN, which doesn't properly reflect the airport property boundaries and onsite aeronautical uses.
- Page 78 in Appendix Y incorrectly states that Capital International Cargo operates at SAN.
- Page 78 in Appendix Y includes statements that air cargo operations are constrained due to limited airport space for expansion.

As identified in its 2013 Northside Improvements Environmental Assessment, the Airport Authority is proposing a new *SAN Northside Cargo Development* project. The project would include a consolidated





Page 5 of 6

31-9  
cont.

warehouse to fully accommodate onsite cargo sorting and staging, as well as expanded apron to accommodate additional cargo aircraft parking.

Additionally, the Airport Authority opened a new 93,000-square-foot Airline Support Building on North Harbor Drive this year, which will allow for more efficient processing of bulky cargo items shipped in the bellies of passenger jets. Approximately 15% of SAN's freight volumes are transported as "belly cargo."

- Page 78 in Appendix Y relies on the outdated 2009 Destination Lindbergh Study to estimate SAN's air cargo capacity and identify cargo operational deficiencies.

The FAA approved the most recent SAN aviation activity forecast in June 2019, which is publicly available at [www.san.org/plan](http://www.san.org/plan). The forecast anticipates that the number of cargo aircraft operations (i.e. takeoffs or landings) will increase by nearly 71% by 2050, even with the Airport's single-runway configuration.

As such, the Airport Authority requests that the 2021 Regional Plan be updated to incorporate the more accurate information presented above.

**5. Updating Airport Ground Access Modeling Assumptions**

Similar to other regional transportation plans, the Draft 2021 Regional Plan relies on an integrated forecasting model to determine future population, housing, and employment growth. This information is then applied to an activity-based model to simulate detailed transportation behaviors, such as where, when, and how people travel on a daily basis.

On page 20 in Appendix C, the Draft Plan states that its model relies on airport passenger survey data from 2008 to estimate airport-related travel patterns and demands on local and regional transportation facilities. The Airport Authority notes that ground access characteristics have changed dramatically over the last decade, especially with the introduction of rideshare companies. The Airport Authority also noticed that the modeling appears to be based on SAN aviation activity forecasts that were developed in 2013 (Figure S.18 in Appendix S). As previously stated, the FAA approved the most recent aviation activity forecast in June 2019, which is publicly available at [www.san.org/plan](http://www.san.org/plan). The new "constrained demand scenario" forecast estimates that SAN will serve approximately 20.3 million enplaned passengers in 2050.







Page 6 of 6

As such, the Airport Authority requests that the 2021 Regional Plan's modeling be updated to be based on more accurate modal assumptions for airport users and the more recent SAN aviation activity forecast.

Again, the Airport Authority appreciates the opportunity to provide feedback on the Draft 2021 Regional Plan. Please feel free to contact me at [breed@san.org](mailto:breed@san.org), if you have any questions or need additional information.

31-9  
cont.

Sincerely,

**Brendan Reed**  
Director of Airport Planning & Environmental Affairs

cc: Dennis Probst, Airport Authority, Vice President - Development  
Ted Anasis, Airport Authority, Airport Planning Manager  
Ralph Redman, Airport Authority, Airport Planning Manager  
Michelle Brega, Airport Authority, Senior Director of External Relations  
Matt Harris, Airport Authority, Director of Government Relations





**COMMENT LETTER 32: SAN DIEGO TRANSPORTATION EQUITY WORKING GROUP**

Comment Letter 32



October 8, 2021

Kirsten Uchitel  
Associate Planner  
San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92101

Via E-mail, RegionalPlanEIR@sandag.org

Re: San Diego Transportation Equity Working Group Comments to the Draft Environmental Impact Report for the 2021 Regional Plan

Respected Ms. Uchitel:

The San Diego Transportation Equity Working Group (SDTEWG) expresses overall support and commends the SANDAG team for all the efforts to advance a transformational Regional Plan (RP) that improves the quality of life of the San Diego Region while addressing climate pollution and greenhouse gas (GHG) emission. **Although visionary, the Draft Environmental Impact Report (DEIR) for the 2021 RP includes significant air quality impacts, housing displacement, and insufficient GHG emission reductions.** The following letter expresses the concerns of the SDTEWG core organizations and provides mitigation measures to best decrease the RP environmental impacts particularly to communities at the frontlines of the climate disaster.

The SDTEWG was established in 2018 by community-based organizations (CBOs) in an effort to elevate transportation and environmental justice opportunities in Mid-City and South Bay for years to come. The core organizations are the Center on Policy Initiatives (CPI), City Heights Community Development (CH CDC), Environmental Health Coalition (EHC), Mid-City CAN (MCC), and SanDiego350 (SD350). Supporting organizations include Casa Familiar (CF) and the Urban Collaborative Project (UCP).

**1. Air Quality Impacts**

The DEIR states that Particulate Matter 10 (PM10), 2.5 (PM2.5) will increase and have significant impacts. PM10 and PM2.5 refer to PM emission that are smaller than or equal to 10 or 2.5 microns respectively. Although new vehicle technology will release less fuel emission, road dust from brakes and tire wear will continue to grow and as result emit more PM10 & PM2.5. The SDTEWG recommends that:

- a. **Mitigation GHG-5b**, which establishes new funding programs for zero-emission vehicles and infrastructure, should be amended to include the acceleration of the region's bus fleet

**RESPONSE TO COMMENT 32-1**

Thank you for the San Diego Transportation Equity Working Group's (SDTEWG) expressed support for the proposed Plan. SANDAG appreciates SDTEWG's participation in the environmental review process, and SDTEWG's concerns are addressed in detail in the responses to comments that follow.

**RESPONSE TO COMMENT 32-2**

MTS's Zero Emissions Bus (ZEB) Pilot Program has set a 2040 goal for full bus electrification. The ZEB Program prioritizes bus assignments on routes serving SB 535 Disadvantaged Communities (DACs) during fleet transition years.

Changes have been made to mitigation measure GHG-5b as described in response to comment Chatten-Brown 34-2, which accelerate adoption of these measures.

Changes to mitigation measure GHG-5a are not required in response to this specific comment. Reduction measures local jurisdiction's climate action plan (CAP) result in local emission reductions. These local emission reductions can result in air quality co-benefits by reducing natural gas combustion for space and water heating or by reducing VMT from vehicle travel. While many CAPs discuss the potential air quality and public health co-benefits of measures, quantification of these co-benefits is not standard CAP practice nor is it required for CAPs to be adopted by jurisdiction's elected decision-making body.

Lastly, the comment incorrectly states that the proposed Plan will result in significant PM2.5 impacts. No significant PM2.5 impacts are identified in the Draft EIR.

32-2 cont.	<p>transition to 100% electric by 2030 with priority implementation in disadvantaged communities as identified by CalEnviroScreen (CES).</p> <p><b>b. Mitigation GHG-5a</b> be enhanced by prioritizing grant funding for jurisdictions that integrate regulatory mechanisms to actively decrease toxic air pollution in the Climate Action Plan Updates or GHG reduction plans.</p>
32-3	<p><b>2. Housing Displacement</b> The DEIR states the Plan will displace substantial numbers of people or housing units. Therefore, the Regional Plan must commit to near-term actions to prevent displacement particularly in disadvantaged communities as identified by CES. The SDTEWG recommends:</p> <p><b>a. The Regionwide Displacement Study</b> be completed no later than June 2022.</p> <p><b>b. Near-term Action 8(c)</b>, directs SANDAG to implement a regional housing incentive grant program to support housing development in transit-rich areas. The mitigation should be amended to incorporate the protection of low-income communities of color living near transit corridors from gentrification with proactive strategies that include building affordable housing while preserving naturally occurring affordable housing, community ownership, and tenant protections.</p>
32-4	<p><b>3. Insufficient Greenhouse Gas Emission Reductions</b> The SDTEWG strongly recommends the prioritization of mitigation measures focused on the electrification of <b>mass public transit</b>. The proposed regional plan shows a dramatic decrease of GHG emissions compared to previous regional plans due to transit improvements and compact development. However, the DEIR recognizes that the Plan would be inconsistent with the State's ability to achieve the SB 32 target of reducing statewide GHG emissions to 40 percent below the 1990 levels by 2030, ability to achieve the EO B-55-18 goal of statewide carbon neutrality by 2045 across all sectors, and achieve the EO S-3-05 goal of reducing California's GHG emissions to 80 percent below 1990 levels by 2050.</p> <p>Mitigation measures provided include establishing new funding for zero emission vehicles and infrastructure. The over-reliance on electric single occupancy vehicles and infrastructure sidetracks efforts to rapidly decrease GHG emissions, congestion, and vehicle miles traveled (VMT). The SDTEWG recommends a stronger focus on the electrification of <b>mass public transit</b> to accelerate emission reductions.</p>
32-5	<p><b>c. Mitigation GHG-5b</b>, which establishes new funding programs for zero-emission vehicles and infrastructure, should be amended to include the acceleration of the region's bus fleet transition to 100% electric by 2030 with priority implementation in disadvantaged communities as identified by CalEnviroScreen (CES).</p> <p><b>a. Include no-cost transit analysis:</b> Although CEQA does not require EIRs to analyze the impact of non-infrastructure projects, we recommend conducting an analysis on the environmental impact of no-cost transit. The analysis should consider its impact on emission reductions and air quality.</p>
32-6	<p>Additionally, measures to mitigate GHG from the development of projects should involve partnering with Community Based Organizations (CBO) to prioritize community engagement that identifies best ways to increase transit use through service frequency and affordability.</p>

**RESPONSE TO COMMENT 32-3**

SANDAG is in the process of preparing the Regional Displacement Study, as identified in Appendix B of the proposed Plan. The commenter is requesting a specific completion date of the study as well as implementation of a regional housing incentive grant program, which are beyond the scope of the EIR; these requests will be considered by the SANDAG Board of Directors when it considers adoption of the proposed Plan.

**RESPONSE TO COMMENT 32-4**

In addition to making observations about GHG emissions under the proposed Plan and summarizing the conclusions of the Draft EIR, this comment also “strongly recommends” mitigation measures related to electrification of public transit. Specifically, it asserts that mitigation measure GHG-5b “should be amended to include acceleration of the region’s bus fleet to 100 percent electric by 2030 with priority implementation in disadvantaged communities as identified by CalEnviroScreen (CES).”

Mitigation measure GHG-5b (page 4.8-47) requires that SANDAG shall, prior to December 2025, establish one or more funding programs for zero-emissions vehicles and infrastructure, including, among other things, allocation of “funding for zero-emissions buses and infrastructure (e.g., EV charging equipment and/or hydrogen fueling stations).” Entities eligible for funding under this measure include “public transit operators for zero-emission bus and infrastructure funding.” Electric buses and charging infrastructure would qualify to receive funding under this measure.

This mitigation measure was developed in part to help public transit agencies in the San Diego region comply with CARB’s Innovative Clean Transit Regulation, which requires all public transit agencies in California to gradually transition to a 100 percent zero-emission bus fleet. The comment does not provide any reason or evidence that narrowing the focus of this measure from zero-emission technology to electric technology or prioritizing implementation within CES-defined

disadvantaged communities would increase the measure's GHG reduction effectiveness.

Mitigation Measure GHG-5b has been accelerated and strengthened in revisions made in response to Draft EIR comments. See response to comment Chatten-Brown 34-2.

Moreover, SANDAG does not have the authority to amend this mitigation measure to require that "the region's bus fleet transition to 100% electric by 2030" or to require that public transit agencies "priorit(ize) implementation in disadvantaged communities as identified by CalEnviroScreen (CES)."

While incorporating this comment into mitigation measure GHG-5b is not required under CEQA, it is acknowledged for the record and will be forwarded to the decision-making bodies for their consideration prior to making a decision on adopting the proposed Plan. SANDAG has prioritized equity in the proposed Plan more than ever before, promising a system that is a faster, fairer, and cleaner transportation system that is intended to uplift people who have been historically faced with social injustice

#### **RESPONSE TO COMMENT 32-5**

The proposed Plan has been developed with equity at the forefront. An equity-specific project list has been included in Appendix H of the proposed Plan. In addition, one of the Implementation Actions listed in Appendix B of the proposed Plan is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a 1-year pilot that may provide free fares for youth under age 19. The proposed Plan supports the electrification of the region's transit buses and the State's Innovative Clean Transit regulation. Appendices A and B of the proposed Plan include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 and 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website at: <https://ww2.arb.ca.gov/our->

work/programs/innovative-clean-transit/ict-rollout-plans. Land use authority is reserved to local jurisdictions: the cities and the County.

#### **RESPONSE TO COMMENT 32-6**

This comment asserts that “measures to mitigate GHG from the development of projects” should include partnering with Community Based Organizations (CBOs) and community engagement to identify the best ways to increase transit use through service frequency and affordability. For purposes of responding to this comment SANDAG assumes the commenter is referring to Draft EIR mitigation measure GHG-5f. SANDAG agrees with this comment and has revised mitigation measure GHG-5f as follows (page 4.8-51):

- Measures that reduce VMT by increasing transit use, carpooling, bike-share and car-share programs, and active transportation, including the following:
  - Building or funding a major transit stop within or near development, in coordination with transit agencies.
  - Developing car-sharing and bike-sharing programs.
  - Providing pedestrian network improvements and a comprehensive bicycle network.
  - Providing traffic calming measures.
  - Providing transit incentives, including transit passes for Metropolitan/North County Transit District buses and trolleys.
  - Consistent with the Regional Bike Plan, incorporating bicycle and pedestrian facilities into project designs, maintaining these facilities, and providing amenities incentivizing their use; and planning for and building local bicycle projects that connect with the regional network.
  - Implementing Complete Streets consistent with the SANDAG Regional Complete Streets Policy, including adopting local Complete Streets policies.
  - Implementing Mobility Hubs consistent with the Regional Mobility Hub Strategy.
  - Improving transit access to bus and trolley routes through incentives for constructing transit facilities within developments, and/or providing dedicated shuttle service to trolley and transit stations.
  - Implementing measures to increase transit use through service frequency and affordability as identified through community

engagement activities, including but not limited to input from local residents, stakeholders, and Community-Based Organizations.

32-7 SANDAG's Social Equity Early Action Transit Pilot program serves as a model to build upon. The SDTEWG recommends the following:

- a. **Mitigation GHG – 5f**, which includes measures to reduce VMT should be amended to prioritize an increase of frequency and affordability of bus and trolley services particularly in areas under construction informed by the local CBOs and respective stakeholders.

32-8 **4. Coastal Access**  
 Unfortunately, the draft Regional Plan and associated DEIR do not adequately analyze how the Plan impacts coastal and beach access for disadvantaged communities in San Diego. We ask staff to conduct this analysis and make changes to improve access.

We thank the SANDAG team for all the efforts to integrate equity in the Regional Plan and look forward to continue collaborating.

Sincerely,

**The San Diego Transportation Equity Working Group**

**Center on Policy Initiatives**, Keara Piña  
**City Heights Community Development Corporation**, Randy Torres-Van Vleck  
**Environmental Health Coalition**, Laura Benavidez & Carolina Martinez  
**Mid-City CAN**, Diana Ross  
**SanDiego350**, Toshihiko Ishihara & Steven Gelb

**RESPONSE TO COMMENT 32-7**

The comment recommends that Draft EIR mitigation measure GHG-5f should be amended to “prioritize an increase of frequency and affordability of bus and trolley services particularly in areas under construction informed by the local CBOs and respective stakeholders.”

Draft EIR mitigation measure GHG-5f states that the County of San Diego and cities can and should implement measures to reduce GHG emissions and achieve zero-net energy during the planning, design, project-level CEQA review, construction, and operation of development projects. It includes several measures that would reduce VMT, including the following related to improving public transit service:

- Improving transit access to bus and trolley routes through incentives for constructing transit facilities within developments, and/or providing dedicated shuttle service to trolley and transit stations.
- Subsidizing transit service expansion by increasing service hours, decreasing fares, and adding additional transit fleets.
- Implementing a school bus program in areas currently not served by school buses.

As shown above, mitigation measure GHG-5f already includes measures addressing increased frequency and affordability of bus and trolley services as requested by the commenter. Also refer to response to comment Del Mar 13-6, which shows how the text of mitigation measure GHG-5f has been revised to reference measures that increase frequency and affordability of transit services through input by CBOs, other stakeholders, and residents.

**RESPONSE TO COMMENT 32-8**

It should be noted that as SANDAG developed the proposed network for the proposed Plan, data on trip-making was used to understand the critical connections of the region. Connections to coastal areas are represented in these critical connections. Implementation of the regional bike network as well as complete streets in Mobility Hubs will support enhancement for active transportation in coastal communities, benefiting all residents in the region including disadvantaged communities.

“Second-tier projects” that would implement the Plan include site-specific transportation network improvements and development projects that would be subject to project-specific environmental review under CEQA and NEPA, where applicable. The corresponding project-

specific environmental documentation would identify significant impacts with regard to conflicts with land use policies of adopted plans, including specific impacts related to coastal access, and identify mitigation measures to avoid or lessen significant physical impacts on the environment resulting from any conflicts.



**COMMENT LETTER 33: SIERRA CLUB SAN DIEGO**

Comment Letter 33



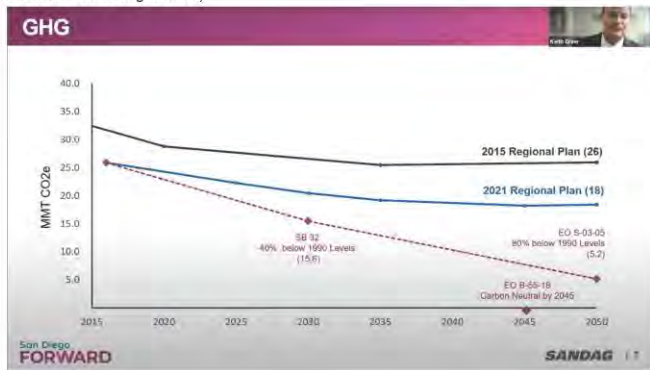
October 11, 2021

Via E-mail (RegionalPlanEIR@sandag.org)  
 Kirsten Uchitel  
 Associate Planner, SANDAG  
 401 B Street, Suite 800  
 San Diego CA, 92101  
 Dear Ms. Uchitel,

These comments are in response to the 2021 SANDAG Draft Regional Plan as detailed in the Draft Environmental Impact Review of that plan

SANDAG's Regional Plan has strong reinforcement of important improvements for the San Diego region; however, although we support many of the transit and infill improvements and emissions reductions, the Draft Environmental Impact Report exposes that the plan falls short of the ambition needed to reduce emissions quickly, dramatically force a mode shift, and reduce overall Vehicle Miles Travelled. Specifically, the plan does not meet state goals for GHG reductions, including SB 32, Executive Order B-55-18, and Executive Order S-03-05. (source SANDAG Board Mtg 10/8/21)

33-1



**RESPONSE TO COMMENT 33-1**

The proposed Plan significantly reduces per capita VMT; however, total VMT increases through the life of the Plan. VMT growth is predominantly due to the population and employment growth within the region, notwithstanding that the SCS land use pattern and the proposed transportation network improvements and programs in the proposed Plan would help to reduce VMT growth. That said, the increase in VMT, from baseline Year 2016 conditions, was identified as a significant impact under Impact TRA-2 in the EIR.

The proposed Plan exceeds the SB 375 target of 19 percent reductions of GHG by 2035 and the Board Resolution for a 30 percent reduction of GHG emissions from all on-road transportation by 2035. However, the proposed Plan's GHG emissions would be inconsistent with the State's ability to achieve the goals of EO B-55-18 and S-3-05. As discussed in additional detail in Section 4.8.4 in the EIR, mitigation measures would help reduce regional GHG emissions by reducing VMT, increasing use of zero-emission fuels, sequestering carbon from the atmosphere, and other measures; they would reduce inconsistency of the proposed Plan's GHG emissions with the State's ability to achieve the SB 32, EO B-55-18, and EO S-3-05 GHG reduction goals. However, full implementation of the changes required to achieve these goals is beyond SANDAG's and local agencies' current jurisdiction and authority. As such, impacts were identified as significant.

SANDAG recognizes that substantial reductions in global, state, and regional GHG emissions are an urgent priority, and strives in its regional plans and programs to do its part in reducing GHG emissions from all sources. However, there is no current legal or planning requirement that the SANDAG region's emissions be reduced by the same percentage ("equal share") as the statewide percentage in order for the State to achieve the Executive Orders' goals. More specifically, there is no legal or planning requirement that the proposed Plan achieve these reductions or be on a trajectory to achieve these reductions.

While the proposed Plan results in significant impacts related to VMT and GHG, anticipated reductions in per capita VMT and GHG, along with proposed mitigation measures, would reduce inconsistency of the proposed Plan with the State's ability to achieve VMT and GHG goals

and puts SANDAG on a trajectory that more closely aligns with regulatory targets.

Furthermore, as discussed in Chapter 2, *Project Description*, SANDAG updates the Regional Plan every 4 years, and, as the State continues to identify new plans and technologies to meet the mid-century GHG emission targets, SANDAG will be able to implement these features into future plans to further the region's progress toward the State's goal of carbon neutrality by 2045.

33-2 Transportation represents more than 50% of our regional emissions when fuel procurement is included, and the report explains repeatedly that the region will likely be subjected to average temperature increases of up to 4.8 °F by 2050 and sea level rise up to 4.6' by 2100. Rather than treat those dire predictions as a mandate to create a plan that addresses Climate Crisis with accelerated pace, the plan uses state mandates as the upper limit of ambition, while still managing to miss three of those mandated goals. Plans originally slated to connect the county via proper investment in lasting and extremely low emissions electric rail have been scrapped and replaced with Bus Rapid Transit, allegedly for flexibility to adapt routes to anticipated accepted usage. Urban planners and the science agree that electric rail is the right investment, because increasing the use of electric trains to satisfy our needs is the most efficient, and least emitting method of transporting people long distances. Movement over shorter distances in a deepening Climate Crisis should be centered around active transportation and micromobility, again focusing on extremely low emissions movement.

33-3 The planning initially indicated a network of electric trains through the center of the county, along the I-15 corridor, and also connecting in many East-West configurations. But with an assumption that North County residents will never have a willingness to use trains, instead it resulted in a degraded regional rail plan with pessimistic propensity scores dictating which communities would be served in 2050 by rail and who would have to fall back on Bus Rapid Transit and continue using cars seemingly forever. (images from SANDAG Transportation, Regional Planning, and Borders Committees Joint Meeting 8/7/2020)



**RESPONSE TO COMMENT 33-2**

As an initial matter, this comment relates to the contents of the proposed Plan and not to the adequacy of the Draft EIR’s analysis.

As discussed throughout the Draft EIR and particularly in Appendix C, *Climate Change Projections, Impacts, and Adaptation*, of the EIR, SANDAG is aware of and deeply concerned about the implications of climate change on the San Diego region.

As described in Section 4.8, the 2017 Scoping Plan establishes the statewide framework for achieving the goal of a 40 percent reduction from 1990 GHG levels in 2030 and putting post-2030 statewide emissions on a downward trajectory toward the long-term statewide GHG reduction goals for 2045 and 2050. The 2017 Scoping Plan indicates that to achieve these targets and goals, long-term investments in renewable energy generation, electrified transportation, energy efficient and decarbonized buildings, enhanced industry efficiency, restoration of California’s natural and working lands, and sustainable solid waste management are among many actions the State must take. In addition, the State has not adopted a plan analogous to the 2017 Scoping Plan that addresses achieving the EO S-3-05 goal of reducing statewide GHG emissions by 80 percent below 1990 levels by 2050 or the B-55-18 goal of achieving statewide carbon neutrality no later than 2045.

As discussed in the Final EIR (page 4.8-40), available research and reports indicate that achieving statewide GHG reduction goals will require major shifts or even fundamental transformations in the economic, social, technological, and political fabric of life in California and beyond, including the development of new technologies and large-scale deployment of new and existing technologies; and in the roles of local, State, and the federal government in regulating economic activities and personal behaviors that affect GHG emissions. The precise pathway to meeting the State’s mid-century goals (e.g., achieving carbon neutrality no later than 2045; reducing emissions to 80 percent below 1990 levels by 2050) is still unclear, but would require the decarbonization of the State’s electrical sector; decarbonization of existing buildings and new construction; electrification of the entire transportation sector; investments in healthy soils; sustainable solid waste and wastewater management; and carbon dioxide removal

strategies, such as land-based carbon sequestration and direct air capture of CO<sub>2</sub>.

The required GHG reductions from the aforementioned sectors will be achieved through a coordinated effort by, at minimum, State, regional, and local agencies, organizations, and stakeholders, and is well beyond the scope and jurisdiction of SANDAG alone.

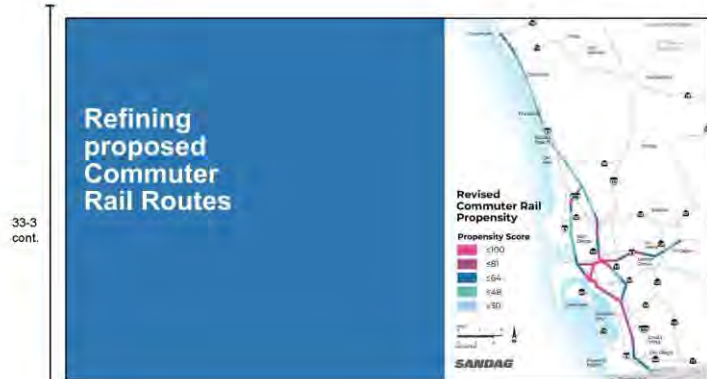
SANDAG investments will also support the transition of transit and freight vehicles to zero emission including funding for hydrogen fuel cell electric buses and battery electric buses. The proposed Plan supports investments in the electrification of cars, trucks, and buses and their supporting infrastructure (e.g., EV charging stations and hydrogen fueling stations) and supports the transition of transit and freight vehicles to zero emission including funding for hydrogen fuel cell electric buses and battery electric buses. These electric vehicle investments are one of the ways SANDAG is working to reduce regional GHG emissions and improve local air quality. Appendices A (Table A.17) and B of the proposed Plan show SANDAG's proposed EV commitments such as regional electric vehicle and charging infrastructure incentive programs. Innovation and advanced technologies will be critical to meeting regional GHG reduction goals in 2035.

Furthermore, as discussed in Chapter 2, SANDAG updates the Regional Plan every 4 years, and, as the State continues to identify new plans and technologies to meet the mid-century GHG emission targets, SANDAG will be able to implement these features into future plans to further the region's progress toward the State's goal of carbon neutrality by 2045.

### **RESPONSE TO COMMENT 33-3**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

Following the 5 Big Moves data-driven approach to develop a comprehensive and integrated transportation system, the project-evaluation criteria methodology relied on regional data and information analyzed with geospatial tools (ArcGIS) and spreadsheets (Excel). SANDAG used GIS analytics and data, including land use density, access to transit, car ownership, and income to refine the networks. Origin-destination pairs were analyzed and refined to assess which routes warranted commuter rail solutions and which warranted alternate transit solutions that would reduce automobile use.



33-3 cont.

This was a massive change in strategy after the 5 Big Moves had been described for more than a year as having a Transit Leap. California's High Speed Rail (HSRA) is only expected to serve Escondido and downtown San Diego, so it does not take the place of a regional rail line on the I-15 corridor.

33-4

The bike infrastructure plans are too slow, incremental, and don't fundamentally pattern streets for the radical mode shift we need. The RP has chosen to wait for a separate plan update for the regional bicycle network. Unfortunately the bike network is treated like a separate ancillary addition, forming a patchwork of insufficiently wide rail trails (actually Multi Use Paths) and painted class 1 bike lanes. It fundamentally fails to restructure the more dense areas as walkable and bikeable cities. This will result in continuing to miss projected targets of increasing Active Transportation that is necessary for lower emissions in our cities' Climate Action Plans. This Regional Plan is for 28 of the most critical years that San Diego will ever face, yet the plans don't meet the depth of mode shift needed. Single occupancy cars are still given deference in 2050, creating no fundamental change.

33-5

This plan's inclusion of new rail in the South Bay is admirable and reinforces the need to move people who are expected to embrace transit. But the plan is placing too little emphasis on mass transit in the rest of the county, attempting to reduce congestion with Managed (HOT) Lanes and underwhelming carpooling strategies, assuming that most San Diegans will never give up their cars. This is not the right response from planners who are tasked with helping us radically reduce VMT. Although the Report does acknowledge the reduction of per capita VMT, it actually predicts an increase in VMT by 6.7% because of new population growth. That is completely unacceptable with our world in the balance.

**RESPONSE TO COMMENT 33-4**

As an initial matter, this comment relates to the contents of the proposed Plan, and not to the adequacy of the Draft EIR's analysis.

The projects from the active transportation network were laid out and prioritized based on the analysis performed in Riding to 2050, SANDAG's Adopted Regional Bike Plan. While the deadline year for build out is 2050, this just means it would be proposed to be completed by that time. Many projects will likely be completed earlier. This is especially true as new funding sources become available. Additionally, as an early action out of the proposed Plan, SANDAG will be developing a new Regional Active Transportation Network in which projects will be reassessed and reprioritized based on data and community engagement. Finally, the intention of the network proposed in this Plan is a regional framework which facilitates trips associated with regional purposes (trips to school and work, trips within Mobility Hubs, trips to major destinations, and others). The regional network complements the much more extensive networks that local jurisdictions plan and construct on their own streets.

**RESPONSE TO COMMENT 33-5**

Commuter Rail Line 582 is included in the proposed Plan to serve north-south travel needs in Sorrento Mesa, National City, Kearny Mesa, and University Heights. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is completing a more detailed ridership analysis of this route.

The proposed Plan is focused on creating more mobility options for all people in the San Diego region through a fast, reliable, and fair public transportation system and micromobility options such as e-bikes and scooters, rideshare, and microtransit shuttles. The Plan also proposes a network of Managed Lanes using existing infrastructure that provides priority access for people using transit, carpooling, or vanpooling. The Managed Lane Network supports transit services making transit a compelling alternative to driving.

The proposed Plan maximizes the region's existing roads using technology to manage how lanes are used, which reduces traffic congestion and delay. The proposed network of Managed Lanes also encourages carpooling, vanpooling, and taking transit, which creates more roadway capacity without adding additional lanes.

As discussed in Draft EIR Section 4.16, achieving further reductions in the total and per capita VMT generated within the region depends upon additional State policy actions and funding, as well as local jurisdictions' review and entitlement of individual land use development projects and Regional Arterial System (RAS) transportation projects. In addition, transportation sponsors other than SANDAG, such as Caltrans, must evaluate and potentially mitigate any induced VMT that may be associated with the implementation of enhancements to the freeway and State Highway System.

The Draft EIR proposes mitigation measure TRA-2, which focuses on project-specific mitigation measures that can and should be implemented to further reduce the region's total VMT and VMT per capita. SANDAG cannot require local agencies implementing development projects, or other transportation project sponsors not receiving TransNet grants, to adopt the mitigation measures, and it is ultimately the responsibility of the CEQA lead agency to determine and adopt mitigation. In addition, the State has indicated that additional State policy actions and funding would be required to close the VMT gap between what the MPOs could achieve through implementation of their SCSs and reductions needed to meet State goals.



33-6 The DEIR states, "RTP transportation network improvements must be "revenue constrained" (23 CFR 450.324(f)(11), meaning that the MPO has specified the public and private funds that are reasonably expected to be available and that are needed to implement the proposed transportation plan."  
 Though the mandate may state that the RTP must be revenue constrained, this ultimately forces it to be compromised to the extent that it does not satisfy the other constraints, such as legally mandated climate emissions reductions goals.

It is plain to see that the plan was altered to be more affordable and politically more acceptable by current SANDAG board representatives. That is a disservice to the future generations that this plan underserves. With VMT still going up in the wrong direction, and not enough influence of increasing Passenger Miles Travelled via high density rail movement, the plan fails to account for any worse case scenarios demanded by future emissions reductions goals.

Because the plan is revised every 4 years, if the 2050 vision is valuable for anything, it is critical as a way of driving the big swings in mass transit, and laying the foundation for the difficult task of building electrified permanent infrastructure for transit and walkable and bikeable streets in all our communities to connect them to transit, thus reimagining extremely low impact travel.

33-7 This plan relies on Bus Rapid Transit using Managed Lanes to ensure those buses move in a timely manner, which we cannot guarantee without a fully dedicated bus lane. Furthermore, buses leaving the main route to meet riders at off-road transit stations as the 235 route currently does, makes the BRT solution significantly slower, than traveling the same distance by car. The choice to use BRT instead of rail, fails to invest in what would be the faster, cheaper to operate, higher capacity system, not subject to conflict with road traffic. The use of "HOT" paid access to prioritize the wealthy while leaving behind those without the means to pay ever-changing Managed Lanes tolls, is an inequitable policy that should be abandoned. If Managed Lanes are a lever to encourage reduction of VMT through the enhancement of per vehicle Passenger Miles Traveled, then the policy cannot have loopholes for the wealthy driving solo, even if HOT lane policy might be expected to fund other programs. While today, there are HOV privileges for EVs, hybrids, and motorcycles, the plan doesn't describe a specific trigger for when those privileges will be rescinded. As internal combustion cars are phased out and EVs are the norm, it will no longer make sense, or be possible, to allow them to use those Managed Lanes in single occupancy mode. Despite the state's insistence the HOV lanes reduce emissions, there is little evidence to show that Managed Lanes induce carpooling. The plan shows only an eventual 6.4% reduction in percentage of car mode share in 2050 compared to 2016 (85.9% -> 79.5%), meaning it is failing miserably to diminish car driving behaviors. If the intention of Managed Lanes is to reduce congestion in the hope that cars move more freely, the reduced congestion will discourage the necessary mode shift to adoption of GHG-reducing, higher PMT mass transit. Marginally reducing congestion is an outdated goal, no longer relevant in a community that is now tasked with eliminating GHG emissions rather than just slightly cutting them. Managed lanes were described during the community engagement phase of the RTP as a dynamic sign-based system in the 5 Big Moves preview, one that could be operated without the creation of any new lanes. Here it is shown as a feature of the Next OS, which is described as

**RESPONSE TO COMMENT 33-6**

As an initial matter, this comment relates to the contents of the proposed Plan, and not to the adequacy of the Draft EIR's analysis.

Planning a better transportation system that reduces congestion, addresses social equity considerations, and meets State and federal mandates for reducing GHG emissions and air pollution is key to SANDAG's vision for the region. Revenues to fund the projects do not come in all at once, but dollars that are available are applied to ensure that the best projects are initiated first and, as the comment suggests, lays the foundation for future changes to come.

Also as the commenter notes, SANDAG updates the Regional Plan every 4 years, and, as the State continues to identify new plans and technologies to meet the mid-century GHG emission targets, SANDAG will be able to implement these features into future plans to further the region's progress toward the State's goal of carbon neutrality by 2045.

**RESPONSE TO COMMENT 33-7**

As an initial matter, this comment relates to the contents of the proposed Plan, and not to the adequacy of the Draft EIR's analysis.

The proposed Plan places emphasis on maximizing the use of existing facilities to add corridor capacity to ease congestion while also trying to meet State and federal greenhouse gas and air quality targets. The proposed Managed Lanes Network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit (including Bus Rapid Transit), carpools, vanpools, and low-emission vehicles with appropriate decals. The system of Managed Lanes and supporting connectors support Transit Leap and HOVs to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes. Solo drivers will have options to use the lanes, but at a price, and transit services can travel congestion free. The result is better optimization of the system that encourages higher occupancy travel but with real alternatives that are competitive with driving.

SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are



impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources. SANDAG also will collaborate with State and federal agencies that are partnering to evaluate road charge programs in California.

The Plan proposes an expanded public transit network including commuter rail, light rail, Rapid bus, and local bus services. The network was developed to be a comfortable, convenient option to the automobile. The commuter rail service connects the highest demand trip areas between residents and employment centers. The purple line alignment through City Heights is being studied in the South Bay to Sorrento Comprehensive Multimodal Corridor Plan currently underway. Funding for the relocation of rail on the Del Mar Bluffs to a tunnel is prioritized in the proposed Plan.



But the plan calls for the creation of hundreds of miles of additional lanes. Any new lane miles will add capacity and induce new demand, thus increasing VMT and emissions.

33-8 Regarding the Plan Alternatives, Sierra Club prefers Alternative 3 to the actual Plan. The increased focus on infill and associated benefits of access to transit and mobility options are responsible policy that will limit habitat disruption, protect native species, and drive down emissions more quickly, although we feel this is not enough, nor is it fast enough.

33-9 Our community members cannot build their own train system nor can they build their own separated bike lanes. They rely on SANDAG planners to witness the proven low emissions strategies that other cities are using to radically prepare for a low GHG emissions future. The car, truck and SUV have brought us high emissions and pollution, and extremely high congestion, and we cannot afford the time and risk of phasing out internal combustion cars to replace them with an equal number of substantially heavier, battery electric EVs which have no advantage in reducing congestion. The next generation will look at this plan, at how it morphed from one of great promise to one of great fiscal compromise, in a time that we could not afford to favor business-as-usual over dramatic mode shift. The Climate Crisis is expected to get substantially worse, and this plan contains far too much incrementalism. The Climate Emergency demands bold plans with dramatic reductions in overall VMT and with contingencies within the plan, to accelerate more rapid emissions reductions as we continually reevaluate and find that accelerated emissions reductions are absolutely necessary.

Sincerely,  
Karl Aldinger  
Organizer - Sierra Club San Diego

**RESPONSE TO COMMENT 33-8**

The Sierra Club’s support for Alternative 3 is acknowledged. At the conclusion of the EIR process, the decision-makers (in this case the SANDAG Board of Directors) make final determinations as to the feasibility of alternatives, considering information in the Draft EIR, additional information in the Final EIR and elsewhere in the administrative record, and policy factors (see CEQA Guidelines Section 15091(a)(3)). Therefore, this comment will be provided to the Board of Directors and will be considered before it makes a decision on adopting a final Regional Plan.

**RESPONSE TO COMMENT 33-9**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

That said, SANDAG understands the commenter’s concerns, which align with the proposed Plan’s goal of healthier air and reduced GHG emissions regionwide, while facilitating the efficient movement of people and goods and providing access to affordable, reliable, and safe mobility options for everyone. The proposed Plan is a long-range planning document and is required by federal law to provide a reasonably feasible funding strategy for the projects, policies, and programs of the Plan. Significant additional work, including public involvement, pilot testing, legislation, and much more will be necessary to inform implementation of elements of the proposed Plan. At a minimum this Plan is updated every four years with the latest in planning ideas and concepts.

We appreciate your support and feedback. Please continue to follow along in this process by visiting [SDForward.com](http://SDForward.com).

**COMMENT LETTER 34: CHATTEN BROWN, CARSTENS & MINTER LLP (ON BEHALF OF SIERRA CLUB SAN DIEGO)**

Comment Letter 34

**Hermosa Beach Office**  
Phone: (310) 798-2400

**San Diego Office**  
Phone: (619) 940-4522



**Chatten-Brown, Carstens & Minter LLP**

2200 Pacific Coast Highway, Suite 318  
Hermosa Beach, CA 90254  
www.cbcearthlaw.com

**Sunjani Supekar**  
Email Address:  
s.sunjani@cbcearthlaw.com  
Direct Dial:  
310-798-2400 Ext. 7

October 11, 2021

Via E-mail (RegionalPlanEIR@sandag.org)  
Kirsten Uchitel  
Associate Planner, SANDAG  
401 B Street, Suite 800  
San Diego CA, 92101

Dear Ms. Uchitel,

On behalf of the San Diego Chapter of the Sierra Club, we are providing the following comments regarding the Draft 2021 SANDAG Regional Plan (“Regional Plan” or “Plan”) and Draft Environmental Impact Report (“DEIR”). Please also see additional letters submitted separately by members of Sierra Club San Diego for further comments on the Regional Plan and DEIR, explaining deficiencies of the Regional Plan and requesting improvements.

Because the Regional Plan fails to sufficiently reduce greenhouse gases and vehicle miles travelled, and protect biological resources, we urge SANDAG to revise the Plan and recirculate a new DEIR. The DEIR contains deficiencies, which we have described below.

34-1

**I. The Regional Plan Fails to Sufficiently Reduce GHG Emissions.**

The Regional Plan fails to sufficiently reduce greenhouse gas (“GHG”) emissions. Courts have emphasized the importance of regional transportation and land use planning in meeting statewide GHG reductions. (*Cleveland National Forest Foundation v. San Diego Assn. of Governments* (2017) 17 Cal.App.5th 413, 429 (“*CNFF II*”), *Golden Door Properties, LLC v. County of San Diego* (2020) 50 Cal.App.5th 467, 533-34 (“*Golden Door II*”).) Yet the Regional Plan will have significant and unavoidable impacts to greenhouse gas emissions, as it is inconsistent with the state’s ability to achieve statewide GHG reductions under SB 32, EO S-3-05, and EO B-55-18. (Impact GHG-5, DEIR, p. 4.8-35 to -52.)

**A. The DEIR’s GHG Mitigation Measures Violate CEQA.**

“Formulation of mitigation measures shall not be deferred until some future time.” (CEQA Guidelines § 15126.4, subd. (a)(1)(B).) Deferral of the development of mitigation is only allowable where “specific performance criteria” are required at the

34-2

**RESPONSE TO COMMENT 34-1**

This comment asserts that the proposed Plan fails to sufficiently reduce GHG emissions and refers to more detailed comments provided later in the letter. It is true that the Draft EIR found that the proposed Plan would have significant and unavoidable impacts to greenhouse gas emissions. This comment does not assert any reasons why those findings are inadequate.

**RESPONSE TO COMMENT 34-2**

The comment restates the program-level mitigation measures. The description of these measures as “impermissible deferred mitigation” is not explained in detail in this comment. In general, however, mitigation measures in a first-tier EIR for a program-level project such as the proposed Plan may contain generalized mitigation criteria and policy-level alternatives (*Koster v. County of San Joaquin* (1996) 47 Cal.App.4th 29). See *California Native Plant Society v. City of Rancho Cordova* (2009) 172 Cal.App.4th 603 (the details of exactly how the required mitigation and its performance standards will be achieved can be deferred pending completion of a future study). The proposed Plan “integrates land use, transportation systems, infrastructure needs, and public investment strategies within a regional framework,” and its EIR is a first-tier Program EIR for which mitigation measures may be more generalized than in a project-level EIR. (see Draft EIR page 1-1.)

This comments assert that Draft EIR mitigation measures GHG-5a, GHG-5b, GHG-5c, and GHG-5d lack specific performance criteria. However, these mitigation measures do include specific performance standards as described below.

**GHG-5a Allocate Competitive Grant Funding to Projects that Reduce GHG Emissions and for Updates to CAPs or GHG Reduction Plans** (pages 4.8-46 to 4.8-47).

By adopting this measure, SANDAG would commit to two actions: (1) implementing a grant program(s) that allocate(s) funding on a competitive basis to underfunded GHG-reducing projects that implement strategies or measures included in an adopted climate action plan (CAP) or GHG reduction plan, and (2) as part of next cycle of the *TransNet* Smart Growth Incentive and Active Transportation Grant Programs Smart Growth Incentive Program, continue to require locally

adopted CAPs or GHG reduction as prerequisites to be eligible for grant funding, and make funding available for local jurisdictions to prepare and update CAPs and GHG reduction plans that keep pace with future longer-term State targets and goals for GHG emissions reductions.

Mitigation measure GHG-5a does include specific performance standards that the grant program(s) will be required to achieve, as described below.

First, the measure commits SANDAG to achieving additional *annual* GHG emissions reductions during the proposed Plan horizon by implementing projects that would otherwise not occur due to insufficient funding and additional *cumulative* GHG emissions reductions during the proposed Plan horizon by implementing projects ahead of schedule and realizing GHG reductions earlier than they would otherwise occur due to timing of funding availability. To ensure that this measure achieves additional annual and/or cumulative GHG emissions reductions, funding applicants are required to demonstrate, to SANDAG's satisfaction, that their projects would not be financially feasible, either due to insufficient funding or the timing of funding availability, in the absence of SANDAG funding.

Second, to receive the competitively awarded grant funding, projects must be included in an adopted CAP or GHG reduction plan. That adopted CAP or GHG reduction plan is required, in part, to establish a locally appropriate 2030 GHG reduction target for community-wide emissions derived from the State's legislative 2030 target, and to quantify how local GHG reduction strategies, programs, and measures would meet or exceed the 2030 target. Applicants are also required to estimate the GHG emissions reductions from their project, subject to review and approval by SANDAG.

Third, the measure includes a commitment by SANDAG to structure the grant program(s) by using evaluation criteria, evaluation criteria weighting, or similar means that prioritize the allocation of funds to projects that include measurable programs for achieving the GHG emissions reduction targets identified in that jurisdiction's adopted CAP or GHG reduction plan. This measure also includes a commitment by SANDAG to report annually to the Board of Directors on the estimated GHG reductions achieved by the projects funded through this grant program.

It is not possible at this time for SANDAG to establish additional performance criteria for this mitigation measure in the form of a

specific numeric amount of GHG emissions reductions that would be achieved by implementation of the grant program(s). While examples of the types of projects that would be eligible for funding are listed in the measure (e.g., existing building retrofits to reduce electricity or natural gas use or install onsite renewable energy systems), there is not sufficient information available at this time about the nature, scope, size, location, and other details of specific projects that would apply for funding (e.g., number, type, age, and condition of buildings that would be retrofitted; number, system size, and type of onsite renewable energy systems installed).

Lastly, SANDAG has made the following minor revisions to the text of mitigation measure GHG-5a to clarify the points raised in this response. The following revisions also reflect edits made in response to comment Chatten-Brown 34-3.

**GHG-5a Allocate Competitive Grant Funding to Projects that Reduce GHG Emissions and for Updates to CAPs or GHG Reduction Plans.** ~~Prior to December 2025 (adoption of the next Regional Plan), and beginning as soon as~~ No later than December 2023, SANDAG shall implement a grant program(s) that allocate(s) funding on a competitive basis to underfunded GHG-reducing projects that implement the stated strategies or measures in local jurisdiction CAPs or GHG reduction plans. To be eligible, CAPs or GHG reduction plans shall meet the minimum criteria specified below. Examples of such projects to reduce GHG emissions include existing building retrofits to reduce electricity or natural gas use or install onsite renewable energy systems, activities at the local level that reduce VMT, Smart Cities<sup>3</sup> measures that result in the reduction of GHG, programs and infrastructure to divert organic waste from landfills, and tree planting. ~~The purpose of such new and/or revised grant program(s) shall is to:~~ (1) achieve additional annual GHG emissions reductions during the proposed Plan horizon by implementing projects that would not otherwise occur due to insufficient funding, and (2) achieve additional cumulative GHG emissions reductions under the proposed Plan planning horizon by implementing projects ahead of schedule and realizing GHG reductions earlier than they would otherwise occur due to timing of funding availability. Reducing total annual and cumulative GHG emissions under the proposed Plan planning horizon would reduce the proposed Plan's contribution to climate change.

To be eligible for grant funding, local jurisdictions would be required to have a CAP or GHG reduction plan adopted by the agency's elected decision-making body. Applicants shall provide sufficient evidence in their funding proposals demonstrating, to SANDAG's satisfaction, that their projects would not be financially feasible, either due to insufficient funding or the timing of funding availability, in the absence of SANDAG funding. Applications shall include estimated GHG emissions reductions from the project, which shall be prepared using established methods or protocols and shall be reviewed and approved by SANDAG. The grant program(s) shall be structured (e.g., using evaluation criteria and/or weighting of evaluation criteria) to prioritize the allocation of ~~allocate~~ funds to projects based on the amount of ~~that make~~ measurable progress they achieve towards achieving the GHG emissions reductions targets identified in that jurisdiction's adopted CAP or GHG reduction plan.

As part of next cycle of the *TransNet* Smart Growth, Incentive and Active Transportation Grant Programs Smart Growth Incentive Program to be released prior to December 2023, SANDAG shall: (1) continue to require locally adopted CAPs or GHG reduction as prerequisites to be eligible for grant funding, and (2) make funding available for local jurisdictions to prepare and update CAPs and GHG reduction plans that keep pace with future longer term State targets and goals for GHG emissions reductions. Any new or updated CAP or GHG reduction plan receiving funding through this program shall also meet the following minimum criteria:

- The CAP or GHG reduction plan shall be adopted by the jurisdiction's elected decision-making body.
- The CAP or GHG reduction plan shall establish a locally appropriate 2030 GHG reduction target for communitywide GHG emissions derived from the State's legislative target for 2030 (as established by SB 32 or as amended by future legislation), and should establish long-term targets.
- The CAP or GHG reduction plan shall quantify, using substantial evidence, how local GHG reduction strategies, programs, and measures would meet or exceed the local GHG reduction target.

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<sup>3</sup> Smart Cities use Information and Communications Technology to enhance the quality and performance of public services in order to reduce resource consumption and operate efficiently. Investment in reliable technology and high-speed connectivity are critical to the success of Smart Cities.

- The CAP or GHG reduction plan shall establish a mechanism to monitor the plan's progress toward achieving the target, including reporting data to SANDAG consistent with, and inclusion in, the Climate Action Data Portal or similar database, and a requirement to amend the plan if it is not achieving adopted goals.

Sources of funding that SANDAG shall use include the grants to fund CAP implementation and the Resilient Capital Grants and Innovative Climate Solutions Program (approximately \$40 million dollars) identified in the proposed Plan (Table 2-13 in Chapter 2 and Near-Term Actions 9(b) and 9(d) in Appendix K, respectively). SANDAG shall also pursue federal and State partnerships to leverage additional dollars for these programs. SANDAG shall document and report to the SANDAG Board of Directors the activities funded by this grant program and the estimated GHG emissions reductions on an annual basis.

**GHG-5b. Establish New Funding Programs for Zero-Emissions Vehicles and Infrastructure.** (pages 4.8-47 to 4.8-48)

By adopting this measure, SANDAG commits to two actions: (1) establishing one or more new programs to allocate funding for zero-emission buses and infrastructure (e.g., EV charging equipment and/or hydrogen fueling stations), zero-emissions goods movement vehicles (e.g., medium- and/or heavy-duty trucks) and infrastructure, and electric micromobility (e.g., personal electric bikes, cargo delivery electric bikes, neighborhood electric vehicles) and associated infrastructure; and (2) establishing one or more programs to allocate funding for public and private light duty vehicle fleets in the San Diego region to install zero-emission vehicle infrastructure and/or purchase zero-emission vehicles (e.g., battery electric vehicles, fuel cell electric vehicles).

Mitigation measure GHG-5b does include a specific performance standard that the program will be required to achieve, as described below.

As described in the Draft EIR, the mitigation measure requires that new funding awarded through these programs shall be above and beyond that for which reductions in GHG emissions have already been considered as part of the off-model calculations to achieve the SB 375 target. In addition, SANDAG has revised mitigation measure GHG-5b to specify the number of electric bikes, zero-emission buses, and zero-



emission light-duty vehicles and/or chargers that will result from implementation of this measure. SANDAG has also revised this mitigation measure to clarify the timing and other details of implementation. The revisions to the text of mitigation measure GHG-5b are provided below.

**GHG-5b. Establish New Funding Programs for Zero-Emissions Vehicles and Infrastructure.** ~~Prior to December 2025,~~ SANDAG shall establish one or more new programs to allocate funding for zero-emission buses and infrastructure (e.g., EV charging equipment and/or hydrogen fueling stations), zero-emissions goods movement vehicles (e.g., medium- and/or heavy-duty trucks) and infrastructure, and electric micromobility (e.g., personal electric bikes, cargo delivery electric bikes, neighborhood electric vehicles) and associated infrastructure.

Eligible entities could include but are not limited to public transit operators for zero-emission bus and infrastructure funding; port tenants, distributors, wholesalers, warehouse developers and/or owners, truck owners and/or operators, truck manufacturers, infrastructure providers, and any company that has a fleet of medium- and/or heavy-duty trucks for zero-emission goods movement funding; and local residents, last mile delivery services, and ride-share and/or ride-hail services for electric micromobility funding and associated infrastructure.

SANDAG shall include approximately \$100 million by 2025 of the Electric Vehicle Program (Table 2-13 in Chapter 2 and Near-Term Action 9[b] in Appendix K), and approximately \$5 million of Transportation Demand Management funding for an electric bike incentive program (Table 2-13 in Chapter 2).

The funding for electric bikes will become available beginning in FY 2022 with the launch of a \$500,000 incentive program and will be expanded through FY 2025. This program will reduce GHG emissions by providing funding for, at minimum, 200 electric bikes and associated services.

The funding for zero-emission buses and infrastructure will become available in FY 2023 to enable investments in zero emission transit buses, zero emission school buses, and supporting infrastructure through partnerships with the transit agencies (the Metropolitan Transit System [MTS] and North County Transit District [NCTD]) and San Diego County Air Pollution Control District (APCD). This program

will reduce GHG emissions by providing funding for, at minimum, 100 zero-emission buses, as well as associated fueling/charging infrastructure and services.

Beginning in FY 2022 SANDAG will begin two planning strategies to inform transition to zero-emission goods movement: the California Energy Commission-funded Medium Duty/Heavy Duty EV Blueprint grant for San Diego Region in partnership with Port of San Diego, and the Caltrans-funded San Diego and Imperial Counties Sustainable Freight Implementation Strategy. SANDAG will also rely on the Portside Community Emissions Reduction Plan (CERP) and Maritime Clean Air Strategy (MCAS) to inform investment decisions. Investments in goods movement vehicle and infrastructure will begin in FY 2024.

~~Prior to December 2025~~, SANDAG shall also establish one or more programs to allocate approximately \$30 million in funding for public and private light duty vehicle fleets in the San Diego region to install zero-emission vehicle infrastructure and/or purchase zero-emission vehicles (e.g., battery electric vehicles, fuel cell electric vehicles). Eligible entities could include, but are not limited to, school districts, water districts, local jurisdictions, TNCs, private businesses, and non-profit organizations. New funding will be above and beyond that for which reductions in GHG emissions have already been considered as part of the off-model calculations to achieve the SB 375 target.

Beginning in FY 2023, SANDAG will formalize a partnership with CALeVIP San Diego County Incentive Project administrator to make available incentives for fleet charging infrastructure. Beginning in FY 2024, SANDAG will establish a vehicle incentive program that allocates funding incentives for public and private fleet vehicles. This program will reduce GHG emissions by providing funding for a minimum of 5,000 light-duty vehicles and/or chargers.

To further support this mitigation measure, SANDAG shall also participate in federal and State processes to support transportation electrification as well as pursue federal, State, and local partnerships to leverage additional dollars for these programs.

**GHG-5c Implement Nature-Based Climate Solutions to Remove Carbon Dioxide from the Atmosphere** (pages 4.8-48 to 4.8-49).

By adopting this measure, SANDAG commits to establishing a Nature-Based Climate Solutions Program that will remove CO<sub>2</sub> from the

atmosphere by restoring or enhancing natural infrastructure that uses or mimics natural processes to benefit people and wildlife.

Mitigation measure GHG-5c does include specific performance standards that the program will be required to achieve, as described below.

First, the measure commits SANDAG to implementing, or providing funding to implement, projects that restore or enhance native habitats to increase rates of carbon sequestration over baseline conditions. Toward this end, prior to implementation of any projects proposed for funding under this program, SANDAG shall prepare, or require the preparation of, studies demonstrating that such proposed projects would increase rates of carbon sequestration over baseline conditions. SANDAG shall document the proposed carbon sequestration for each project receiving funding under this program and provide a report to the SANDAG Board on an annual basis.

It is not possible at this time for SANDAG to specify a specific numeric amount of CO<sub>2</sub> that would be removed from the atmosphere. While examples of the types of projects that would be eligible for funding are listed in the measure (e.g., restoring buried or concreted watercourses to riparian habitat to return them to more natural conditions, restoration of fallow agricultural native coastal sage scrub and chaparral), there is not sufficient information available at this time about the nature, scope, size, location, and other details of specific projects that would apply for funding to be able to estimate the level of GHG reductions that would be achieved. (e.g., acreage, type of vegetative cover, soil type).

SANDAG has revised this mitigation measure to clarify that implementation will begin immediately upon adoption of the proposed Plan. The revisions to the text of mitigation measure GHG-5c are provided below.

**GHG-5c. Implement Nature-Based Climate Solutions to Remove Carbon Dioxide from the Atmosphere.** Beginning immediately upon adoption of the proposed Plan and pPrior to December 2025 (adoption of the next Regional Plan), SANDAG shall establish a Nature-Based Climate Solutions Program that will restore or enhance natural infrastructure that uses or mimics natural processes to benefit people and wildlife. Through this program SANDAG shall implement, or provide funding to implement, projects that restore or enhance native habitats to increase rates of carbon sequestration over baseline

conditions. Examples include, but are not limited to, restoring buried or concreted watercourses to riparian habitat to return them to more natural conditions, restoration of fallow agricultural native coastal sage scrub and chaparral, and removal of fill within salt and freshwater and restoration with wetland habitat.

Prior to implementation of any projects proposed for funding under this program, SANDAG shall prepare, or require the preparation of, studies demonstrating that such proposed projects would increase rates of carbon sequestration over baseline conditions. SANDAG shall document the proposed carbon sequestration for each project receiving funding under this program and provide a report to the SANDAG Board on an annual basis.

SANDAG shall use the Nature-Based Climate Solutions Program (approximately \$40 million) identified in the proposed Plan (Table 2-13 in Chapter 2 and Near-Term Action 9(e) in Appendix K) to fund projects under this program. Additional funding could come from the *TransNet* Environmental Mitigation Program Fund for mitigation projects that require restoration and/or land management grants for the restoration of land to native habitat. SANDAG shall also pursue federal and State partnerships to leverage additional dollars for this program.

**GHG-5d. Develop and Implement Regional Digital Equity Strategy and Action Plan to Advance Smart Cities and Close the Digital Divide.** (pages 4.8-49 to 4.8-50)

By adopting this measure, SANDAG commits to adopting a Regional Digital Equity Strategy and Action Plan that reduces GHG emissions by identifying and addressing gaps in accessing affordable, high-quality broadband service (Near-Term Action 6(c) in Appendix K). Access to broadband service allows for remote education, telemedicine, work from home, and the potential for other remote access opportunities that reduce car travel and associated GHG emissions.

Mitigation measure GHG-5d does include a specific performance standard that the program will be required to achieve, as described below.

As described in the Draft EIR, the measure commits SANDAG to reducing car travel and associated GHG emissions by increasing access to affordable, high-quality broadband service that in turn allows for remote education, telemedicine, and working from home. The increased access to broadband service results from the measure's allocation of

\$32 million to undertake projects in the Action Plan that have quantified GHG reductions. The measure also commits SANDAG to identifying and quantifying, where possible, the GHG reductions that will result from the Action Plan, and reporting annually to the SANDAG Board on the measure's funding expenditures and quantified GHG reductions.

It is not possible at this time for SANDAG to establish additional performance criteria for this mitigation measure in the form of a specific numeric amount of GHG emissions reductions that would be achieved by implementation of projects to increase access to broadband service that are identified in the Action Plan. This is because the data needed to quantify GHG reductions that would result from increasing access to broadband service are not currently available. While examples of the types of virtual activities that would be supported by increasing access to broadband service are included in the measure and would reduce car travel and associated GHG emissions (e.g., remote education, telemedicine, teleworking), there is not sufficient information available at this time about the specific attributes of communities that currently lack access to broadband service. Examples of these attributes include: communities' access to telehealth services; the types of jobs held by people in such communities and the ability of those jobs to be performed virtually; the extent of online delivery adoption for packages, medical devices and supplies, and food and household items; and the potential for utilizing remote services for governmental and social services.

SANDAG has revised this mitigation measure to clarify that implementation will begin immediately upon adoption of the proposed Plan. The revisions to the text of mitigation measure GHG-5d are provided below.

**GHG-5d. Develop and Implement Regional Digital Equity Strategy and Action Plan to Advance Smart Cities and Close the Digital Divide.** Subsequent to adoption of the proposed Plan and Prior to January 2023, SANDAG shall adopt a Regional Digital Equity Strategy and Action Plan that identifies and addresses gaps in accessing affordable, high-quality broadband service (Near-Term Action 6(c) in Appendix K). Access to broadband service allows for remote education, telemedicine, work from home, and the potential for other remote access opportunities that reduce car travel and the associated GHG emissions. Investment in reliable technology and high-speed

connectivity are critical to close the digital divide and the foundation of a Smart Cities efforts to become more efficient, use less resources and reduce GHG. The Action Plan will identify specific actions, responsible parties, and a timeline for implementing the strategies identified in the Action Plan. Prior to December 2024, SANDAG commits to researching and evaluating methodologies for and quantifying, where possible, the corresponding GHG reductions associated with improved access to remote services enabled by broadband (e.g., telehealth, remote work, distance learning, and other remote services). SANDAG shall implement the Next OS (approximately \$32 million) identified in the proposed Plan (Table B-1, Page B-5 in Appendix K) to fund projects that advance Smart Cities efforts and close the digital divide. SANDAG shall also participate in federal and State processes to support projects that increase access to broadband infrastructure, as well as pursue federal, State, and private partnerships to leverage additional dollars for these programs. SANDAG shall document SANDAG's funding expenditures and progress on implementing the Action Plan and provide a report to the SANDAG Board on an annual basis. Prior to December 2025 (adoption of the next Regional Plan), SANDAG will identify and commit approximately \$32 million to undertake projects in the Action Plan that have quantified GHG reductions. SANDAG shall document the funding expenditures and quantified GHG reductions and provide a report to the SANDAG Board on an annual basis.

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34-2 cont. “time of project approval.” (*Sacramento Old City Association v. City Council of Sacramento* (1991) 229 Cal.App.3d 1011, 1029.) “Simply stating a generalized goal for mitigating an impact does not allow the measure to qualify for the exception to the general rule against the deferred formulation of mitigation measures.” (*King & Gardiner Farms, LLC v. County of Kern* (2020) 45 Cal.App.5th 814, 856.) The DEIR relies on the following program-level mitigation measures which constitute impermissible deferred mitigation due to the lack of specific performance criteria:

- GHG-5a: Allocate Competitive Grant Funding to Projects that Reduce GHG Emissions and for Updates to CAPs or GHG Reduction Plans.
- GHG-5b: Establish New Funding Programs for Zero-Emissions Vehicles and Infrastructure.
- GHG-5c: Implement Nature-Based Climate Solutions to Remove Carbon Dioxide from the Atmosphere.
- GHG-5d: Develop and Implement Regional Digital Equity Strategy and Action Plan to Advance Smart Cities and Close the Digital Divide.

(DEIR, pp. 4.8-45 to -47.)

34-3 GHG-5a requires SANDAG to implement a competitive grant funding program, but does not allow such program to commence until 2023. Further, the mitigation measure does not ensure specific sources of funding for the program (requiring SANDAG to “pursue” funding), nor does it evaluate the performance of funded plans, instead delegating such authority to grant applicants. (DEIR, pp. 4.8-45 to -46.)

34-4 Further, GHG-5b, GHG-5c, and GHG-5d have no stated performance criteria.

34-5 The mitigation measures also lack enforcement mechanisms as required by CEQA. (Pub. Resources Code, § 21081.6, subd. (b); *Lincoln Place Tenants Assn. v. City of Los Angeles* (2007) 155 Cal.App.4th 425, 445.)

34-6 Further, Project-Level Mitigation Measure GHG-5e states that “transportation project sponsors *can and should* implement measures to reduce GHG emissions.” (DEIR, p. 4.8-48, emphasis added.) SANDAG states it does not have the authority to require other agencies to implement this measure (DEIR, p. 4.8-51), but to the extent SANDAG controls or provides funding for any such transportation projects, SANDAG must require that these mitigation measures are mandatory as a condition for receiving funding. Additionally, any projects relying on the Regional Plan DEIR must incorporate the Regional Plan DEIR’s mitigation measures. (CEQA Guidelines § 15168, subd. (c)(3).)

**RESPONSE TO COMMENT 34-3**

This comment asserts that mitigation measure GHG-5a “does not allow (the competitively funded grant program) to commence until 2023, does not ensure specific funding sources, or evaluate the performance of funded projects. These three points are responded to individually below.

Regarding commencement of the program, SANDAG has revised the mitigation measure to clarify that SANDAG will start to develop the program immediately upon approval of the Plan with award of grants no later than December 2023. Refer to response to comment Chatten-Brown 34-2 for the revised text of mitigation measure GHG-5a. This implementation date is based on the time to develop the program, secure funding, and include in the budget that would be adopted in July of 2022, and time to set out a call for projects, review applications, and get approvals of the Policy Advisory Committees (PACs) and the Board of Directors.

Regarding funding sources, the measure does identify specific funding sources for mitigation measure GHG-5a. It does not only commit SANDAG to pursue funding as asserted by the commenter. The EIR identifies the following specific funding sources for mitigation measure GHG-5a (page 4.8-47):

Sources of funding that SANDAG shall use include the grants to fund CAP implementation and the Resilient Capital Grants and Innovative Climate Solutions Program (approximately \$40 million dollars) identified in the proposed Plan (Table 2-13 in Chapter 2 and Near-Term Actions 9(b) and 9(d) in Appendix K, respectively).

Refer to response to comment Chatten-Brown 34-2 for the revised text of mitigation measure GHG-5a that clarifies the amount of funding that has been allocated to this measure.

Regarding performance evaluation, the measure does not delegate this authority to grant applicants as asserted by the commenter. As explained in the Draft EIR, grant applications are required to include estimated GHG emissions reductions from the project, and SANDAG is required to document and report to the Board of Directors annually on the estimated GHG reductions achieved from the grant program (pages 4.8-46 to 4.8-47). In addition, refer to response to comment Chatten-Brown 34-2 showing how the text of mitigation measure GHG-5a has



been revised to state that SANDAG shall review and approve the GHG emissions reductions estimates included in grant applications.

**RESPONSE TO COMMENT 34-4**

This comment asserts that mitigation measures GHG-5b, GHG-5c, and GHG-5d lack stated performance criteria.

Regarding GHG-5b, this measure provides new funding for zero-emissions busses and infrastructure, including at least \$100 million by 2025. That \$100 million figure is a performance criterion, as well as the requirement that that funding be used for zero-emissions busses and infrastructure. This mitigation measure's performance can easily be tracked by simply calculating the amount of additional funding procured for these zero-emissions buses and infrastructure, and comparing it to the \$100 million required by GHG-5b.

Mitigation Measure GHG-5c requires the preparation of studies showing that any proposed nature-based climate solutions would "increase rates of carbon sequestration over baseline conditions." This requirements acts as the performance standard for this measure. Additionally, this measure identified \$40 million of funding for this specific program. (Draft EIR 4.8-47.)

Mitigation measure GHG-5d similarly requires SANDAG to commit a specific amount of funds (\$32 million) to "to fund projects that advance Smart Cities efforts and close the digital divide" (page 4.8-49).

Additionally this measure provides: "SANDAG shall document SANDAG's funding expenditures and progress on implementing the Action Plan and provide a report to the SANDAG Board on an annual basis." The funding commitment and requirement to document expanded access are performance criteria.

Refer to response to comment Chatten-Brown 34-2 for additional information.

**RESPONSE TO COMMENT 34-5**

This comments asserts "lack of enforcement mechanisms" for mitigation measures GHG-5a, GHG-5b, GHG-5c, and GHG-5d. However, each of these measures does include an enforcement mechanism, as described below.

Mitigation measures GHG-5a through 5d each include a commitment that SANDAG "shall" implement the mitigation measure and each identifies the specific funding source(s) and amounts that SANDAG is committing to use to implement the mitigation measure (pages 4.8-46

to 4.8-49). To ensure these measures are implemented, SANDAG would adopt them as part of the Mitigation Monitoring and Reporting Program following certification of the EIR and adoption of the proposed Plan (CEQA Guidelines Section 15097). Moreover, as described in the Draft EIR under the heading, *Background: Summary and Status of Previously Adopted GHG Mitigation Measures* (pages 4.8-43 to 4.8-44), SANDAG successfully implemented the GHG emissions mitigation measures that it committed itself to and adopted as part of the EIR prepared for the 2015 Regional Plan.

#### **RESPONSE TO COMMENT 34-6**

This comment acknowledges that SANDAG does not have authority to require other agencies to implement certain mitigation measures, such as GHG-5e, but requests that SANDAG should, to the extent it “controls or provides funding for any such transportation projects . . . require that these mitigation measures are mandatory as a condition for receiving funding.” SANDAG’s ability to require other agencies to implement specific mitigation measures, and the Draft EIR’s use of the phrase “can and should” in its mitigation measures, is discussed in Master Response 2.

This response also argues that CEQA Guidelines Section 15168 subdivision (c)(3) requires that all mitigation measures in the proposed Plan be incorporated into any projects relying on this Draft EIR. Section 15168 subdivision (c)(3) states “[a]n agency shall incorporate feasible mitigation measures and alternatives developed in the program EIR into later activities in the program.” Notably, only “feasible” mitigation measures must be incorporated into a project that tiers off of a programmatic EIR. Because the determination of “feasibility” of any given mitigation measure is made at the project level, this Draft EIR cannot definitively say whether the mitigation measures discussed in the Draft EIR will or will not be incorporated into any specific project that tiers from this analysis. It is therefore not correct that *any* projects tiering off this Draft EIR *must*, in all cases, incorporate *every* mitigation measure discussed in the Draft EIR.

Further, if a second-tier project does not incorporate every EIR mitigation measure, this does not make the Program EIR mitigation measures invalid. Rather, the consequence is that the second -tier CEQA review may not rely on the Program EIR for CEQA streamlining for those significant impacts where Program EIR mitigation measures are not incorporated.

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34-7 Further, the DEIR asserts that Impact GHG-5 will be significant and unavoidable, as GHG emissions in the San Diego region will exceed SB 32 targets. (DEIR, p. 4.8-33.) This impact, however, is not unmitigable. Agencies are required to adopt all mitigation measures and discuss and analyze all feasible mitigation measures and alternatives before approving a project with significant impacts. (Pub. Resources Code § 21081; *King & Gardiner Farms, LLC*, *supra*, 45 Cal.App.5th 814, 865-66, 869.)

34-8 Finally, to maximize accountability and enforceability of mitigation, Sierra Club urges that all greenhouse gas emissions be mitigated locally in San Diego County.

**B. Calculations of GHG Emissions from Projects Contemplated by the Regional Plan Must Include the Actual Lifespan of the Projects.**

34-9 CEQA Guidelines section 15064.4, subd. (a) requires an agency to make a “good-faith effort, based to the extent possible on scientific and factual data,” to calculate the full GHG emissions expected from a project. Calculations of GHG emissions of transportation and other projects contemplated under the Regional Plan must include the period of construction and the actual lifespan of the projects rather than an unsupported, arbitrarily limited lifespan such as the periods of 30 years sometimes utilized in CEQA review documents for development projects. These assumptions were not identified in the DEIR’s GHG analysis (DEIR, pp. 4.8-1 to -52) or the Regional Plan’s Appendix X GHG Emissions Inventory.

**C. The Significance Threshold for Impact GHG-1 Is Inadequate.**

34-10 The significance threshold for Impact GHG-1 is whether the Regional Plan “[d]irectly or indirectly result[s] in an increase in GHG emissions compared to existing conditions.” (DEIR, p. 4.8-19.) Yet the severity of the climate crisis necessitates reductions in GHG emissions from baseline. (see, e.g., Intergovernmental Panel on Climate Change Report, *Climate Change 2021*, available at [https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC\\_AR6\\_WGI\\_Full\\_Report\\_summary.pdf](https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report_summary.pdf).) Given the severity of the climate crisis, supported by compelling evidence, a threshold that measures increases to GHG emissions is insufficient to evaluate the Regional Plan’s impacts on GHG emissions and the ongoing climate disaster. Instead, SANDAG should adopt a significance threshold focused on reductions of GHG emissions from baseline.

**RESPONSE TO COMMENT 34-7**

This comment asserts that Impact GHG-5 “is not unmitigable” and that agencies are required to adopt all mitigation measures and discuss and analyze all feasible mitigation measures and alternatives before approving a project with significant impacts.

The Draft EIR identifies Impact GHG-5 as a significant impact in the year 2030, 2045, and 2050. The Draft EIR identifies several mitigation measures to reduce this significant impact by achieving additional GHG emissions reductions above and beyond the reductions shown in the analysis for Impact GHG-5 (mitigation measures AQ-3b, AQ-3c, AQ-4, TRA-2, WS-1a, WS-1b, GHG-5a, GHG-5b, GHG-5c, GHG-5d, GHG-5e, and GHG-5f). However, even with the additional GHG emissions reductions from these mitigation measures, total regional GHG emissions would remain inconsistent with the State’s ability to achieve the 2030 reduction target of SB 32 and the 2045 and 2050 reduction goals of EO B-55-18 and EO S-3-05. Achieving the necessary level of reductions from all GHG emissions sectors will require a coordinated effort by, at minimum, State, regional, and local agencies, organizations, and stakeholders, and is well beyond the scope and jurisdiction of SANDAG alone. Therefore, the Draft EIR appropriately concludes that Impact GHG-5 would be significant and unavoidable.

The comment does not identify any additional feasible mitigation measures that would further reduce this significant GHG emissions impact, or provide any evidence to support its assertion that Impact GHG-5 “is not unmitigable.” The Draft EIR provides a detailed discussion of the types of actions required to achieve the statewide GHG emissions targets and goals analyzed in Impact GHG-5 and explains why SANDAG alone cannot bring about all of the needed reductions. No further response is required.

**RESPONSE TO COMMENT 34-8**

This comment “urges that all GHG emissions be mitigated locally in San Diego County.” This is not required by CEQA. Further, the Draft EIR mitigation measures (GHG-5a through GHG-5f) are focused on reducing GHG emissions within the San Diego region and on projects within the region that would remove carbon emissions from the atmosphere. EIR

mitigation measures do not include out-of-County offsets. No further response is required.

**RESPONSE TO COMMENT 34-9**

The comment asserts that GHG emissions calculations of transportation and other projects included in the proposed Plan “must include the period of construction and the actual lifespan of the projects” instead of using “an unsupported, arbitrarily limited lifespan such as the periods of 30 years sometimes utilized in CEQA review documents for development projects.” The Draft EIR properly estimates GHG emissions under implementation of the proposed Plan including from construction activities resulting from regional growth and land use change and transportation network improvements and programs as described below.

The GHG emissions projections included in the Draft EIR reflect GHG emissions that would be generated by activities associated with implementing the two main physical components of the proposed Plan: regional growth and land use change, and transportation network improvements and programs. It analyzes the combined emissions of these components.

The projections are reported out to 2050, because this the horizon year of the proposed Plan. Further, Executive Order S-3-05, which is included in the significance threshold for Impact GHG-5, also has a 2050 horizon year for GHG emissions reductions, and the 2017 Scoping Plan sets a path for achieving these GHG emissions reductions in 2050. Projecting Regional Plan GHG emissions beyond 2050 would be speculative due to likely but unknown changes in both economic activity and GHG reduction policies and technology.

Specifically, as explained in Draft EIR Section 4.8.4, *Environmental Impacts and Mitigation Measures*, the GHG emissions calculations included in the Draft EIR include “15 emissions categories,” one of which is the off-road equipment sector (Draft EIR page 4.8-19). As explained in Draft EIR Appendix H, the off-road equipment sector includes construction equipment emissions from implementation of regional growth and land use change and transportation network improvements and programs under the proposed Plan (Draft EIR Appendix H page X-37). Thus, GHG emissions from construction of projects included in the proposed Plan are accounted for in the GHG emissions calculations included in the Draft EIR.

The Draft EIR does not use “an unsupported, arbitrarily limited lifespan such as the periods of 30 years.” Further, the GHG emissions projections are not based on the “period of construction and the actual lifespan” of every individual transportation network improvement and land use development project included in the proposed Plan because the project-specific details needed to perform such analysis are not available at this time (e.g., project design, site conditions, type and number of equipment needed, site conditions, construction start date and duration). As explained in Draft EIR Chapter 4, *Environmental Impact Analysis Approach* (Draft EIR pages 4-1 to 4-2), this EIR analyzes impacts of the proposed Plan at the same level of detail as the proposed Plan and does not analyze the project-specific impacts of individual projects. Project-specific and site-specific details of subsequent transportation and land use projects will vary widely. When a first-tier Program EIR is prepared, “leaving project-specific details to subsequent EIRs when specific projects are considered” is a proper approach to CEQA tiering (In re Bay Delta [2008] 43 Cal. 4th 1143, 1174).

#### **RESPONSE TO COMMENT 34-10**

This comment asserts that the Draft EIR significance criterion for Impact GHG-1, which addresses whether the proposed Plan would directly or indirectly result in an increase in GHG emissions compared to existing conditions (2016), is inadequate because the severity of the climate crisis requires reductions in GHG emissions from baseline, and that instead SANDAG should use a significance threshold focused on reductions of GHG emissions from baseline.

It is misleading to imply that the significance threshold for Impact GHG-1 is the only Draft EIR GHG significance threshold. The Draft EIR in fact uses five significance criteria to evaluate whether implementation of the proposed Plan would have a significant GHG emissions impact (page 4.8-20). As described in the Draft EIR, these significance criteria were developed based on the Initial Study checklist questions provided in Appendix G of the CEQA Guidelines and CEQA Guidelines Section 15064.4 (page 4.8-20). Impact GHG-1, which is addressed by the commenter, is based on CEQA Guidelines Section 15064.4(b)(1), which states that lead agencies should consider, “the extent to which the project may increase or reduce greenhouse gas emissions as compared to the existing environmental setting.”

Three of the significance criteria address reductions of GHG emissions below baseline as requested by the commenter:

- GHG-2, which evaluates whether the proposed Plan would conflict with the SANDAG region's achievement of SB 375 GHG emissions reduction targets for 2035 (a 19 percent reduction from 2005 levels).
- GHG-3, which evaluates whether the proposed Plan would conflict with or impede achievement of an at least 30 percent reduction in per capita GHG emissions from the entire on-road transportation sector by 2035 compared to existing conditions (2016).

GHG-5, which evaluates whether the proposed Plan would be inconsistent with the State's ability to achieve the 2030 reduction target of SB 32 (40 percent below 1990 levels by 2030) and long-term reduction goals of EO S-3-05 (80 percent below 1990 levels by 2050) and EO B-55-18 (carbon neutrality no later than 2045).

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**II. The Regional Plan Has Significant Transportation Impacts Requiring Mitigation.**

**A. The Regional Plan Overly Emphasizes Roadway Construction and Fails to be Consistent with Statewide Climate Goals and Federal RTP Policy Objectives.**

**1. The Regional Plan is Inconsistent with Statewide Climate Goals.**

“CEQA requires public agencies like SANDAG to ensure that [] analysis stay in step with evolving scientific knowledge and state regulatory schemes.” (*Cleveland National Forest Foundation v. San Diego Assn. of Governments* (2017) 3 Cal.5th 497, 504 (“*CNEFF I*”).) Executive Order No. S-03-05, enacted in 2005, established GHG reduction targets to 80 percent below 1990 levels by 2050. (*Golden Door Properties, LLC v. County of San Diego* (2018) 27 Cal.App.5th 892, 895 (“*Golden Door I*”).) SB 32, enacted in 2016, “adopts a goal of reducing [GHG] emissions by 40 percent below 1990 levels by the year 2030”—a “necessary interim target to ensure that California meets its longer-range goal of reducing [GHG] emissions to 80 percent below 1990 levels by the year 2050.” (*Golden Door II, supra*, 50 Cal.App.5th 467, 488.) In 2008, SB 375 was enacted to “reduce GHG emissions through improved land use and transportation planning.” (*Id.* at 533, emphasis added.)

The Regional Plan’s emphasis on freeway construction is misguided and counterproductive to the goals of Executive Order No. S-03-05, SB 32, and SB 375. As the DEIR notes, on-road transportation of light-duty vehicles and passenger cars contributes the largest share of GHG emissions in the San Diego Region. (Table 4.8-7, DEIR, p. 4.8-23.) According to Table 4.16-6, the Regional Plan *increases* the total number of roadway lane miles within the region under Year 2025 conditions, as compared with baseline. (DEIR, p. 4.16-32.) This includes increases in miles from freeways, tollways, state highways, and arterials. (*Ibid.*) The Regional Plan will also result in an increase of average daily vehicular trips of 122,278. (*Ibid.*) The total number of roadway miles continues to increase under the 2035 scenario (DEIR, p. 4.16-36 [an increase of 622 miles]) and 2050 scenario (DEIR, p. 4.16-40 [an increase of 799 miles]). The DEIR mischaracterizes the increase of 799 roadway miles over baseline in 2050 as a “slight” increase, but that is an increase of 11.5 percent. (DEIR, p. 4.16-40.)

The Regional Plan, however, touts a decrease in roadway mode share under Year 2025 conditions of 3.3% under baseline, and a decrease of 0.18 miles—950 feet—of average length of vehicular trip under baseline. (DEIR, p. 4.16-32.) These paltry figures demonstrate the Regional Plan’s lack of ambition in meeting GHG reduction goals. While the roadway mode share decreases further under the 2035 and 2050 scenarios, the

**RESPONSE TO COMMENT 34-11**

The comment notes that implementation of the proposed Plan will increase the total number of roadway lane miles within the San Diego Region, under each Horizon Year:

- Year 2025 – Increases 233 lane miles
- Year 2035 – Increases 617 lane miles
- Year 2050 – Increases 788 lane miles

Please note that the transportation analysis information presented in the Draft EIR has been updated in the Final EIR. These updates are primarily due to minor modifications in the transportation network improvements included within the proposed Plan, as noted in Appendix B. Additionally, minor corrections to ABM 2+ were also made, which are detailed in Appendix S of the proposed Plan (page S-104).

The comment also notes that the proposed increase in roadway lane miles is counterproductive to the region’s ability to meet the State’s GHG emission goals, as prescribed in SB 32 and SB 375.

As an initial matter, it should be noted that much of the increase in lane miles under the proposed Plan would be managed lanes, not general purpose lanes, with the vast majority of new lanes in 2035 and 2050 being managed lanes. Although this comment’s notes that the average length of a vehicle trip “does not meaningfully change,” trip length alone is not a complete datapoint where managed lanes promotes carpooling, high-occupancy vehicles, and public transportation, all of which tend to lower per-capita VMT.

This comment is addressed in the Draft EIR, under TRA-2, as follows:

**2025 Conditions**

*Page 4.16-51:*

Additionally, as displayed previously in Table 4.16-6, implementation of the proposed Plan, in Year 2025, would increase the number of roadway lane miles within the region by ~~245~~ 233 miles. Some of the additional lane miles added to the network would be managed lanes (~~39~~ 34 miles); however, these improvements would still increase the overall vehicular capacity of the region’s roadway network, resulting in the potential for induced travel.

*Page 4.16-51:*

Implementation of the proposed Plan would also result in an increase of ~~477,196~~ 923,702 daily VMT generated within the San Diego region



compared to Baseline Year 2016 conditions, which is considered a substantial increase. Therefore, this impact (TRA-2) is considered significant in the year 2025 because the proposed Plan would not achieve the substantial VMT reductions needed to help achieve statewide GHG reduction goals.

### **2035 Conditions**

*Page 4.16-53:*

Additionally, as displayed previously in Table 4.16-10, implementation of the proposed Plan, under Year 2035 conditions, would increase the number of roadway lane miles within the region by ~~622~~ 617 net miles. The majority of the additional lane miles added to the network would be managed lanes (~~436~~ 449 miles); however, these improvements would still increase the overall vehicular capacity of the region's roadway network, resulting in the potential for induced travel.

*Page 4.16-53:*

Implementation of the proposed Plan would result in an increase of ~~2,520,860~~ 1,798,264 daily VMT generated within the San Diego region compared to Baseline Year 2016 conditions, which is considered a substantial increase. Therefore, this impact (TRA-2) is considered significant in the year 2035 because the proposed Plan would not achieve the substantial VMT reductions needed to help achieve statewide GHG reduction goals.

### **2050 Conditions**

*Page 4.16-55:*

Additionally, as shown in Table 4.16-14, implementation of the proposed Plan under Year 2050 conditions would increase the number of roadway lane miles within the region by ~~798~~ 788 net miles. The majority of the additional lane miles added to the network would be managed lanes (705 miles); however, these improvements would still increase the overall vehicular capacity of the region's roadway network, resulting in the potential for induced travel.

*Page 4.16-55:*

Implementation of the proposed Plan would result in an increase of ~~5,611,752~~ 4,519,230 daily VMT generated within the San Diego region compared to 2016 conditions, which is considered a substantial increase. Therefore, this impact (TRA-2) is considered significant in the year 2050 because the proposed Plan would not achieve the

substantial VMT reductions needed to help achieve statewide GHG reduction goals.

Therefore, the impacts associated with the additional roadway lane miles, as they relate to Section 15064.3 of the CEQA Guidelines as well as the proposed Plan's ability to achieve the substantial VMT reductions needed to help achieve the statewide GHG reduction goals, are identified and disclosed in the Draft EIR.

Additionally, please note that page 4.16-43 of the Draft EIR has been revised to remove the word "slightly" in describing the increase in roadway lane miles.

Finally, please note that Impact GHG-5 does evaluate the consistency of the proposed Plan with the state's ability to achieve statewide climate goals.

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34-11  
 cont. average length of vehicle trip does not meaningfully change over these time horizons.  
 (DEIR, pp. 4.16-36, 4.16-40.)

The Regional Plan emphasizes that its construction of hundreds of new roadway miles over the course of the Plan are primarily “managed” freeway lanes for the supposed benefit of bus rapid transit rather than comparably extensive commuter rail or dedicated bus lanes. (DEIR, p. 4.16-32.) But managed lanes will not be effective for bus rapid transit because these lanes will also be available for use by high occupancy and fee-payer vehicles that in turn will result in congestion and greatly reduced bus efficiency during critical daily “rush hour” transportation periods as evidenced by conditions on existing rapid bus/HOV lanes on Interstate 15, Interstate 805, Interstate 5, and elsewhere. In order to fully analyze transportation impacts, we request that SANDAG provide information on the performance of current bus rapid transit routes to compare operations during periods of congestion/non-congestion and determine whether these routes are effective when using the same lanes as HOVs and paying users.

34-12

And as shown in the list of projects in DEIR Appendix B, the Regional Plan includes massive new infrastructure to connect managed lanes between freeways and provide separate ramp infrastructure where buses must enter and exit freeways to access transit stations (DEIR, Appendix B) rather than the far more efficient method of bringing people directly to dedicated commuter rail or bus lanes.

**2. The Regional Plan is Inconsistent with the 2019 Federal RTP.**

The DEIR inaccurately concludes that the Regional Plan is consistent with the goals and “general intent” of the 2019 Federal RTP for 2025, 2035, and 2050. (DEIR, pp. 4.16-30, 4.16-35, 4.16-39, 4.16-43.) Under CEQA, “any” inconsistency between a project and an applicable land use plan must be disclosed in an EIR. (CEQA Guidelines § 15125, subd. (d), emphasis added.) Further, a “general” consistency with a plan cannot overcome a specific, fundamental, and mandatory inconsistency. (See *Spring Valley Lake Assn. v. City of Victorville* (2016) 248 Cal.App.4th 91, 101.) The Regional Plan’s increases to roadway miles in 2025, 2035, and 2050, increases to vehicle miles travelled (see Section II.B below), and continued dominance in mode share of roadway travel are completely inconsistent with the goal of the Federal RTP to “[m]ake transportation investments that result in cleaner air, environmental protection, conservation, efficiency, and sustainable living.” (DEIR, pp. 4.16-31 to -33, 4.16-37, 4.16-41.) Due to this inconsistency, the DEIR must find that Impact TRA-1 is significant, and propose mitigation measures for this impact.

34-13

**RESPONSE TO COMMENT 34-12**

he performance of the existing Rapid Bus service is not indicative of the projected future operations of the same services, or their effect on future VMT production within the region. This is because the majority of the region’s existing Rapid Bus services do not operate within exclusive or managed rights-of-way. Thus, the majority of these routes operate within mixed-flow traffic, which would not be the case with the implementation of the proposed Plan.

As noted in Table 4.16-14 of the Draft EIR, the proposed Plan would implement over 705 lane miles of HOV/Managed Lanes along freeways within the region. This is more than six times the number of HOV/Managed Lane miles that are available within the existing transportation network. Therefore, future Rapid Bus services will have substantially more opportunity to operate within exclusive or managed rights-of-way than what is provided today. It should also be noted that the proposed Plan includes additional operational improvements to the service, transit services, including dynamic transit routing, scheduling, and communications, as well as implementation of smart intersections (see Table A.15 in Appendix A of the proposed Plan for additional details). The benefits associated with these improvements are not reflected through the existing performance of the Rapid Bus services. As such, the existing Rapid Bus operations do not correctly reflect future conditions, and are not relevant to the analysis conducted for Impact TRA-2.

The performance of all future transit services within the San Diego region, including the Rapid Bus services that utilize the Managed Lanes included within the proposed Plan, were evaluated using SANDAG’s updated second generation Activity Based Model (ABM2+). The ABM2+ forecasts future travel patterns within the region based on several factors including, but not limited to, population, employment, available transportation facilities (including Managed Lanes) and services (including Rapid Bus), travel speeds, roadway congestion, and pricing. The ABM2+ is the most up-to-date transportation forecast within the San Diego region and is the best tool in which the metrics used to evaluate effects of land use growth and transportation network improvements can be measured at a regional level, including activity and tour (trip) generation, mode split, average trip length, and VMT. As such, the ABM2+ is the most accurate way to project future transit ridership and its effect on VMT within the region. Thus, the regional

VMT analysis conducted under Impact TRA-2 was done as accurately as possible, using the best tools available for projecting future transportation patterns and conditions, including Rapid Bus and other transit services.

Finally, please note that the transit improvements included in Draft EIR Appendix B were coded into and accounted for within the ABM2+ model. The ABM2+ model does account for additional travel times and delays that could occur with buses entering and existing the freeway managed lanes to access transit stations. Therefore, the projected efficiency of the proposed transit system, with the implementation of the proposed Plan, was correctly analyzed under TRA-2..

#### **RESPONSE TO COMMENT 34-13**

This comment asserts that the Draft EIR improperly finds that the proposed Plan is “generally consistent” with the 2019 Federal RTP at the 2025, 2035, and 2050 horizons, but that because the proposed Plan results in increases in roadway miles and total-VMT, as well as “continued dominance in mode share of roadway travel,” it is actually inconsistent with the goal of the Federal RTP to “[m]ake transportation investment that result in cleaner air, environmental protection, conservation, efficiency, and sustained living.”

This comment fails to explain how the proposed Plan is inconsistent with the broad policy goals quotes from the 2019 Federal RTP. The quoted Federal RTP policy goals do not make any increase in roadway capacity inconsistent; to the contrary, as discussed in response to comment Chatten Brown 34-11, much of the roadway capacity increase is for Managed Lanes, which have the effect of lowering per-capita VMT and resulting in cleaner air and greater efficiency.

The Draft EIR’s findings are based on substantial evidence. For example, the Draft EIR finds that the proposed Plan is consistent with the Federal RTP goal cited in this comment because “[t]he proposed expansion of the region’s transit network would also provide more viable multi-modal options for travelers, resulting in reductions in both VMT per capita and VMT per employee within the region, thus reducing GHG emissions, creating a cleaner and more sustainable environment” (Draft EIR page 4.16-31; see also Table 4.16-15). These calculations were performed using the ABM2+ modeling, the most up-to-date transportation forecast within the San Diego region.

In addition, this comment is addressed directly within the Draft EIR as follows:

*Year 2025 – Page 4.16-33*

- *Make transportation investments that result in cleaner air, environmental protection, conservation, efficiency, and sustainable living. The proposed expansion of the region's transit network would also provide more viable multi-modal options for travelers, resulting in reductions in both VMT per capita and VMT per employee within the region, thus reducing GHG emissions, creating a cleaner and more sustainable environment.*

Please note that the increase in VMT under Year 2025 conditions is associated with the anticipated growth in population and employment within the region, and is not directly associated with the increase in roadway lanes miles. As such, implementation of the proposed Plan will result in a decrease in total VMT of 3,729,924 miles as well as a decrease in VMT per Capita of 1.07 miles, when compared to Year 2025 no-build conditions (See table below). Therefore, the proposed Plan is consistent with the 2019 Federal Plan goal of “*Make transportation investments that result in cleaner air, environmental protection, conservation, efficiency, and sustainable living.*” It is assumed that growth in regional population and employment is the predominant factor in the projected increase in total VMT from Base Year (2016) conditions.

*Year 2035 – Page 4.16-38*

- *Make transportation investments that result in cleaner air, environmental protection, conservation, efficiency, and sustainable living. The associated decreases in average vehicular trip length and travel times noted above would result in a lower average VMT per capita and VMT per employee within the region (see Table 4.16-18). These decreases in vehicular traffic would result in lower GHG emissions, creating a cleaner and more sustainable environment.*

Please note that the increase in VMT under Year 2035 conditions is associated with the anticipated growth in population and employment within the region, and is not directly associated with the increase in roadway lane miles. As such, implementation of the proposed Plan will result in a decrease in total VMT of 8,961,822 miles as well as a decrease in VMT per Capita of 2.22 miles, when compared to Year 2035 no-build conditions (See table below). Therefore, the proposed Plan is consistent with the 2019 Federal Plan goal of “*Make transportation*

*investments that result in cleaner air, environmental protection, conservation, efficiency, and sustainable living*” and that it is assumed that growth in regional population and employment is the predominate factor in the projected increase in total VMT from Base Year (2016) conditions.

*Year 2050 – Page 4.16-43*

- *Make transportation investments that result in cleaner air, environmental protection, conservation, efficiency, and sustainable living. The associated decreases in average vehicular trip length and travel times noted above would result in a lower average VMT per capita and VMT per employee within the region (see Table 4.16-19). These decreases in vehicular traffic would result in lower GHG emissions, creating a cleaner and more sustainable environment.*

Please note that the increase in VMT under Year 2050 conditions is more associated with the anticipated growth in population and employment within the region, and is not directly associated with the increase in roadway lanes miles. As such, implementation of the proposed Plan will result in a decrease in total VMT of 11,937,229 miles as well as a decrease in VMT per Capita of 2.87 miles, when compared to Year 2050 no-build conditions (See table below). Therefore, the proposed Plan is consistent with the 2019 Federal Plan goal of “*Make transportation investments that result in cleaner air, environmental protection, conservation, efficiency, and sustainable living.*” and that it is the assumed growth in regional population and employment is the predominate factor in the projected increase in total VMT from Base Year (2016) conditions.

To clarify information presented in the Draft EIR, the following tables show that the additional roadway miles included in the proposed Plan will not increase VMT within the region as compared to the No-Build conditions. Therefore, including the additional roadway miles in the proposed Plan is not inconsistent with the Federal RTP.

**VMT Analysis - Year 2025**

<b>Metric</b>	<b>Base Year (2016)</b>	<b>Year 2025 No Build</b>	<b>Year 2025 Proposed Plan</b>	<b>Δ Proposed Plan to 2016</b>	<b>% Change from Proposed Plan to 2016</b>	<b>Δ Proposed Plan to No Build</b>	<b>% Change from Proposed Plan to No Build</b>
VMT per Capita (miles)	18.94	18.73	17.66	-1.28	-6.8%	-1.07	-5.7%
Total VMT (daily)	83,614,704	88,268,330	84,538,406	923,702	1.1%	-3,729,924	-4.2%
Home-Based VMT	61,848,362	64,134,236	60,470,401	-1,377,961	-2.2%	-3,663,835	-5.7%
Population	3,265,489	3,424,145	3,424,145	158,656	4.9%	0	0.0%
Employment	1,646,419	1,789,965	1,762,747	116,328	7.1%	-27,218	-1.5%
VMT per Employee (miles)	18.91	18.41	16.95	-1.96	-10.4%	-1.46	-7.9%
VMT per Service Population (miles)	17.02	16.93	16.30	-0.72	-4.3%	-0.63	-3.7%
Population within TPAs	764,847	991,785	1,456,876	692,029	90.5%	465,091	46.9%
Employment within TPAs	609,253	742,870	971,340	362,087	59.4%	228,470	30.8%
Service Population within TPAs	1,374,100	1,734,655	2,428,216	1,054,116	76.7%	693,561	40.0%



**VMT Analysis - Year 2035**

<b>Metric</b>	<b>Base Year (2016)</b>	<b>Year 2035 No Build</b>	<b>Year 2035 Proposed Plan</b>	<b>Δ Proposed Plan to 2016</b>	<b>% Change from Proposed Plan to 2016</b>	<b>Δ Proposed Plan to No Build</b>	<b>% Change from Proposed Plan to No Build</b>
VMT per Capita (miles)	18.94	18.80	16.58	-2.36	-12.5%	-2.22	-11.8%
Total VMT	83,614,704	94,374,791	85,412,968	1,798,264	2.2%	-8,961,822	-9.5%
Home-Based VMT	61,848,362	67,184,526	59,251,034	-2,597,328	-4.2%	-7,933,492	-11.8%
Population	3,265,489	3,573,645	3,573,645	308,156	9.4%	0	0.0%
Employment	1,646,419	1,936,818	1,922,475	276,056	16.8%	-14,343	-0.7%
VMT per Employee (miles)	18.91	18.19	15.26	-3.65	-19.3%	-2.93	-16.1%
VMT per Service Population (miles)	17.02	17.13	15.54	-1.48	-8.7%	-1.59	-9.3%
Population within TPAs	764,847	1,135,597	1,985,967	1,221,120	159.7%	850,370	74.9%
Employment within TPAs	609,253	800,730	1,323,929	714,676	117.3%	523,199	65.3%
Service Population within TPAs	1,374,100	1,936,327	3,309,896	1,935,796	140.9%	1,373,569	70.9%

**VTM Analysis – Year 2050**

<b>Metric</b>	<b>Base Year (2016)</b>	<b>Year 2050 No Build</b>	<b>Year 2050 Proposed Plan</b>	<b>Δ Proposed Plan to 2016</b>	<b>% Change from Proposed Plan to 2016</b>	<b>Δ Proposed Plan to No Build</b>	<b>% Change from Proposed Plan to No Build</b>
VTM per Capita (miles)	18.94	18.90	16.03	-2.91	-15.4%	-2.87	-15.2%
Total VTM	83,614,704	100,071,163	88,133,934	4,519,230	5.4%	-11,937,229	-11.9%
Home-Based VTM	61,848,362	69,918,150	59,300,949	-2,547,412	-4.1%	-10,617,201	-15.2%
Population	3,265,489	3,699,373	3,699,373	433,884	13.3%	0	0.0%
Employment	1,646,419	2,095,301	2,087,318	440,899	26.8%	-7,983	-0.4%
VTM per Employee (miles)	18.91	18.21	14.32	-4.59	-24.3%	-3.89	-21.4%
VTM per Service Population (miles)	17.02	17.27	15.23	-1.79	-10.5%	-2.04	-11.8%
Population within TPAs	764,847	1,201,517	2,125,868	1,361,021	177.9%	924,351	76.9%
Employment within TPAs	609,253	864,936	1,470,233	860,980	141.3%	605,297	70.0%
Service Population within TPAs	1,374,100	2,066,453	3,596,101	2,222,001	161.7%	1,529,648	74.0%

Please note that the transportation analysis information presented in the Draft EIR has been updated in the Final EIR. These updates are primarily due to minor modifications in the transportation network improvements included within the proposed Plan, as noted in Appendix B of the Plan. Additionally, minor corrections to ABM 2+ were also made, which are detailed in Appendix S of the Plan (page S-104).

**B. The Regional Plan Subverts Statewide Goals by Increasing Vehicle Miles Travelled.**

34-14 The Regional Plan results in an increase of 477,196 daily VMT above baseline under 2025 conditions, 2,520,860 daily VMT above baseline under 2035 conditions, and a staggering 5,611,752 daily VMT under 2050 conditions. (DEIR, pp. 4.16-47, 4.16-49, 4.16-51.) The Regional Plan thus fails to meet the qualitative significance threshold adopted by SANDAG—not only does the Regional Plan fail to “achieve the substantial VMT reductions needed to help achieve statewide GHG reduction goals,” it actively *increases* VMT in the region throughout the life of the Plan. Increase in VMT is completely antithetical to the state’s GHG reduction goals. (California Air Resources Board, 2017 Scoping Plan-Identified VMT Reductions And Relationship To State Climate Goals, January 2019; *Golden Door II*, 50 Cal.App.5th 467, 544 [“VMT reduction is an integral part of California’s strategy to reach 2030 and 2050 GHG emission reduction targets.”].) Further, the Regional Plan fails to meet the VMT per capita reduction goal of 14.3% by 2050 as required by CARB. (DEIR, p. 4.16-51.)

The DEIR interpolates interim VMT reduction goals for 2025 and 2035 by using a “straight-line interpretation line of the full 14.3 percent reduction in VMT per capita and the 34 years (Base Year 2016 to Horizon Year 2050) the region has to achieve that target,” thus assuming a VMT reduction requirement of 0.4% per year. (DEIR, p. 4.16-46.) The DEIR states that even though the interim reductions of 7.2% in 2025 and 11.6% in 2035 do not meet the 14.3% required reduction, they “remain on target” because they meet the interim target goals that SANDAG has interpolated. (DEIR, p. 4.16-47 to -49.) The DEIR offers no analysis that such an interpolation is supported by substantial evidence. (CEQA Guidelines § 15064, subd. (f)(5) [“Argument, speculation, unsubstantiated opinion or narrative, or evidence that is clearly inaccurate or erroneous, or evidence that is not credible, shall not constitute substantial evidence. Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts.”].)

**C. Mitigation Measures for Transportation Impacts Must be Enforceable.**

34-15 Mitigation measures must be enforceable. (Pub. Resources Code, § 21081.6, subd. (b); *Lincoln Place Tenants Assn. v. City of Los Angeles* (2007) 155 Cal.App.4th 425, 445.) The DEIR’s stated mitigation measures for TRA-2, Achieve Further VMT Reductions for Transportation and Development Projects, permits local jurisdictions to implement such VMT reductions at their discretion. For example, the measure states that “SANDAG shall, and other transportation project sponsors, the County of San Diego, cities, and other local jurisdictions *can and should* implement project-level VMT

**RESPONSE TO COMMENT 34-14**

As the comment points out, the proposed Plan would result in an increase in the total VMT generated within the region as follows:

- Year 2025 Conditions: 477,196 daily VMT
- Year 2035 Conditions: 2,520,860 daily VMT
- Year 2050 Conditions: 5,611,752 daily VMT

Please note that the transportation analysis information presented in the Draft EIR has been updated in the Final EIR. These updates are primarily due to minor modifications in the transportation network improvements included within the proposed Plan, as noted in Appendix B. Additionally, minor corrections to ABM 2+ were also made, which are detailed in Appendix S of the proposed Plan (page S-104). Therefore, the increases in total regional VMT are now:

- Year 2025 Conditions: 923,702 daily VMT
- Year 2035 Conditions: 1,798,328 daily VMT
- Year 2050 Conditions: 4,519,230 daily VMT

As noted on page 4.16-48:

Because there are no State-recommended total VMT significance thresholds for regional plans such as an RTP/SCS, a qualitative threshold is used: would the proposed Plan achieve the substantial VMT reductions needed to help achieve statewide GHG reduction goals? If the Regional Plan would cause substantial increases in total VMT, then it would not achieve the substantial VMT reductions needed to help achieve statewide GHG reduction goals.

Therefore, because no guidance has been provided by the State on this issue the Draft EIR used a threshold of no change from baseline conditions as the threshold. To the extent this comment implies the Draft EIR does not disclose the significant impact of increased total VMT, the increase in daily VMT, from baseline Year 2016 conditions, was identified as a significant impact under Impact TRA-2, as noted in the following sections of the Draft EIR:

- 2025 Conditions - Page 4.16-48, Paragraph 5
- 2035 Conditions - Page 4.16-50, Paragraph 4
- 2050 Conditions - Page 4.16-52, Paragraph 2

Lastly, as noted on page 4.16-48 of the Draft EIR (last paragraph), interim VMT per capita targets were derived to identify if the proposed Plan would be on track to meet the State’s target of 14.3 percent

reduction in VMT per capita by Year 2050, as compared to baseline conditions. It is clearly stated in the last sentence of the paragraph “*The interim VMT per capita targets were not used to determine impact significance.*” This is further reflected in the TRA-2 conclusion sections, for each horizon year, where the State’s target of 14.3 percent is used as the significance threshold for each horizon year and not the identified interim VMT per capita target. Thus the methods used for interpolating interim VMT reduction goals are not relevant to the EIR’s analysis and disclosure of significant VMT impacts.

**RESPONSE TO COMMENT 34-15**

This comment refers to the use of the phrase “can and should” in mitigation measures where another agency, and not SANDAG, would have the responsibility to implement and carry out. Please refer to Master Response 2 for a response to this comment, where it is described why the use of this language is specifically allowed by CEQA in these circumstances.

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 cont. reduction measures.” (DEIR, p. 4.16-53, emphasis added.) This discretionary language makes the mitigation measure non-enforceable, and thus in violation of CEQA.

**III. The DEIR Fails to Adequately Analyze and Mitigate Impacts to Biological Resources.**

34-16 The Regional Plan fails to sufficiently protect biological resources by erroneously concluding that significant impacts are unavoidable and by failing to identify significant conflicts with several existing and planned regional habitat conservation plans (DEIR, pp. 4.4-61 to 113). The Regional Plan also fails to implement adequate mitigation measures.

**A. The Regional Plan is Inconsistent with Federal, State, and Local Goals to Protect Biological Resources.**

The DEIR’s assertion that Impact BIO-4 is less than significant lacks substantial evidence. The Regional Plan is in clear conflict with state and federal goals to protect 30% of land and water natural resources by 2030 (see Governor’s Exec. Order No. N-82-20 (Oct. 7, 2020); Exec. Order No. 14008, 86 Fed. Reg. 7619 (Feb. 1, 2021)). The Regional Plan is also in conflict with regional habitat conservation plans, which must be discussed in the DEIR. (CEQA Guidelines § 15125, subd. (d).)

34-17 If SANDAG maintains its current conclusions of significant and unavoidable impacts to BIO-1, BIO-2, and BIO-3 biological resources, SANDAG must also necessarily conclude that there will be similar significant and unavoidable conflicts with state and federal goals to protect 30% of land and water natural resources by 2030 and local regional habitat conservation plans (i.e., Impact BIO-4) given those plans’ reliance on the same minimization and mitigation measures SANDAG asserts cannot be guaranteed under BIO-1, BIO-2, and BIO-3. (See Section III.B below.)

34-18 The Regional Plan is also in conflict with regional habitat conservation plans because it does not provide a clear path to establishment of an essential regional funding source necessary to implement existing and planned regional habitat conservation plans. Existing regional habitat conservation plans like the San Diego Multiple Species Conservation Plan and Multiple Habitat Conservation Program anticipate and require establishment of a regional funding source to support implementation of the plans. The Regional Plan is the most appropriate planning tool available to provide a regional funding source for the regional habitat conservation plans yet does not include any planning for establishment of the regional funding source.

**RESPONSE TO COMMENT 34-16**

Section 4.4 of the EIR analyzes the impact on biological resources at a programmatic level based on best available information, including impacts on sensitive species, vegetation communities, wetlands, wildlife movement, and consistency with policies and approved HCPs. Impacts were analyzed based on the programmatic footprint developed for the proposed Plan, and mitigation measures were identified accordingly. Additional analysis will be conducted on a project-specific level under CEQA, including project-specific impact analysis of biological resources and identification of mitigation measures. The comment does not explain why the EIR “erroneously” concludes that significant impacts are unavoidable.

**RESPONSE TO COMMENT 34-17**

The comment asserts that impacts addressed in BIO-4 are not less than significant based on the fact that the proposed Plan is in conflict with State and federal goals to protect 30 percent of land and water resources by 2030, and that this goal would not be achieved if the impacts on BIO-1, BIO-2, and BIO-3 are unavoidable. The MSCP targets to protect 172,000 acres of natural lands (excluding agricultural lands); the MHCP targets to protect 19,000 acres. Approximately 100,000 acres of land in the North County MSCP will be unavailable for development. The majority of lands in the East County (approximately 90 percent) are public lands that are already conserved. The total amount of public lands (undeveloped or in open space) in San Diego County amounts to 1.7 million acres. With San Diego County having almost 3 million acres of landmass, of which approximately 2 million is undeveloped or planned for conservation, the conservation percentage of San Diego County far exceeds 30 percent target. Therefore, the EIR is consistent with the goals identified in EO N-82-20 (October 7, 2020) and EO 14008, 86 *Federal Register* 7619. The comment also asserts that the proposed Plan is in conflict with regional HCPs. All approved HCPs have been included and addressed in this EIR, and impacts on approved HCPs have been analyzed; see discussion under Impact BIO-4 in Section 4.4 and Table 4.4-5. The HCPs have been designed to allow for impacts on biological resources so long as the appropriate mitigation measures are adhered to, including mitigation measures outlined in each participating jurisdiction’s ordinances and guidelines that reflect consistency with the regional HCPs and Subarea Plan. These guidelines and ordinances are listed (together with other representative ordinance and guidelines)

in Table 4.4-6. Each Subarea Plan has different conservation classifications, which were included in the data analysis and models in this EIR (see the *Analysis Methodology* under Impact BIO-4). The EIR assumes that all regional and local guidelines and ordinances would be adhered to, and that impacts on hardline preserves would be avoided at the project-specific design level. However, should impacts on hardline preserves be unavoidable, local ordinances governing the implementation of the Subarea Plans have provisions, such as Boundary Line Adjustments, that would be implemented to avoid the loss of highly valuable biological resources and conserved lands consistent with all legal and regulatory provisions of the HCPs. Therefore, the conclusion in Impact BIO-4 correctly identifies that the EIR is not in conflict with any approved HCPs.

**RESPONSE TO COMMENT 34-18**

Please refer to Master Response 1 for discussions regarding including a regional habitat conservation fund in the alternatives. The comment asserts that the proposed Plan does not provide a clear path to the establishment of an essential regional funding source to implement existing and planned regional HCPs. As described in Appendix A of the proposed Plan the final Plan has included a commitment to fund regional habitat conservation, management, and monitoring under a new funding allocation that when combined with the nature-based climate solutions program and habitat mitigation for transportation projects would total \$3 billion. Furthermore, each local jurisdiction that is signatory to the conservation plan and the Implementing Agreement with the Wildlife Agencies that provides the legal “take” authorizations identified in the conservation plan is obligated to fund local costs for land conservation, acquisition, management, and monitoring.

**B. The DEIR’s Biological Resources Mitigation Measures Violate CEQA.**

SANDAG significantly undermines the potential effectiveness of measures to minimize and mitigate impacts to biological resources by concluding that impacts will remain significant because other agencies implementing the plan may not fully implement mitigation measures described in the Regional Plan.

34-19 According to the Regional Plan DEIR, “Implementation of mitigation measures BIO-1a through BIO-1e would reduce or minimize this impact (BIO-1). However, while projects under SANDAG’s control would adhere to these measures, there is no assurance that these mitigation measures would be implemented by non-SANDAG project sponsors or would be equally effective for all projects ... Instances may occur in which impacts are not reduced to less-than-significant levels. Therefore, this impact (BIO-1) would remain significant and unavoidable.” (DEIR, p. 4.4-78.)

SANDAG’s rationale here renders the mitigation measures non-enforceable, and is an abdication of SANDAG’s own responsibility as a lead agency to reach sound conclusions of impacts to the environment and adopt effective mitigation. Rather than minimizing its own responsibility, SANDAG should include language in the DEIR mandating implementation of DEIR mitigation measures for its own projects and for any other agencies implementing projects under the Regional Plan to the extent that they are likely to invoke SANDAG’s Regional Plan DEIR for their own CEQA review and compliance. Subsequent projects relying on the Regional Plan DEIR must incorporate the Regional Plan DEIR’s mitigation measures. (CEQA Guidelines § 15168, subd. (c)(3).)

34-20 Finally, an EIR is required to discuss and adopt all feasible mitigation measures. (*King & Gardiner Farms, LLC, supra*, 45 Cal.App.5th 814, 865-66, 869.) An additional mitigation measure should be added to BIO-4 requiring preparation of a detailed strategic plan to establish the regional funding source for the regional habitat conservation plans.

**IV. The DEIR Failed to Consider a Reasonable Range of Alternatives.**

34-21 The EIR failed to adequately analyze alternatives to the Project, because it did not include a reasonable range of alternatives that would “avoid or substantially lessen” the Project’s significant impacts, as required by CEQA at Public Resources Code section 21002 and CEQA Guidelines section 15126.6 subdivisions (a), (b). While Alternative 3 is the only alternative to reduce VMT further than the Regional Plan, none of the alternatives avoid or *substantially* lessen the Project’s impacts on VMT. (*Golden Door II, supra*, 50 Cal.App.5th 467, 547, citing *Cleveland National Forest Foundation v. San Diego Assn. of Governments* (2017) 17 Cal.App.5th 413, 437 [“it is reasonable to expect

**RESPONSE TO COMMENT 34-19**

Please see Master Response 2 and response to comment Chatten-Brown 34-6, which explain why the EIR’s approach to mitigation measures to be implemented in second-tier projects is consistent with CEQA requirements. As Master Response 2 explains, second-tier transportation project EIR mitigation measures, such as biological resource mitigation measures, would be implemented for transportation projects that SANDAG directly approves or carries out, and implementation of applicable and feasible mitigation measures would be a grant condition for capital projects funded by SANDAG’s TransNet grant programs.

**RESPONSE TO COMMENT 34-20**

To meet the region’s habitat conservation goals, the proposed Plan identifies approximately \$3 billion for habitat-related efforts. This includes \$2,087 million for an enhanced habitat conservation, management, and monitoring program (see Land Use and Habitat programs in Appendix B of the proposed Plan), a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (see Climate Adaptation and Resilience programs in Appendix B of the proposed Plan), and \$300 to \$500 million of land acquisition and restoration for habitat mitigation of transportation projects (incorporated in project costs presented in Appendix A of the proposed Plan). As such, an additional mitigation measure is not required.

**RESPONSE TO COMMENT 34-21**

Please refer to Master Response 1 for a response to this comment, which explains why the EIR’s alternatives analysis complies with CEQA requirements and addresses potential alternatives to substantially lessen VMT and biological resource impacts.



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cont. | at least one project alternative to have been focused primarily on significantly reducing vehicle trips.”].) SANDAG also fails to provide an alternative avoiding or substantially lessening the Project’s significant impacts on biological resources.

**V. Conclusion**

34-22 | Based on the foregoing comments, we respectfully request that SANDAG revise the Regional Plan and recirculate the DEIR to achieve further GHG and VMT reductions, improve protections for biological resources, and resolve the issues addressed in this letter.

Thank you for your consideration of this matter.

Sincerely,



Sunjana Supekar  
Josh Chatten-Brown  
Attorneys for Sierra Club San Diego

**RESPONSE TO COMMENT 34-22**

SANDAG appreciates the comments received for consideration. Please refer to prior responses for in depth discussions regarding the feedback received. Please continue to follow along in this process by visiting [SDForward.com](http://SDForward.com).

**COMMENT LETTER 35: SAVE OUR FOREST AND RANCLANDS/CLEVELAND NATIONAL FOREST FOUNDATION**



**SAVE OUR FOREST  
AND RANCLANDS**

P.O. Box 475 Descanso, CA 91916  
www.sofar.org sofar@nethere.com



P.O. Box 779 Descanso, CA 91916  
www.cnff.org info@cnff.org

Comment Letter 35

www.transitsandiego.org

October 7, 2021

**Via Email**

Kirsten Uchitel, Associate Planner  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101  
[RegionalPlanEIR@sandag.org](mailto:RegionalPlanEIR@sandag.org)

Re: **Draft San Diego Forward: The 2021 Regional Plan and its Draft Environmental Impact Report**

Dear Ms. Uchitel:

35-1 Save Our Forest and Ranchlands (SOFAR) and the Cleveland National Forest Foundation (CNFF), two organizations dedicated to progressive land use planning and the protection of vital natural resources, submit the following comments on San Diego Forward: the 2021 Regional Plan (the proposed Plan) and the draft environmental impact report (DEIR) for the proposed Plan. As detailed below, the proposed Plan inappropriately continues to emphasize auto-based transportation at the expense of much-needed public transportation. This approach will not allow the region to achieve its environmental or land use goals. In addition, the proposed Plan relies on speculative sources of funding and it is therefore unclear whether those public transportation projects that are included in the Plan will actually be funded and implemented.

35-2 The DEIR for the proposed Plan also fails to comply with the California Environmental Quality Act (CEQA). For example, the DEIR does not contain a legally defensible alternatives analysis and lacks a sufficient basis for rejecting SOFAR's and CNFF's Climate, Housing, Transit Alternative. In May 2020, we submitted a letter to the SANDAG Board of Directors urging the agency to include an alternative in the RTP DEIR capable of meeting housing and greenhouse gas (GHG) reduction goals that have been set collectively by the state of California, the City of San Diego, and SANDAG. That letter is attached and is incorporated by reference into this letter. The Climate, Housing, Transit Alternative is centered on building a 21st Century regional mobility system, beginning with a foundational first-phase area-complete transit, bike, and walk system in the "urban core" that is competitive with the automobile

**RESPONSE TO COMMENT 35-1**

This comment inaccurately describes the proposed Plan as emphasizing auto-based transportation at the expense of public transportation. The proposed Plan emphasizes connections to mobility options in neighborhood hubs—whether it be transit, ride share, shuttles, scooter or bike share, walking, or biking. By building out from these centers of activity to an even broader system of smart roadways and transit services, the proposed Plan provides alternatives to driving for both short and long trips around the region.

Transit Leap improvements make public transit a compelling option to driving—fast, convenient, and safe. Improvements include commuter rail, light rail, Rapid, local bus, and ferry service. Next Generation Rapid Service is a Rapid bus service operating in priority travel lanes and/or separated guideways and is given traffic signal priority. Commuter rail includes new and significantly upgraded rail service with high-speed trains that are fast and convenient and provide a compelling alternative to driving. Light Rail Transit (LRT) includes improvements to existing light rail services and new tram services.

Managed Lanes offer priority access to people using transit, carpooling, riding motorcycles, or vanpooling along with emergency vehicles and some low-emission vehicles with appropriate decals. Managed Lanes would be expanded by repurposing shoulders or existing travel lanes, as feasible. Managed Lane improvements are planned for both interregional and urban corridors. Interregional corridors connect us to neighboring counties and beyond and account for about 70 percent of vehicle miles driven on the region's freeways. Urban corridors connect local cities and account for 27 percent of vehicle miles driven on the region's freeways. Interregional corridor trips are typically longer than 20 miles while trips made on urban corridors are often between 5 and 20 miles. See Appendix A, Transportation Projects, Programs, and Phasing, of the proposed Plan at A-2.

This comment also inaccurately describes the financial plan included in the proposed Plan as speculative. Federal and State laws require SANDAG to develop a regional plan built on reasonable assumptions of the revenues that will be available during the period covered by that plan (Government Code Section 65080(b)(4); 23 CFR

450.322(f)(10)(ii)). See Appendix V, Funding and Revenue, of the proposed Plan for additional information about revenue sources.

Also, these introductory comments summarize more detailed comments, for which additional responses are provided below.

**RESPONSE TO COMMENT 35-2**

As explained in Master Response 1, the Draft EIR does evaluate a reasonable range of alternatives that achieve most of the basic project objectives, that are potentially feasible, and that reduce environmental impacts. The discussion also explains why the Draft EIR was not required to consider SOFAR's proposed Climate, Housing and Transit Alternative in detail. See Section 6.5.5 of the Draft EIR for additional discussion of the reasons for rejecting SOFAR's proposed Climate, Housing and Transit Alternative from detailed consideration.

35-2 cont. (i.e., that achieves at least a 50% transit, bike, and walk mode share in the urban core area).<sup>1</sup> As discussed below, SANDAG inappropriately declined to include this Alternative in the DEIR. Therefore, we respectfully reiterate our request for SANDAG to include the Climate, Housing, Transit Alternative in the EIR for the proposed Plan.

**SANDAG is Abdicating its Responsibility to Prepare a “Transit First” Plan.**

35-3 Even a cursory review of the DEIR reveals the proposed Plan does not represent the sea change in regional transportation and land use planning that is necessary to avert a climate catastrophe and to rectify the serious housing challenges facing the region’s residents. This past April, SANDAG committed to reimagining how people and goods move in the 21st century by implementing infrastructure that ensures, among other things, that public transit is competitive with automobile travel. See SANDAG Resolution No. 2021-17. The proposed Plan, however, eschews these admirable goals in favor of a much more “business-as-usual” approach. It is certainly not a “transit first” plan. Critical projects necessary to advance a comprehensive public transportation network, including for example the Miramar Tunnel and complete double-tracking of the COASTER, would not be constructed until 2050, if ever.

At the same time, the proposed Plan calls for \$50 billion in roadway expenditures. As SANDAG is well aware, projects that increase roadway capacity will continue to exacerbate far-flung sprawl development, which in turn will increase vehicle miles traveled (VMT). Pursuing expensive (and expensive) roadway projects is no longer supportable in the face of the housing and climate crises confronting the region. As SANDAG is aware, in order to achieve the region’s environmental and housing goals, the proposed Plan must encourage intensified, compact land use. Unfortunately, antiquated roadway projects—many of which would serve remote destinations—remain front and center in SANDAG’s proposed Plan.

35-4 The RDEIR claims that this highway-centric Plan would result in a 150 percent increase in “walk to transit” and “drive to transit” mode share. Yet this statistic and the information cited in support are misleading. The fact that people may be within walking distance to transit does not mean those people actually use transit. The DEIR indicates that “current” (2016) transit mode share in the SANDAG Plan area is 1.6% percent and is estimated to increase to 5% under the Build Scenario 2050. (DEIR Appendix T (Table T6: Supporting Measure)). At first glance, this increase in transit mode share would appear to suggest that the region is making substantial progress. Yet, the DEIR’s very low estimate of “current” transit mode share appears to be inaccurate, which renders the claimed increase to 5% misleading. The 2010-2012 California Household Travel Survey (CHTS) identifies existing transit mode share for San Diego County as 4.2% (i.e., 2 ½ times greater than that reported in the SANDAG regional travel demand model).<sup>2</sup> If transit mode share is in fact currently just over 4%, the fact that the Plan would increase

<sup>1</sup> Generally speaking, the urban core includes the trolley ring, downtown, the airport, the newly planned intermodal transit center. This area is approximately 60 square miles but has all the facilities, density, zoning, and jobs to launch a successful transit model for the region.

<sup>2</sup><https://www.nrel.gov/transportation/secure-transportation-data/tsdc-california-travel-survey.html> (calculations performed by Norm Marshall).

**RESPONSE TO COMMENT 35-3**

This comment inaccurately characterizes the nature of the roadway projects in the proposed Plan. The proposed Plan emphasizes connections to mobility options in neighborhood hubs—whether it be transit, ride share, shuttles, scooter or bike share, walking, or biking. By building out from these centers of activity to an even broader system of smart roadways and transit services, the proposed Plan provides alternatives to driving for both short and long trips around the region.

Transit Leap improvements do make public transit a compelling option to driving—fast, convenient, and safe. Improvements include commuter rail, light rail, Rapid, local bus, and ferry service. Next Generation Rapid Service is a Rapid bus service operating in priority travel lanes and/or separated guideways and is given traffic signal priority. Commuter rail includes new and significantly upgraded rail service with high-speed trains that are fast and convenient and provide a compelling alternative to driving. LLRT includes improvements to existing light rail services and new tram services.

Where possible, rather than adding new roads, the proposed Plan repurposes general purpose lanes or shoulders to create Managed Lanes. The Managed Lane system is important for supporting the transit network and Flexible Fleets envisioned in the proposed Plan. The Regional Plan is updated every four years, providing opportunities to reflect changes in the network. The proposed Plan’s improvements to the freeway system are limited to Managed Lanes using existing infrastructure such as general purpose lane conversion and shoulders to facilitate additional transit and HOV travel.

Rural corridors serve many remote destinations, mostly located along state routes traversing the eastern two-thirds of the region, and provide people access to rural towns and lands, as well as connectivity to the interstate system. Rural corridors are economic lifelines for rural communities and the region’s many tribal nations. Rural corridors provide access to jobs, education, and healthcare, as well as needed infrastructure for the movement of goods, deliveries, and emergency vehicles.

Along I-8 in East County, projects included in the proposed Plan benefit interchanges to this freeway with substantial safety improvements for SR 94, SR 76, and SR 79 and other state routes. Physical safety improvements are realized with a variety of projects, including shoulder

widening and curve straightening. The region's rural and tribal communities also need new investments in broadband infrastructure. This infrastructure is an essential part of the transportation technology envisioned along rural corridors, by providing travelers with real-time travel information and enabling access to Flexible Fleet options such as shuttles and other on-demand transportation services. But it will not only improve mobility along rural corridors, it will enable residents to, for example, work remotely and learn online.

For the roadway component of the proposed Plan, SANDAG is required to analyze induced demand impacts, which are documented in proposed Plan Appendix D. The activity-based model and other analyses used to inform the Plan have been reviewed through SANDAG's peer review process and documented in the technical methodology submitted to CARB, also included in Appendix D.

With respect to project phasing under the proposed Plan, the proposal for a "Transit First" plan fails to recognize that there are regulatory constraints on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or collected on an annual basis and much funding cannot be advanced. There are also regulatory constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network. For instance, federal formula funds such as Federal Transit Administration (FTA) Section 5307 or Regional Surface Transportation Program (RSTP) funds are apportioned annually; SANDAG can make assumptions about how much can be anticipated in the future based on historical data but has no ability to advance any project(s) that need the funding in years prior to apportionment. Other funds that SANDAG cannot advance and redirect to transit include funds going to other agencies, such as the State Highway and Protection Program (SHOPP) funds, which are managed by the California Transportation Commission and are used for safety, operations, and rehabilitation projects on the state highway system by Caltrans.

Specific to the comment that critical projects would not be constructed until 2050, the phasing of projects in the proposed Plan depends upon several factors including project readiness, connectivity, social equity, and anticipated revenues by implementation period. As the proposed Plan is implemented, phasing of projects may change if opportunities arise to advance projects into earlier phases of the Plan. All LOSSAN

double tracking projects are phased for completion in 2025 and 2035. Batiquitos Lagoon Double Track, San Onofre to Pulgas Double Track Phase 2, Eastbrook to Shell Double Track, and San Dieguito Double Track projects are phased for completion by 2025. Carlsbad Village Double Track, La Costa to Moonlight Double Track, Moonlight to Swami Double Track, San Onofre Creek Double Track (CP Songs Double Track), and San Mateo Creek Double Track projects are phased for completion by 2035. The Miramar Tunnel is phased for completion by 2050.

Regarding land use and housing, under the SCS for the proposed Plan, 31 Mobility Hub areas were identified as optimal locations for siting transit investments that maximize regional connectivity, and for focusing future transit-oriented growth. By 2050, 53 percent of the population, 71 percent of the jobs, and 54 percent of the housing for the region are projected to be in Mobility Hub areas. See Tables F.4 through F.6 in Appendix F of the proposed Plan for more details on the regional population, jobs, and housing within Mobility Hub areas. Development under the SCS for the proposed Plan is substantially more compact than previous plans, conserving far more land and open space due to densification in the Mobility Hub areas. The proposed Plan does “encourage intensified, compact land use,” and includes transportation network improvements, including roadway improvements, that support this land use goal. See Chapter 2 and Sections 4.2, 4.4, 4.11, and 4.14 of the EIR for more discussion of the land use impacts under the proposed Plan.

SANDAG is developing a Regional Housing Incentive Program to meet the goals of the proposed Plan and assist local jurisdictions in achieving housing goals. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, and consider climate change and resiliency, availability of transit and active transportation, and consistency with the transportation improvements included in the proposed Plan. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The Plan proposes a land use scenario that accommodates the Regional Housing Needs Assessment and, when combined with the transportation system, allows the region to meet its SB 375 greenhouse gas reduction target.

**RESPONSE TO COMMENT 35-4**

This comment inaccurately characterizes the mode share shifts achieved under the proposed Plan. This comment relies upon mode share numbers generated by the California Household Travel Survey (CHTS), which presents a less accurate picture of regional behavior and mode share than SANDAG's ABM2+ forecast, for several reasons. The CHTS was conducted by Caltrans between 2010 and 2013. This was during the time of the Great Recession, which created unique influences on travel behaviors and characteristics. The SANDAG ABM2+ was updated based on the San Diego Regional Transportation Study (SDRTS) conducted between 2016 and 2017. The SDRTS used smartphone-based travel diaries as the primary means of travel data collection and included nearly 6,200 participating households. From a data quality perspective, the SDRTS is considered superior to the CHTS based on the more recent time period for survey collection, travel survey data collection methodology, and San Diego region sample size. Additionally, the CHTS and the SDRTS are limited to travel surveys of residents. However, the ABM2+ forecasts travel for all types of trips—resident, visitor, cross border, airport, non-resident trips starting/ending external to San Diego, commercial, and truck. SANDAG collects supplemental travel survey and data on these other travel markets for inclusion in ABM2+ forecasts. Again, from a data perspective, the ABM2+ forecast, including mode share numbers, is superior to the CHTS numbers referenced in SOFAR's comment.

As shown in Appendix O-2 of the EIR, the transit mode share for all trips in 2050 is 5.2 percent under the proposed Plan, and the transit mode share for work trips in 2050 for peak period and all day is 13.2 percent. This comment inaccurately characterizes GHG reductions achieved under the proposed Plan. The proposed Plan achieves 20.4 percent per capita GHG reductions from passenger vehicles and light duty trucks by 2035 and exceeds the regional GHG reduction target of 19 percent.



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35-4 cont. transit mode share to 5% reflects almost no change at all. In any event, until SANDAG accurately characterizes existing transit mode share, any future mode share projections are not credible. Moreover, even if the Plan's 2050 transit mode share of 5.0% is accurate—which appears highly unlikely—this nominal increase in transit ridership does not come close to achieving the region's GHG reduction goals.<sup>3</sup>

35-5 The proposed Plan's focus on regional mode share also deprives both SANDAG and the public of information necessary to take the first foundational steps toward building a transit bike and walk system that is truly competitive with the auto—i.e., a system that achieves a 50% walk, bike and transit mode share—in areas surrounding mobility hubs. This is the level of investment and innovation that might actually start to meet GHG targets and VMT reduction goals. However, information on current and projected mode shares for specific area-complete transit systems such as the Central Mobility Hub are not to be found in the DEIR. Obviously, this a critical omission because it forecloses discussion on locating the first stepping stones and taking the first steps to meet the looming social, ecological, and health challenges facing the globe and our local region. San Diego is the seventh most ozone-polluted metro area in the country.<sup>4</sup> The proposed Plan fails to take meaningful steps toward mitigating the impacts of continued reliance on automobiles.

35-6 A definition of insanity often attributed to Albert Einstein is “doing the same thing over and over again and expecting different results”. If true, then San Diego is insane because we've been doing the same thing over and over with a growing inability to meet the existential challenges that face the region.

35-7 Paradoxically, the DEIR asserts that the purpose of the Plan's roadway-building component is to increase public transportation. (See DEIR at 6-13, stating that the Plan does not include general purpose lanes, but instead focuses on adding Managed Lanes which “increase the efficiency of roadway travel for vehicles and transit.”) The DEIR repeats this assertion in rejecting alternatives identified by members of the public. (See DEIR at 6-11, 6-13.) However, the DEIR fails to provide any factual support for the claim that Managed Lanes promote transit use. In order to justify road building as a measure of increasing transit ridership, the FEIR must actually model the effect that Managed Lanes have on transit ridership (i.e., how many transit trips would occur with Managed Lanes versus without Managed Lanes). It must also disclose the cost effectiveness of Managed Lanes per additional transit trip. Finally, it must disclose whether other types of transit investments would be more cost-effective and result in increased transit ridership compared to Managed Lanes. Without this information, the DEIR's conclusions regarding Managed Lanes' support for transit and its rejection of alternatives lack evidentiary support. The DEIR also fails as an informational document.

<sup>3</sup> The City of San Diego's Climate Action Plan identifies a 50% transit, walk and bike mode share for commuters within ½ mile of a major transit stop within City of San Diego by 2035; see Climate Action Plan p.37; available at [https://www.sandiego.gov/sites/default/files/final\\_july\\_2016\\_cap.pdf](https://www.sandiego.gov/sites/default/files/final_july_2016_cap.pdf); accessed September 28, 2021.

<sup>4</sup> American Lung Association, State of the Air Report Card, San Diego-Chula Vista-Carlsbad, at <https://www.lung.org/research/sota/city-rankings/msas/san-diego-chula-vista-carlsbad-ca/ozone>.

## RESPONSE TO COMMENT 35-5

DAG recognizes that substantial reductions in global, state, and regional GHG emissions are an urgent priority, and strives in its Regional Plans and programs to do its part in reducing GHG emissions from all sources. Section 4.8.1 of the EIR properly describes existing conditions related to GHG emissions, including background information on various greenhouse gases, their sources, and their potential to trap heat in the Earth's atmosphere and contribute to global warming. The EIR describes the main sources of GHG emissions in the state and in the San Diego region. The effects of climate change (“climate destabilization”) are summarized, with detailed description based on scientific studies of how climate change is anticipated to impact California and the San Diego region provided in EIR Appendix C. Section 4.8 also describes the regulatory setting for GHG emissions, providing descriptions of State legislation and EOs B-30-15 and S-3-05 goals for statewide GHG reductions. The statewide GHG reduction goals adopted by the Legislature and expressed by the Governor's EOs are based on limiting global warming to levels necessary to avoid potentially catastrophic climate change impacts.

CEQA does not require analyzing projected mode share for specific areas within the region in a programmatic impact analysis prepared for a comprehensive regional plan under CEQA. The degree of specificity required in an EIR corresponds to the degree of specificity involved in the underlying activity, which is described in the EIR. (CEQA Guidelines Section 15146.)

The Draft EIR properly evaluates the significant environmental impacts of the proposed Plan consistent with CEQA requirements, and concludes that the Plan would have significant and unavoidable GHG emissions impacts. The Draft EIR then identifies mitigation measures and alternatives to the proposed Plan that would reduce this significant impact. For more detail see EIR Section 4.8 and Chapter 6.0.

## RESPONSE TO COMMENT 35-6

This comment expresses an opinion about challenges facing the region. It does not address EIR adequacy, and no further response is required.

## RESPONSE TO COMMENT 35-7

is comment inaccurately asserts that Managed Lane investments do not support transit use. The Managed Lane system would support a robust network of Next Generation Rapid Service operating in priority travel

lanes and/or separated guideways and would be given traffic signal priority. Next Generation Rapid routes would provide competitive alternatives to single-occupancy vehicle travel and be connected via the Regional Mobility Hub Network. In addition, the proposed Managed Lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to modes of transportation that would reduce VMT over single-occupancy vehicles, i.e., transit, carpools, vanpools, and low-emission vehicles with appropriate decals.

Data from model runs comparing the proposed Plan network with Managed Lane investments to a network consistent with SOFAR’s proposed Climate, Housing and Transit Alternative, which omits new Managed Lanes, demonstrates that the proposed Climate, Housing and Transit Alternative’s impacts on VMT are similar to the proposed Plan’s impacts, and that it does not substantially reduce the proposed Plan’s significant impacts.

Database	Proposed Final Plan		SOFAR’s Climate, Housing and Transit Alternative	
	2035	2050	2035	2050
SB 375 VMT	79,725,710	81,804,496	79,877,932	82,247,926
SB 375 VMT/Person	22.0	21.8	22.1	22.0
Final Per Capita GHG Reductions for 2050	-20.4%	-21.0%	-20.4%	-20.7%

See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR’s proposed Climate, Housing and Transit Alternative from detailed consideration.

**The Proposed Plan Relies on Highly Speculative Funding Sources.**

The proposed Plan relies on revenue sources that are highly speculative and thus provides no assurance that the Plan's transit projects would be funded. The Plan identifies 163.3 billion in total revenues (2020 dollars). (Draft RTP Appendix V Table V.4, pp. 26-27.) This includes \$62.1 billion in "New" revenue sources:

- \$10.0 billion from 1/2 cent TransNet sales tax starting in 2025
- \$7.2 billion from 1/2 cent MTS sales tax starting in 2025
- \$2.2 billion in ride hailing service fees starting in 2026
- \$17.2 billion in state road user charges starting in 2026
- another \$17.2 billion in regional road user charges starting in 2026
- \$4.7 billion from assumed increase in Federal gas tax

All of these revenue sources are highly speculative. More than half of the "New" revenue is from road user charges that do not yet exist. The Draft RTP's sole justification for including this revenue is that a committee authorized by the Legislature is investigating the possibility of such charges. (See Draft RTP Appendix V, p. V-17 - V-18). According to transportation expert Norm Marshall, there is no authorization for or mechanism in place to collect such charges. The next largest components of the "New Revenue" are from two 1/2 cent sales taxes that the proposed Plan simply assumes will be approved by the voters. SANDAG similarly assumed additional sales tax revenue in connection with the 2015 RTP, but the voters rejected Measure A in 2016. Passage of these two additional tax increases is highly uncertain.

Moreover, the proposed Plan shows that 45% of the total Plan expenditures are for non-capital items including operations, local streets and roads, programs and debt service. These comprise about \$73.5 billion. (Draft RTP, Figure 3.3, Section 3, at 7). Without the "New" revenue sources, total revenue is only \$103.2 billion, leaving only about \$30 billion for capital projects or only one-third of the \$90 billion in capital projects in the Plan (\$55 of \$163.6 billion). If complete funding is not assured, there will be a large revenue shortfall. In this event, the FEIR should disclose which capital projects would be prioritized.

**The DEIR Lacks a Legally Defensible Alternatives Analysis.**

The alternatives analysis in the DEIR does not remedy the deficiencies identified by the California Court of Appeal in *Cleveland National Forest Foundation v. San Diego Association of Governments*. (17 Cal.App.5th 413, 435-437 (2017)). In that case, the Court determined that the EIR did not identify an alternative that results in a substantial reduction in VMT. The Court found this omission was inexplicable given SANDAG's acknowledgement in its Climate Action Strategy that the state's efforts to reduce GHG emissions from on-road transportation will not succeed if the amount of driving,

**RESPONSE TO COMMENT 35-8**

This comment inaccurately describes the revenue sources included in the proposed Plan as highly speculative. Federal and State laws require SANDAG to develop a regional plan built on reasonable assumptions of the revenues that will be available during the period covered by that plan (Government Code Section 65080(b)(4); 23 CFR 450.322(f)(10)(ii)). New funding sources are revenues that do not currently exist or that may require additional steps before the MPO or transit agency can commit such funding to transportation projects (2017 RTP Guidelines for MPOs). Strategies for ensuring their availability must be identified and future revenues may be projected based on historical trends, including consideration of past legislative or executive actions (2017 RTP Guidelines for MPOs). The level on uncertainty in projects based on historical trends is generally greatest for revenues in the "outer years" (10 years or more) of an RTP.

Specific to the revenue sources cited, this comment fails to recognize that SANDAG has succeeded in passing two past sales tax measures to fund transportation in the region, indicating it is reasonable to assume additional transportation sales tax measures would be passed. With respect to ridehailing service fees, SANDAG has an existing partnership with researchers at UC Berkeley to analyze data collected by SANDAG to better understand the time and price tradeoffs of ridehailing service users, exploring opportunities, challenges, and social equity considerations for policies to promote pooled ridehailing trips. This analysis will be completed by FY 2023 and will inform the development of a ridehailing fee program by 2026.

The State is currently studying implementation of a road user charge, and it would be unreasonable for SANDAG to disregard the actions at the State-level that would directly impact anticipated revenue during the period covered by the proposed Plan. The proposed Final Plan now assumes collection of both the State and regional road usage charges would begin by 2030. As a near-term action, SANDAG will launch a study in FY 2022 to evaluate different transportation funding sources, and a working group would oversee the development of a comprehensive value pricing and user fee implementation strategy that supports the goals of the proposed Plan.

35-8

35-9

35-10

SANDAG is partnering with the Sacramento Area Council of Governments and Southern California Association of Governments on a Caltrans Planning Grant to develop a research design framework for pilot projects to test the effectiveness of road pricing strategies combined with demand management approaches (incentives) to advance equity, reduce vehicle miles traveled and GHG emissions, manage roadway congestion, and provide sustainable revenues for system maintenance and operation. This study will put California MPOs in a position to complement the efforts of Caltrans through its Road Charge Pilots Program. Caltrans was recently awarded \$2.15 million from the Federal Highway Administration to continue pilot testing user acceptance and the technological feasibility of implementing road user charges.

Both studies will include a robust public-engagement process and lay the foundation for prioritizing different goals and understanding the potential of these tools in advancing these goals. SANDAG will leverage existing coordination efforts with the other major MPOs in California to ensure an integrated approach when possible. Once these initial studies are complete, SANDAG will begin deploying pilot testing by FY 2026 to inform the detailed design of new pricing. Through coordination with State and MPO partners, SANDAG would pursue legislative action for authority to administer a road usage charge program by 2030.

Specific to the federal gas tax, an increase is assumed based on public discussion by members of Congress and the president to introduce legislation to increase the gas tax, a carbon tax, or a tax on other fuels based on the life cycle for carbon emissions in order to fund a modern and strong transportation system.

#### **RESPONSE TO COMMENT 35-9**

This comment asserts that the Final EIR should disclose which capital projects would be prioritized in the event of a funding shortfall, which is a speculative scenario. Federal and State laws require SANDAG to develop a regional plan built on reasonable assumptions of the revenues that will be available during the period covered by that plan (Government Code Section 65080(b)(4); 23 CFR 450.322(f)(10)(ii)). See Appendix V, *Funding and Revenue*, of the proposed Plan for additional information about revenue sources.

Further, under CEQA case law, an EIR is entitled to assume that assumptions that are an integral part of the proposed project will become reality (*Village Laguna of Laguna Beach, Inc. v. Board of*

*Supervisors* (1982) 134 Cal. App. 3d 1022,1030). An EIR can make reasonable assumptions based on substantial evidence about future conditions without guaranteeing that those assumptions will remain true (*Environmental Council of Sacramento v. City of Sacramento* (2006) 142Cal. App. 4<sup>th</sup> 1018,1036).

**RESPONSE TO COMMENT 35-10**

As explained in Master Response 1, the Draft EIR does evaluate a reasonable range of alternatives that achieve most of the basic project objectives and that are potentially feasible. The discussion also explains why the Draft EIR was not required to consider SOFAR's proposed Climate, Housing and Transit Alternative in detail. See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR's proposed Climate, Housing and Transit Alternative from detailed consideration.

35-10 cont. or VMT, is not significantly reduced. The Climate Action Strategy explained, “Lowering vehicle miles traveled means providing high-quality opportunities to make trips by alternative means to driving alone such as walking, bicycling, ridesharing, and public transit, and by shortening vehicle trips that are made.” (*Id.*)

The current DEIR suffers from this same deficiency because it does not include an alternative that would result in a meaningful reduction in VMT. Nor, as discussed above, does it include an alternative that would result in a meaningful increase in high-quality opportunities to make trips by alternative means to driving.

In addition to the No Project Alternative, the DEIR identifies just two alternatives. Alternative 2: 2019 Transportation Network with New Value Pricing and User Fee Policies and Alternative 3: All Growth Focused in Mobility Hubs and More Progressive Value Pricing and User Fee Policies.

35-11 Alternative 2 would result in higher per capita and overall VMT compared to the proposed Plan and compared to existing (2016) conditions. (DEIR at 6-56; DEIR Appendix O, Table O-3: SB 375 Reductions for Alternatives Considered in Detail in this EIR (pdf page 932).) The DEIR identifies the increase in VMT under this alternative as a significant impact; Alternative 2 would actually *increase* VMT compared to the proposed Plan. (DEIR at 6-56 — 6-59.)

35-12 Although Alternative 3 would reduce per capita VMT compared to existing (2016) conditions, there is very little difference in per capita VMT between the proposed Plan and Alternative 3 in 2025, 2035 and 2050. Like Alternative 2, Alternative 3 would *not* reduce VMT impacts to a less than significant level. (DEIR at 6-56—6-59.) Moreover, Alternative 3 would result in an overall increase in VMT in 2035 and 2050 compared to existing conditions. (DEIR at 6-22; Appendix O, Table O-3: SB 375 Reductions for Alternatives Considered in Detail in this EIR (pdf page 932).)

35-13 The end result is that the DEIR fails to provide a *transportation-network* alternative that would result in substantive decreases in VMT and substantive benefits in transit/bike/walk mode share. This is because *Alternative 3 calls for the same transportation network as the proposed Plan.* (DEIR at 6-4.) The fact that Alternative 3 would result in (nominal)VMT reductions compared to the proposed Plan is largely due to its compact land use patterns. (DEIR at 6-6.) While CNFF concurs that development must be concentrated in urban areas to achieve the region’s GHG reduction and housing goals, modifications to land use alone are not sufficient to achieve GHG reduction goals. Moreover, it is imperative to note that an RTP alternative that emphasizes land use rather than transportation projects is misguided because, as the DEIR itself acknowledges, SANDAG has little control over land use. (DEIR at 6-14.)

**The DEIR Incorrectly Rejects the Climate, Housing and Transit Alternative.**

35-14 The DEIR rejects SOFAR’s and CNFF’s Climate, Housing and Transit Alternative as both duplicative and infeasible. The DEIR’s rejection is unsupported on both grounds. First, the DEIR asserts that the proposed Plan includes the transit components identified in the SOFAR’s and CNFF’s Alternative. While the proposed Plan does include some of the transit projects identified in the Climate, Housing and Transit Alternative, the proposed Plan also calls for a massive increase in road and freeway building. As we have explained, building a comprehensive regional public transportation network will

**RESPONSE TO COMMENT 35-11**

As explained in Master Response 1, the Draft EIR does evaluate a reasonable range of alternatives that achieve most of the basic project objectives and that are potentially feasible. Alternative 2 was included for detailed consideration because it reduces other significant impacts, including air quality and population and housing, as compared to the proposed Plan. See Chapter 6 and Table 6-3 for additional discussion of the comparative impacts of the proposed Plan and Alternative 2. The discussion also explains why the Draft EIR was not required to consider SOFAR’s proposed Climate, Housing and Transit Alternative in detail. See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR’s proposed Climate, Housing and Transit Alternative from detailed consideration.

**RESPONSE TO COMMENT 35-12**

As explained in Master Response 1, the Draft EIR does evaluate a reasonable range of alternatives that achieve most of the basic project objectives and that are potentially feasible. The discussion also explains why the Draft EIR was not required to consider SOFAR’s proposed Climate, Housing and Transit Alternative in detail. See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR’s proposed Climate, Housing and Transit Alternative from detailed consideration.

SOFAR suggests that the Draft EIR should have evaluated a project alternative that substantially reduced VMT below existing levels. Alternative 3 consists of the proposed Plan transportation network, a land use pattern that restricts all regional growth to the Mobility Hubs, and more progressive value pricing and user fees policies than what is included in the proposed Plan; it achieves lower VMT than the proposed Plan, though still above existing levels. An alternative including *further* VMT-reduction measures to reduce VMT below existing levels is not currently feasible for several reasons, including:

- *Further* substantial changes needed in State and federal policy and legislation. These would include still *further* changes in state road pricing policy, land use policies, and parking policies—beyond those included in the proposed Plan and Alternatives 2 and 3—that are not reasonably foreseeable.
- Lack of funding for *further and accelerated* major transit service improvements (recognizing that, as discussed in additional detail in

subsequent discussion, increased transit investments alone cannot achieve substantial VMT reductions). The request to switch funding from roadways to transit fails to recognize that there are regulatory constraints on directing roadway funds to transit, and on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or collected on an annual basis and much funding cannot be advanced. There are also constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network.

- Severe economic and social impacts caused by substantial increases in driving costs. Alternative 3 already increases fees compared to the proposed Plan. From a consumer standpoint, increases in fuel or vehicle user costs can be a trade-off with discretionary expendable income for purchasing food, clothing, and other personal items, especially for lower income households. A significant increase in fuel cost or vehicle user fees would also result in lower spending in other areas of the economy, and economic disruption would occur in adjusting to higher fuel or vehicle registration prices.
- Lack of authority for SANDAG and local governments to implement such *further* measures. For example, SANDAG has no authority to increase state road pricing, or require local governments to implement land use or parking policies.

SANDAG cannot control the total regional population growth that is the main cause of total VMT increases. As SANDAG modeling indicates, population growth is the main driver of future VMT growth. Alternative 3 would result in VMT per capita of 15.6 (home-based) compared to the proposed Plan VMT per capita of 16.03 in 2050. Alternative 3 would result in a total VMT increase of 2,756,715 miles per day in year 2050, which is approximately 39 percent lower than the proposed Plan (total VMT increase of 4,519,230 miles per day in year 2050). Population growth under the proposed Plan, however, increases by 13 percent. Even with decreases in driving per capita, under Alternative 3 total VMT still increases by 3.2 percent compared to 2016 because population growth outpaces driving reductions. As courts have noted, “CEQA is not intended as a population control measure” (*Center for Biological Diversity v. Department of Fish & Wildlife* (2015) 62 Cal.4th 204, 220).



**RESPONSE TO COMMENT 35-13**

As explained in Master Response 1, the Draft EIR does evaluate a reasonable range of alternatives that achieve most of the basic project objectives and that are potentially feasible. The discussion also explains why the Draft EIR was not required to consider SOFAR's proposed Climate, Housing and Transit Alternative in detail. See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR's proposed Climate, Housing and Transit Alternative from detailed consideration.

To be legally adequate under federal transportation law and SB 375, the proposed Plan is required to address transit projects, highway projects, and sustainable land use patterns; all three components are integrated into the basic project objectives described in EIR Section 2.4 (page 2-6). An EIR must discuss alternatives to a project in its entirety but is not required to discuss alternatives to each particular component of a project. SOFAR proposes a "transportation-network" alternative but does not address the regulatory constraints on redirecting roadway funds to transit, and on when money becomes available during the lifespan of the proposed Plan. For instance, federal formula funds such as FTA Section 5307 or RSTP are apportioned annually; SANDAG can make assumptions about how much can be anticipated in the future based on historical data but cannot advance any project(s) that need the funding in years prior to apportionment. Other funds that SANDAG cannot advance and redirect to transit include funds going to other agencies, such as SHOPP funds, which are managed by the California Transportation Commission and are used for safety, operations, and rehabilitation projects on the state highway system by Caltrans.

Given these constraints, Alternative 3 did not assume an alternate transportation network different than that of the proposed Plan. Instead, Alternative 3 included more progressive pricing and user fees, as well as an intensified land use pattern in order to reduce significant impacts on the environment. Inclusion of this more compact land use pattern is appropriate as the SCS land use pattern is an integral component of a regional plan, as mandated by SB 375. As compared to the proposed Plan, Alternative 3 reduces significant impacts on aesthetics and visual resources, agriculture and forestry, air quality, biological resources, cultural resources, geology, GHG, mineral resources, noise, public services and utilities, transportation, and

wildfire. See Chapter 6 and Table 6-3 for additional discussion of the comparative impacts of the proposed Plan and Alternative 3.

**RESPONSE TO COMMENT 35-14**

his comment inaccurately characterizes the nature of the roadway projects in the proposed Plan.

Where possible, rather than adding new roads, the proposed Plan repurposes general purpose lanes or shoulders to create Managed Lanes. The Managed Lane system is important for supporting the transit network and Flexible Fleets envisioned in the proposed Plan. The Regional Plan is updated every four years, providing opportunities to reflect changes in the network. The proposed Plan's improvements to the freeway system are limited to Managed Lanes using existing infrastructure such as general purpose lane conversion and shoulders to facilitate additional transit and high occupancy vehicle travel.

This comment also inaccurately characterizes the nature and comparative impacts of the proposed Plan as compared to SOFAR's proposed Climate, Housing and Transit Alternative on freeway expansion and roadway capacity. In 2050, under the proposed Plan, the region has 2,122 miles of general purpose freeway lanes (including auxiliary lanes) due to existing lane conversions. In 2050, under SOFAR's proposed Climate, Housing and Transit Alternative, which includes no roadway improvements, the region has 2,352 miles of general purpose freeway lanes (including auxiliary lanes). The proposed Plan includes 821 miles of HOV/Managed Lanes, which SOFAR inaccurately suggests will continue to contribute to substantial increases in VMT and GHG emissions. Data from model runs comparing the proposed Plan network to SOFAR's proposed Climate, Housing and Transit Alternative demonstrates that the proposed Climate, Housing and Transit Alternative has similar impacts as the proposed Plan in achieving the State's GHG reduction goals and does not substantially reduce the proposed Plan's significant impacts.

Database	Proposed Final Plan		SOFAR's Climate, Housing and Transit Alternative	
	2035	2050	2035	2050
SB 375 VMT	79,725,710	81,804,496	79,877,932	82,247,926
SB 375 VMT/Person	22.0	21.8	22.1	22.0
Final Per Capita GHG Reductions for 2005	-20.0%	-21.0%	-20.4%	-20.7%

See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR's proposed Climate, Housing and Transit Alternative from detailed consideration, including a discussion of selected elements of SOFAR's alternative that are similar to the proposed Plan's elements.

With respect to project phasing under the proposed Plan, this comment fails to recognize that there are regulatory constraints on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or collected on an annual basis and much funding cannot be advanced. There are also regulatory constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network. For instance, federal formula funds such as FTA Section 5307 or RSTP funds are apportioned annually; SANDAG can make assumptions about how much can be anticipated in the future based on historical data but has no ability to any project(s) that need the funding in years prior to apportionment. Other funds that SANDAG cannot advance and re-direct to transit include funds going to other agencies, such as SHOPP funds, which are managed by the California Transportation Commission and are used for safety, operations, and rehabilitation projects on the state highway system by Caltrans.

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35-14 cont. require all of the region’s transportation investment dollars for the foreseeable future. For this reason, the Climate, Housing and Transit Alternative *does not include any freeway expansion*. The billions of dollars spent on freeway expansion the past 20 years have a) failed to reduce congestion, b) caused a substantial increase in VMT and GHG emissions, and c) resulted in a severe housing shortage. The Climate, Housing and Transit Alternative is not duplicative of the proposed Plan or any alternative considered in the DEIR.

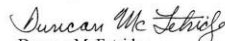
35-15 The DEIR further opines that it will not be possible to achieve the goals identified in the Climate, Housing and Transit Alternative. The DEIR attempts to justify this conclusion by claiming that even Alternative 3, which includes what the DEIR characterizes as the most progressive transportation measures to reduce VMT and GHG, is unable to meet the VMT goals of the CHT Alternative.(DEIR at 6-14.) This statement is incorrect. Alternative 3 does not include the most progressive transportation measures; rather, it calls for an identical transportation network to the proposed Plan. As we explained in our May 6, 2020 letter, the Climate, Housing and Transit Alternative would eliminate the sizable number of road/freeway projects and use that funding to construct and implement a comprehensive transit system.

35-16 We again request that SANDAG model and fully analyze the Climate, Housing and Transit Alternative in the EIR for the proposed Plan. This modeling should advance all of the Alternative’s transit projects to the first ten years of the Plan in order to truly understand the effect that a comprehensive transit network would have in achieving the region’s environmental and housing goals. We remain optimistic that such modeling will demonstrate that this Alternative will be far more effective than the proposed Plan in achieving the state’s GHG reduction goals and substantially reducing the Plan’s significant environmental impacts.

**Conclusion.**

35-17 In the face of a severe, entrenched housing crisis endangering the public welfare and the severe climate crisis endangering the planet, SANDAG owes the public nothing less than a transit alternative that immediately meets these life threatening challenges rather than artificially prolonging them. The DEIR should also be revised and recirculated to correct the deficiencies identified in this letter.

Sincerely,

  
 Duncan McFetridge  
 Director, CNFF  
 President, SOFAR

Attachment: Letter from Duncan McFetridge to SANDAG Board of Directors, May 6, 2020

**RESPONSE TO COMMENT 35-15**

Alternative 3 in the Draft EIR evaluated what additional reductions of VMT and GHG could potentially be achieved by further restricting development to Mobility Hubs, increasing fees associated with automobile use, and decreasing costs associated with transit use. This comment inaccurately characterizes the comparative potential of the proposed Plan network and SOFAR’s proposed Climate, Housing and Transit Alternative to reduce VMT and GHG. Data from model runs comparing the proposed Plan network to SOFAR’s proposed Climate, Housing and Transit Alternative demonstrates that the proposed Climate, Housing and Transit Alternative has similar impacts as the proposed Plan in achieving the State’s GHG reduction goals and does not substantially reduce the proposed Plan’s significant impacts.

Database	Proposed Final Plan		SOFAR’s Climate, Housing and Transit Alternative	
	2035	2050	2035	2050
SB 375 VMT	79,725,710	81,804,496	79,877,932	82,247,926
SB 375 VMT/Person	22.0	21.8	22.1	22.0
Final Per Capita GHG Reductions for 2005	-20.0%	-21.0%	-20.4%	-20.7%

See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR’s proposed Climate, Housing and Transit Alternative from detailed consideration.

This comment also fails to recognize that there are constraints on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or collected on an annual basis and much funding cannot be advanced. There are also regulatory constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network. For instance, federal formula funds such as FTA Section 5307 or RSTP are apportioned annually; SANDAG can make assumptions about how much can be anticipated in the future based on historical data but has no ability to advance any project(s) that need the funding in years prior to apportionment. Other funds that SANDAG cannot advance and re-direct

to transit include funds going to other agencies, such as SHOPP funds, which are managed by the California Transportation Commission and are used for safety, operations, and rehabilitation projects on the state highway system by Caltrans.

**RESPONSE TO COMMENT 35-16**

The proposal to advance all of the Alternative's transit projects to the first 10 years of the proposed Plan fails to recognize that there are constraints on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or collected on an annual basis and much funding cannot be advanced. There are also constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network. For instance, federal formula funds such as FTA Section 5307 or RSTP are apportioned annually; SANDAG can make assumptions about how much can be anticipated in the future based on historical data but has no ability to advance any project(s) that need the funding in years prior to apportionment. Other funds that SANDAG cannot advance and re-direct to transit include funds going to other agencies, such as SHOPP funds, which are managed by the California Transportation Commission and are used for safety, operations, and rehabilitation projects on the state highway system by Caltrans.

This comment inaccurately characterizes the GHG reductions that can be achieved under the proposed Plan network as compared to SOFAR's proposed Climate, Housing and Transit Alternative. SANDAG modeling data demonstrates that the proposed Climate, Housing and Transit Alternative has similar impacts as the proposed Plan in achieving the State's GHG reduction goals and does not substantially reduce the proposed Plan's significant impacts.

Database	Proposed Final Plan		SOFAR's Climate, Housing and Transit Alternative	
	2035	2050	2035	2050
SB 375 VMT	79,725,710	81,804,496	79,877,932	82,247,926
SB 375 VMT/Person	22.0	21.8	22.1	22.0
Final Per Capita GHG Reductions for 2005	-20.0%	-21.0%	-20.4%	-20.7%

See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR's proposed Climate, Housing and Transit Alternative from detailed consideration.

**RESPONSE TO COMMENT 35-17**

This comment makes statements about challenges facing the region, to which no further response is required. This comment also asserts the need to recirculate the Draft EIR based on the inaccurate assertions made in comments 35-1 through 35-16, for which responses have already been provided above. No information has been added to the Draft EIR that would trigger recirculation under CEQA Guidelines Section 15088.5.



May 26, 2021

*Via E-mail*  
 SANDAG Board of Directors  
 401 B Street  
 San Diego, CA 92101  
[clerk@sandag.org](mailto:clerk@sandag.org)

**RE: Transportation Network Scenarios for the 2021 RTP**

Save Our Forest and Ranchlands ("SOFAR") and the Cleveland National Forest Foundation ("CNFF"), two organizations dedicated to progressive land use planning and the protection of vital natural resources, are submitting comments for the draft transportation network scenarios for the 2021 Regional Transportation Plan Update. We recognize that SANDAG, under its new leadership and with new board members, has undergone a tectonic shift towards building a regional transit system to serve the urbanized western section of San Diego County. The focus of this letter is centered on the required first step towards building a 21<sup>st</sup> Century regional mobility system, i.e., a first phase area- complete transit, bike, walk system in the urban core that is competitive with the auto.

35-18 Therefore, SOFAR and CNFF urge the SANDAG Board of Directors to include a Climate, Housing, Transit Alternative in the 2021 RTP update—an alternative focused on meeting both the housing needs and greenhouse gas ("GHG") reduction goals for a qualified land use area that have been set collectively by the State of California, the City of San Diego, and SANDAG:

- 40% reduction in GHG below 1990 levels by 2030 (California AB 32 and SB 32)
- 80% reduction in GHG below 1990 levels by 2050 (Governors Schwarzenegger and Brown)
- 25% reduction in per capita GHG from passenger cars and trucks relative to 2005 by 2035 (California SB 375; California Air Resources Control Board<sup>1</sup>)
- 14.3% reduction in total daily VMT per capita, and 16.8% reduction in total light-duty VMT per capita, relative to 2015-2018 average by 2050 (California Air Resources Board)<sup>2</sup>
- 50% transit, walk and bike mode share for commuters within ½ mile of a major transit stop in City of San Diego by 2035 (Climate Action Plan, City of San Diego)<sup>3</sup>
- 150% increase in transit mode share (SANDAG's *Urban Area Transit Study*)<sup>4</sup>

<sup>1</sup><https://ww2.arb.ca.gov/resources/documents/carb-2017-scoping-plan-identified-vmt-reductions-and-relationship-state-climate>

<sup>2</sup>[https://ww2.arb.ca.gov/sites/default/files/2019-01/2017\\_sp\\_vmt\\_reductions\\_jan18.pdf](https://ww2.arb.ca.gov/sites/default/files/2019-01/2017_sp_vmt_reductions_jan18.pdf)

<sup>3</sup><https://www.climateactioncampaign.org/wp-content/uploads/2018/02/CAP-Report-Card-2nd-Edition.pdf>

1

**RESPONSE TO COMMENT 35-18**

The proposed Plan aligns with many of the elements of the Climate, Housing and Transit Alternative while meeting all legal requirements. As the Plan is implemented, SANDAG looks forward to continuing to advance efforts related to climate, housing, and transit.

SANDAG is developing a Regional Housing Incentive Program to meet the goals of the proposed Plan and assist local jurisdictions in achieving housing goals. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, and consider climate change and resiliency, availability of transit and active transportation, and consistency with the transportation improvements included in the Regional Plan. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed Plan proposes a land use scenario that accommodates the Regional Housing Needs Assessment and, when combined with the transportation system, allows the region to meet its SB 375 greenhouse gas reduction target.

This comment inaccurately assumes the proposed Climate, Housing and Transit Alternative would significantly reduce VMT and GHG emissions, and substantially increase transit use. The Climate, Housing and Transit Alternative would have similar impacts as the proposed Plan on VMT and GHG emissions, and there is no evidence transit use would be greater.

See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR's proposed Climate, Housing and Transit Alternative from detailed consideration, including a discussion of selected elements of SOFAR's alternative that are similar to the proposed Plan's elements.



35-18 cont.

- Adequately plan to meet the housing needs of everyone in the community (California)<sup>4</sup>
- SB 743 VMT reduction goals

Meeting these goals is not only reasonable, but also urgently required if we are going to solve some of the unrelenting challenges faced by residents of San Diego. Indeed, SANDAG's prior RTP was found to be deficient for failing to discuss an alternative which could significantly reduce total vehicle miles traveled ("VMT") (*Cleveland National Forest Foundation v. San Diego Association of Governments*. 17 Cal.App. 5th 413, 435-437 (2017)). Heretofore, the San Diego region has met these challenges with clever words, not deeds. These goals are achievable only if land use and transportation are addressed together.

These synergies are recognized in SANDAG's *Urban Area Transit Strategy* and the City of San Diego's *General Plan Housing Element* which includes this goal:

*Ensure the provision of sufficient housing for all income groups to accommodate San Diego's anticipated share of regional growth ...in a manner consistent with the development pattern of the Sustainable Communities Strategy (SCS), that will help meet regional GHG targets by improving transportation and land use coordination and jobs/housing balance, creating more transit-oriented, compact and walkable communities, providing more housing capacity for all income levels, and protecting resource areas.<sup>5</sup>*

The Climate, Housing, Transit Alternative would pick up where SANDAG's *Urban Area Transit Strategy* left off in 2011.

35-19

**Housing + Transportation Affordability (H+T)**

There is a huge amount of attention on housing affordability but too little focus on housing and transportation ("H+T") affordability. Outlying housing may be cheaper in the short run than housing in the region's core because of supply and demand – but any savings often are eaten up by increased transportation costs. Dispersed housing requires more cars per household and more VMT and GHG emissions per household.

The Center for Neighborhood Technologies has modeled H+T costs relative to income for the entire U.S. with support of the U.S. Department of Housing and Urban Development. Figure 1 shows the H+T affordability results for the San Diego region for households with the regional typical household income of \$64,309.

<sup>4</sup>2050 RTP/SCS Appendix U.17 *Urban Transit Strategy*, San Diego Association of Governments (SANDAG) and Parsons Brinckerhoff, October 2011.

<sup>5</sup><http://www.hcd.ca.gov/community-development/housing-element/index.shtml>

<sup>6</sup><https://www.sandiego.gov/sites/default/files/legacy/planning/genplan/heu/pdf/housingelementfull.pdf>

## RESPONSE TO COMMENT 35-19

Under the SCS for the proposed Plan, 31 Mobility Hub areas were identified as optimal locations for siting transit investments that maximize regional connectivity, and for focusing future growth. Nine factors were used to assess the propensity for transit-based trip making to identify the Mobility Hub areas integrated into the proposed Plan, including employment, population density, age, proximity to activity centers, trips within census block groups, communities of concern, and VMT per capita.

The areas indicated in the figure provided by SOFAR are well-aligned with the Mobility Hub areas identified in the proposed Plan. The Mobility Hub areas contain 70 percent of the Center for Neighborhood Technology's H+T index values that are considered affordable, i.e., less than the regional median. The remaining 30 percent of the H+T index values that are considered affordable are located primarily in East County, where development would contribute to urban sprawl in the backcountry and impede achieving regional reductions of VMT and GHG emissions.

While land use authority is reserved to local jurisdictions—the 18 cities and the County—SANDAG will work closely with jurisdictions to incentivize building of housing in the Mobility Hub areas. In coordination with the development of the proposed Plan, SANDAG will embark on developing a housing incentive program that will support jurisdictions in the development and adoption of policies and process improvements to accelerate housing production. The program will also look for ways to leverage funding from the State to provide more housing in the region and meet the goals of the proposed Plan.

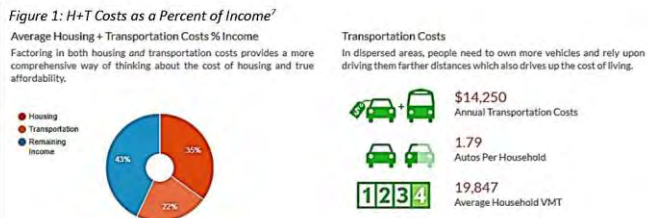
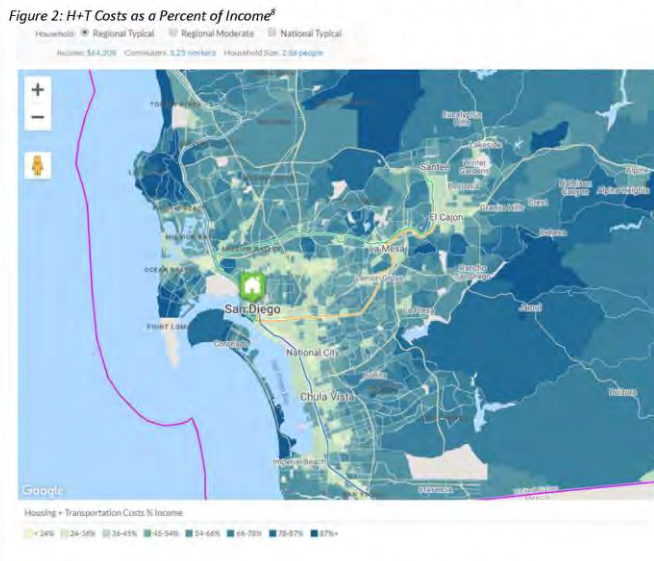


Figure 1 shows that, on average, transportation costs are about two-thirds as large as housing costs. However, transportation costs vary greatly across the region. Figure 2 maps H+T affordability.

35-19 cont.



<sup>7</sup> Center for Neighborhood Technologies. <https://htaindex.cnt.org/fact-sheets/?focus=cbsa&gid=42>

<sup>8</sup> Center for Neighborhood Technologies. <https://htaindex.cnt.org/>

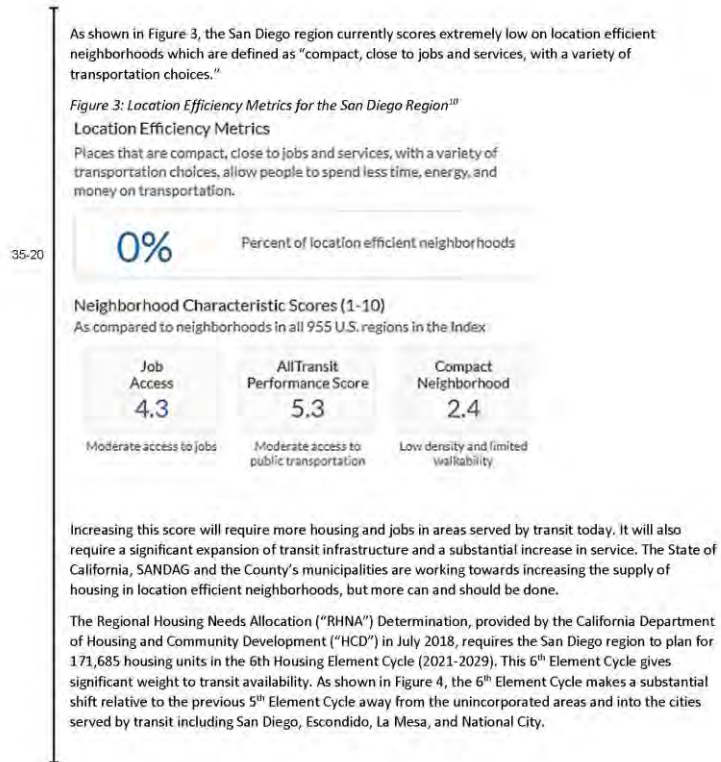
35-19  
cont.

As shown in Figure 2, when both housing and transportation costs are considered, the most affordable areas are in the light-colored areas primarily in the region's core and along major transit corridors. The housing affordability problem cannot be solved by building new housing in the darker-colored areas because high transportation costs make those areas inherently unaffordable. The areas in the more remote locations in San Diego County (i.e., even further from the City center) are not shown in order to make the map more readable, but these areas also tend to be more unaffordable when taking into account H+T.<sup>9</sup>

Real estate developers and their allies are currently pressuring San Diego County to retain its unlawful and inaccurate thresholds for assessing VMT impacts under SB 743, claiming that mitigation for VMT impacts will make housing in more remote parts of the County unaffordable. But housing in these areas is already unaffordable when transportation costs—that is, costs of driving long distances from locations not served by transit—are taken into account. SANDAG can help facilitate a better approach through the RTP, one that encourages the County to plan for housing in areas where transportation costs are low rather than allowing developers to build in remote areas and then trying to “mitigate” for the resulting VMT.

**The answer to housing affordability is H+T affordability. It is building more housing in the H+T affordable light-colored areas and in expanding the supply of H+T affordable areas through increased transit service.**

<sup>9</sup>Transportation costs—both in absolute terms and as a percentage of income—are even higher in many North County and East County communities (for example, transportation costs alone range from 25% of income in Alpine and Fallbrook to 27% of income in Borrego Springs and 28% of income in Julian and Pala). See <https://htaindex.cnt.org/fact-sheets/>.



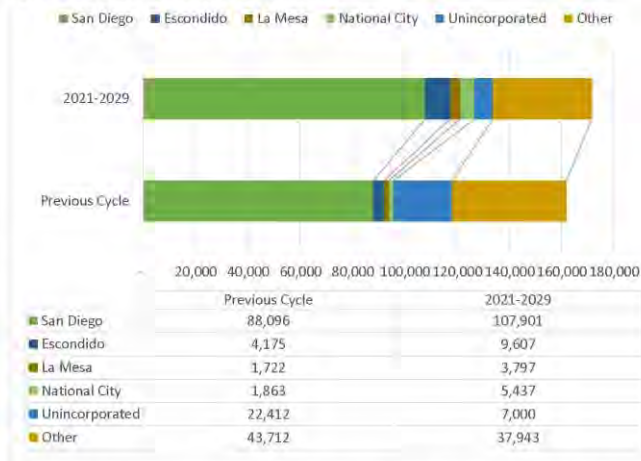
<sup>10</sup>Center for Neighborhood Technologies. <https://hta.index.cnt.org/fact-sheets/?focus=cbsa&id=42>

**RESPONSE TO COMMENT 35-20**

This comment largely describes positive changes at the State and local level to increase housing supply, which requires no further response. It also inaccurately asserts that all transportation spending can be shifted towards transit and non-motorized infrastructure. There are regulatory constraints on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or collected on an annual basis and much funding cannot be advanced. There are also regulatory constraints on which dollars stay with SANDAG and which dollars are distributed directly to other agencies to maintain, operate, and rehabilitate the transportation network. For instance, federal formula funds such as FTA Section 5307 or RSTP funds are apportioned annually; SANDAG can make assumptions about how much can be anticipated in the future based on historical data but has no ability to advance any project(s) that need the funding in years prior to apportionment. Other funds that SANDAG cannot advance and re-direct to transit include funds going to other agencies, such as SHOPP funds, which are managed by the California Transportation Commission and are used for safety, operations, and rehabilitation projects on the state highway system by Caltrans.

35-20  
cont.

Figure 4: RHNA Allocations 2020-2029 and 2010-2019<sup>11</sup>



The City of San Diego's share of the total has risen from 54% of the total in the previous cycle to 63% in the new cycle. The City has ample capacity for this housing. It has identified capacity to construct 164,142 housing units or 56,241 more than required.<sup>12</sup> A large percentage of this capacity is in transit corridors.

These are positive changes. However, in the past, the housing allocations have been aspirational but not enforced. The State has signaled that it plans to be more aggressive about enforcement during this cycle. SANDAG can help the municipalities achieve their housing goals by shifting all transportation spending towards transit and non-motorized (walk and bike) infrastructure. These investments, which will facilitate getting people out of the cars, will also help the region increase density without large impacts on neighborhoods.

35-21

In addition to personal savings on car ownership (e.g., acquisition, registration, and insurance) and costs associated with driving (e.g., gasoline, replacement parts, and repairs), municipalities are beginning to recognize that neighborhoods served by transit require fewer parking spaces. Last year, the City of San Diego passed a parking reform package that eliminated parking requirements for sites located within

<sup>11</sup> Center for Neighborhood Technologies. <https://htaindex.cnt.org/>

<sup>12</sup> City of San Diego General Plan Housing Element 2021-2029 (March 2020 Draft), p. HE-38.

**RESPONSE TO COMMENT 35-21**

This comment describes past changes to parking space requirements, and no further response is required.



35-21  
cont.

1/2-mile of a transit stop. This is a tremendously important reform for housing affordability because construction of parking can cost as much as \$90,000 per space in structures.<sup>13</sup>

Building a Real Regional Transit System – the Climate, Housing, Transit Alternative  
SANDAG’s Executive Director Hasan Ikhata said:

*I don't buy the debate that transit doesn't work. Transit doesn't work now because it's not designed to work. You know, if you come from the border to downtown and it takes you, you know... it's about 20 some miles... it takes you an hour in transit, that's not real transit, as far as I'm concerned.<sup>14</sup>*

The San Diego region’s transit system performs much more poorly than its west coast peers. As shown in Figure 5, a much smaller share of the region’s workers commute by transit than other west coast regions.

Figure 5: Transit Work Mode Share in Four West Coast Regions

35-22



Source: U.S. Census American Community Survey

<sup>13</sup><https://timesofsandiego.com/politics/2019/03/04/san-diego-city-council-votes-to-repeal-minimum-parking-requirements-for-new-housing/>

<sup>14</sup>San Diego Tribune, February 27, 2019. <https://www.sandiegouniontribune.com/opinion/commentary/sd-utbg-sandag-ikhata-transit-interview-20190227-story.html>

7

**RESPONSE TO COMMENT 35-22**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

SANDAG cannot confirm the metrics used for the comparison depicted in Figures 5 and 6 in the comment, nor can SANDAG confirm the accuracy of the transit work mode share and commute time data for other metropolitan regions based on the information provided in the comment. For the San Diego region, 3.4 percent of the work trips were made by public transit in 2016 (Final Plan, Table T6.2). With implementation of the proposed Plan, the transit mode share for all work trips increases to 11.7 percent in 2035 and 13.2 percent in 2050. As for the ratio of average transit commute time to average auto commute time, that ratio is not calculated in the proposed Plan. However, Table T6.3 of the Final Plan includes travel times for transit, auto, and carpool by corridor.

This comment relies upon commute times generated by the CHTS, which presents a less accurate picture of regional behavior and mode share than SANDAG’s ABM2+ forecast, for several reasons. The CHTS was conducted by Caltrans between 2010 and 2013 during the Great Recession, which created unique influences on travel behaviors and characteristics. The SANDAG ABM2+ was updated based on the San SDRTS conducted between 2016 and 2017, which used smartphone-based travel diaries as the primary means of travel data collection and included nearly 6,200 participating households. From a data quality perspective, the SDRTS is considered superior to the CHTS based on the more recent time period for survey collection, travel survey data collection methodology, and San Diego region sample size.

Additionally, the CHTS and the SDTRS are limited to travel surveys of residents. However, the ABM2+ forecasts travel for all types of trips—resident, visitor, cross border, airport, non-resident trips starting/ending external to San Diego, commercial, and truck. SANDAG collects supplemental travel survey and data on these other travel markets for inclusion in ABM2+ forecasts. Again, from a data perspective, the ABM2+ forecast is superior to the CHTS numbers referenced in SOFAR’s comment.

The proposed Plan includes the Miramar tunnel to support improvements to the Coaster, new commuter rail service, and upgrades to existing light rail service, including grade separations and eliminating

stops for express service. The proposed Plan also includes a Central Mobility Hub to connect the urban core, the airport, the LOSSAN corridor, the trolley system, and many bus routes.

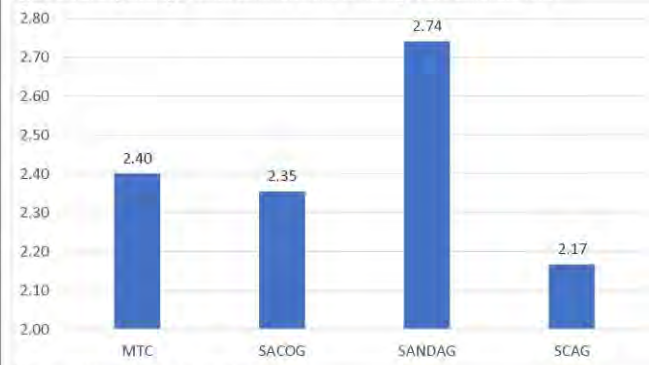
Specific to express bus service, the proposed Plan includes an expanded network of Rapid buses and improvements to the local bus system to facilitate more frequent and longer spans of service. The Rapid bus network is envisioned to connect to Mobility Hubs, communities, job centers, and other destinations. The infrastructure to support these connections includes better connectivity on city streets, direct access ramps from freeway facilities, plus an assortment of transit operational improvements to facilitate access. By 2035, about 30.4 percent of the region's population is projected to be living within a half-mile of a Rapid transit stop. For those living further from Rapid transit stops, the proposed Plan investments in Flexible Fleets will allow for more options to facilitate first mile/last mile connections with solutions that can be customized for different communities (microtransit, ridesharing, bikeshare, etc.).

The proposed Plan also includes a land use pattern that focuses growth in Mobility Hub areas to align with transportation investments and facilitate more bikeable and walkable communities. SANDAG is working closely with the City of San Diego to ensure that the proposed Plan complements the City's efforts to achieve the mode share goals of its Climate Action Plan.

35-22  
cont

Those who do commute by transit in the San Diego region suffer an enormous travel time penalty relative to the other large regions in California (Figure 6).

Figure 6: Ratio of Average Transit Commute Time to Average Auto Commute Time



Source: California Household Travel Survey

Improving the regional transit system is not a new idea in the San Diego region; there just has not been enough follow through. Almost a decade ago, SANDAG prepared the *Urban Area Transit Strategy* (“UATS”) as part of its 2011 RTP to connect regional housing needs with transit infrastructure:

*The overarching goal of the UATS was to create a world-class transit system for the San Diego region in 2050, with the aim of significantly increasing the attractiveness of transit, walking, and biking in the most urbanized areas of the region.*

*The vision called for a network of fast, flexible, reliable, safe, and convenient transit services that connect our homes to the region’s major employment centers and destinations. Achievement of this vision would make transit a more appealing option for many trips, reducing the impact of vehicular travel on the environment and on public health. Other key goals included:*

- *Making transit more time-competitive with automobile travel;*
  - *Maximizing the role of transit within the broader transportation system; and*
  - *Reducing vehicle miles traveled and greenhouse gas emissions in the region.*
- (p. TA 7-5)<sup>15</sup>

<sup>15</sup> SANDAG, Urban Area Transit Study.

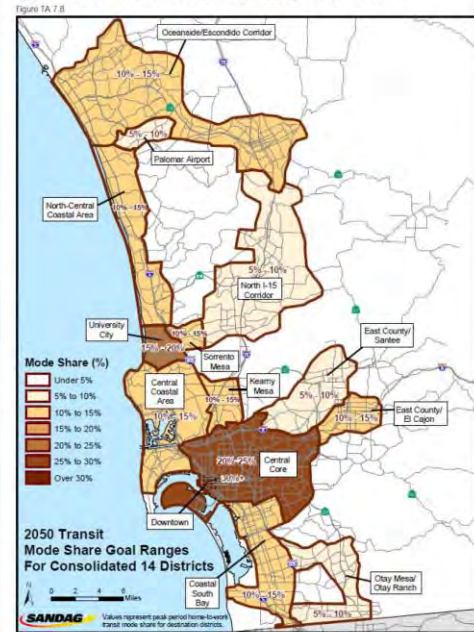
<http://www.sandag.org/index.asp?projectId=368&fuseaction=projects.detail>



35-22  
cont.

The UATS showed a high potential for transit ridership in the region's urban core (Figure 7).

Figure 7: SANDAG Urban Area Transit Study Figure TA 7.8



For transit to become time-competitive with the automobile, the Climate, Housing, Transit Alternative will require much more than a few isolated projects. It will require comprehensive investments at each of the four levels shown in Figure 8.

Figure 8: Complete Transit System



35-22  
cont.

At the top level, improving rail service in the Los Angeles to San Diego (“LOSSAN”) corridor is a top priority. To this end, an important study by Caltrans and CNFF has just been completed regarding the potential transit ridership on the LOSSAN rail corridor between San Diego and Los Angeles. This study arose as a result of litigation filed by CNFF challenging the planned expansion of the I-5 freeway between La Jolla and Oceanside as inconsistent with California’s GHG emission targets. CNFF and Caltrans reached a settlement that focused on the potential to improve rail service on the LOSSAN corridor. In particular, the parties agreed to study the feasibility of constructing a double-track rail tunnel through Miramar Hill to facilitate transit on the corridor. The parties believed that the Miramar tunnel could reduce travel times and provide improved connections to local transit services in the University Town Center (UTC) area.

The recently-completed study concludes that the Miramar tunnel and rail line straightening would add a critical link to the LOSSAN rail corridor. See Exhibit #1 (Miramar Tunnel Feasibility Study). Critically, it finds that the feasibility criteria for the Miramar tunnel have been satisfied. Its specific findings include the following:

1. The project would increase discretionary passengers by 1,300 to 1,700 per day, thereby reducing annual VMT 200 million to 240 million miles and GHG by 70,000 to 84,000 tons.
2. The project would provide competitive travel times, including a transit system average clock time that is approximately 3% faster than the automobile.
3. The project would be cost competitive, with transit riders cost at \$180/month versus automobile costs of \$507/month.
4. The project has no fatal engineering flaws.

**RESPONSE TO COMMENT 35-23**

Appendix D of the proposed Plan includes an induced demand analysis (as required by CARB) to be factored into estimated 2035 greenhouse gas emissions. This analysis utilized the Induced Demand Calculator referenced in the comment.

35-22  
cont.

The study further acknowledges a prior federal study that found construction of the Miramar tunnel along with other corridor improvements would reduce travel time between San Diego and Los Angeles to two hours. In short, construction of the new tunnel, which would provide enhanced access to downtown and the airport, would be a key transportation improvement for the region and the state. As the study notes, the LOSSAN rail corridor—together with the I-5 freeway—is the second-most traveled route in North America. The Miramar tunnel must be considered a key component of the Climate, Housing, Transit Alternative.

At the next level is a network of higher-speed, high frequency transit lines with separate rights of way and fewer stops. In many regions, a light rail service fills this niche, but in the San Diego region the Trolley has not filled this niche well. It operates too slowly and service is not frequent enough. Improvements are needed in both these dimensions. Achieving the required level of service in this higher-speed tier will require a rethinking of the system. As part of the Climate, Housing, Transit Alternative, SANDAG should evaluate speeding up the existing lines through grade separations and eliminating stops, as well as creating new higher-speed lines.

Express buses on managed lanes currently do not serve this higher-speed niche well because they connect freeway interchanges instead of land uses. A typical trip using these express buses will be unattractive because it also will involve connecting bus service on one or more circuitous routes. Express buses and managed lanes can work well for some park-and-ride travelers traveling to major destinations but cannot serve a significant portion of the region's population well.

Both the regional rail and higher-speed high-frequency tiers need to be well connected. The Climate, Housing, Transit Alternative must include an inter-modal terminal (Grand Central) connecting San Diego's urban core, the Airport, the LOSSAN corridor, the Sprinter corridor, and the Trolley system.

The Climate, Housing, Transit Alternative must also include efficient connections with frequent local buses (which could possibly be automated in the future). To this end, SANDAG must grapple with the first mile/last mile issue as this reflects a failure in land use and the existing transit system. While higher income travelers may have a choice of Uber-type services to solve this problem, this should not be viewed as a remedy for the average traveler.

Finally, the goal of a functional transit system is to serve an area-complete bike and walkable land use because no trip begins or ends on a transit vehicle. Most transit trips begin and end with a walk trip. In regions with high transit use, there are generally about twice as many walk trips as transit trips. Investments in walk and bike infrastructure should be a top priority. Consistent with the City's Climate Action Plan, the Climate, Housing, Transit Alternative must model a 50% transit, walk and bike mode share for residents in the central core.

35-23

**Stop Expanding Freeways**

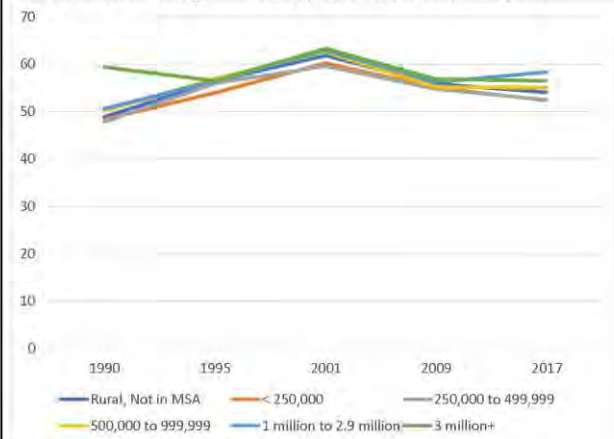
Building a real regional transit network will require all the region's transportation investment dollars for the foreseeable future. **The Climate, Housing, Transit Alternative must not include any freeway expansion.**

The billions of dollars spent on freeway expansion the past 20 years have A) failed to reduce congestion, B) caused a substantial increase in VMT and GHG emissions, and C) resulted in a severe housing shortage. The transportation models used to justify these freeway expansion projects have been wrong

35-23  
cont.

on all counts. These models - both in the San Diego region and in regions throughout the U.S. - forecast dire increases in travel time if freeways are not widened, and substantial increases in travel time even if they are widened. In fact, as shown in Figure 9, travel time has stayed remarkably constant in the U.S. for decades.

Figure 9: Average Time Driving (minutes per day) 1990-2017 by MSA Population (NHTS)



Source: National Household Travel Survey.

Figure 9 shows the “average time spent driving a private vehicle in a typical day.” There was an increase during the 1990s, a time when many women were joining the labor force, but since 2000 there has been little change. Time spent driving also is very similar across differently sized regions. There is evidence that people have a “travel time budget”. If travel speeds drop, they (on average) will adapt to travel a shorter distance.

In contrast, if travel speeds increase, people (on average) will travel longer distances. This phenomenon is known as “induced travel”. In work for the California Air Resources Board (“CARB”), researchers at the University of California and the University of Southern California reviewed the literature on induced travel and concluded:

*Thus, the best estimate for the long-run effect of highway capacity on VMT is an elasticity close to 1.0, implying that in congested metropolitan areas, adding new*

35-23  
cont.

*capacity to the existing system of limited-access highways is unlikely to reduce congestion or associated GHG in the long-run.*<sup>16</sup>

The SANDAG regional transportation model fails to account properly for induced travel although there now are newer algorithms that could address this deficiency.<sup>17</sup>

Senate Bill 743 establishes VMT as the appropriate metric for determining the impacts of transportation projects. This has made properly accounting for induced VMT critical in the regulatory process. The Office of Planning and Research's ("OPR") *Technical Advisory on Evaluating Transportation Impacts in CEQA* recommends:

*Whenever employing a travel demand model to assess induced vehicle travel, any limitation or known lack of sensitivity in the analysis that might cause substantial errors in the VMT estimate (for example, model insensitivity to one of the components of induced VMT described above) should be disclosed and characterized, and a description should be provided on how it could influence the analysis results. A discussion of the potential error or bias should be carried into analyses that rely on the VMT analysis, such as greenhouse gas emissions, air quality, energy, and noise.*<sup>18</sup>

The National Center for Sustainable Transportation at the University of California at Davis has produced an *Induced Travel Calculator*<sup>19</sup> to help address the deficiencies in the models. Recently, Caltrans also has issued new draft guidance on accounting for induced travel. It recommends following the OPR recommendations:

*Caltrans recommends using the VMT analysis approaches recommended in OPR's advisory when evaluating the transportation impacts of projects on the State Highway System (SHS).*<sup>20</sup>

Neither expanding freeways nor not expanding freeways will have any effect on regional congestion or average travel times. However, expanding freeways will cause significant increases in VMT and GHG emissions, and will continue to starve the transit system of needed investments.

<sup>16</sup> Handy, Susan and Marlon G. Boarnet. "Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions: Policy Brief" prepared for California Air Resources Board, September 30, 2014.

<sup>17</sup>Marshall (2018). Forecasting the Impossible: The status quo of estimating traffic flows with static traffic assignment and the future of dynamic traffic assignment. *Research in Transportation Business & Management*. **29**, 85-92 (2018)

<sup>18</sup> California Office of Planning and Research. *Technical Advisory on Evaluating Transportation Impacts in CEQA*, p. 29, December 2018. [http://opr.ca.gov/docs/20190122-743\\_Technical\\_Advisory.pdf](http://opr.ca.gov/docs/20190122-743_Technical_Advisory.pdf)

<sup>19</sup><https://ncst.ucdavis.edu/research-product/induced-travel-calculator>

<sup>20</sup> Caltrans. Draft Transportation Analysis Framework: Induced Travel Analysis, March 2020. <https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-04-13-taf-a11y.pdf>



A Completely New Direction is Needed

Given that transit in the San Diego region has been and continues to be severely under-funded and under-built compared to roadway projects, as discussed above, the Climate, Housing, Transit Alternative must exclude roadway/freeway funding and expansion. Heretofore, SANDAG's planning has arbitrarily segmented freeway and transit projects. This artificial segmentation is not only irrational, it is fatal in achieving sustainable housing goals because **transit, bike, and walk mobility and auto-based mobility serve contradictory land use purposes**. SANDAG's failure to historically recognize this fundamental truth is the Achilles heel of its planning and lies at the doorstep of the agency's on-going inability to deliver a plan that truly unites our community on an ecologically sustainable foundation.

It is abundantly clear that SANDAG's past planning efforts have not only been deficient but have repeatedly failed to heed the ominous warnings from the courts, the public, and the planet itself. With California literally on fire due largely to climate change induced drought and high temperatures, SANDAG has failed the public by not aggressively pursuing a transportation scenario that would meet the State's GHG and VMT reduction goals.<sup>21</sup> The Climate, Housing, Transportation Alternative would help achieve targets set in legislation, the California Air Resources Board's Climate Change Scoping Plan, and relevant Executive Orders.

35-24

Similarly, with regard to the local housing crisis, it is inconceivable that SANDAG's prior RTPs have not called for a 50% transit, bike, and walk mode share alternative necessary to activate infill housing, especially since the urban core is already zoned for such housing. Here too, the Climate, Housing, Transit Alternative would facilitate this infill housing and help the City of San Diego achieve the targets set forth in its Climate Action Plan.

Additionally, the County's continued business-as-usual approach to planning makes the need for SANDAG to strengthen guidance regarding future development in the region all the more pressing. In spite of all the talk of a new direction, the County recently unveiled a plan update for the forest community of Alpine which can only be described as a VMT and ecosystem catastrophe. This planning contradiction was noted in Shute Mihaly's comment letter on the Alpine plan<sup>22</sup>. The tectonic shift in regional transit mobility mentioned in the opening paragraph of this letter must become a reality soon to avoid irreversible damage to our wild lands and a missed opportunity for the region.

Faced with these pressing social and environmental challenges, SANDAG's new regional direction can be strengthened by following established judicial, executive, and local legislative guidelines designed to meet the housing and climate crises. The public urgently deserves to see what it would take for the region to build a world-class transit system and to develop reasonably priced infill housing. Common sense dictates that the Climate, Housing, Transit Alternative would necessarily begin with a complete, first phase transit, bike, and walk system with an inter-modal terminal connecting the Airport, the Central Core, the LOSSAN Corridor, the Sprinter corridor, and the Trolley system. It is important to note that the Climate, Housing, Transit Alternative would not only be the "environmentally superior alternative", it would also be the socio-economic superior alternative because a true transit, bike and walk system reduces both the cost and shortage of housing and the cost of driving.

<sup>21</sup> <https://abcnews.go.com/Politics/climate-change-make-wildfires-spread-factor/story?id=56937704>

<sup>22</sup> <https://drive.google.com/file/d/1Nt6sc7weFgbHCNIHsNOIMFCIQK/cvVp/view>

**RESPONSE TO COMMENT 35-24**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR.

This comment inaccurately characterizes the GHG reductions that can be achieved under the proposed Plan network as compared to SOFAR's proposed Climate, Housing and Transit Alternative. SANDAG modeling data demonstrates that the proposed Climate, Housing and Transit Alternative has similar impacts as the proposed Plan in achieving the State's GHG reduction goals and does not substantially reduce the proposed Plan's significant impacts.

Database	Proposed Final Plan		SOFAR's Climate, Housing and Transit Alternative	
	2035	2050	2035	2050
SB 375 VMT	79,725,710	81,804,496	79,877,932	82,247,926
SB 375 VMT/Person	22.0	21.8	22.1	22.0
Final Per Capita GHG Reductions for 2005	-20.0%	-21.0%	-20.4%	-20.7%

See Section 6.5.5 of the Draft EIR for additional discussion of reasons for rejecting SOFAR's proposed Climate, Housing and Transit Alternative from detailed consideration.

35-25 In conclusion, in the face of a severe, entrenched housing crisis endangering the public welfare and the severe climate crisis endangering the planet, SANDAG owes the public nothing less than a transit alternative that immediately meets these life threatening challenges rather than artificially prolonging them.

Duncan McFetridge



Director, CNFF

President, SOFAR

Exhibit #1: Miramar Tunnel Feasibility Study

**RESPONSE TO COMMENT 35-25**

This conclusory comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. See prior responses to this comment letter for explanations of why the Climate, Housing, Transit Alternative would not achieve the benefits asserted by the commenter, as well as why it was rejected from detailed consideration in the Draft EIR.

SANDAG recognizes that substantial reductions in global, State, and regional GHG emissions are an urgent priority, and strives in its regional plans and programs to do its part in reducing GHG emissions from all sources. EIR Section 4.8.1 properly describes existing conditions related to GHG emissions, including background information on various greenhouse gases, their sources, and their potential to trap heat in the Earth’s atmosphere and contribute to global warming. It describes the main sources of GHG emissions in the state and in the San Diego region. The effects of climate change (“climate destabilization”) are summarized, and a detailed description based on scientific studies of how climate change is anticipated to impact California and the San Diego region is provided in EIR Appendix C. Section 4.8 also describes the regulatory setting for GHG emissions, including descriptions of goals adopted by the Legislature and EOs B-30-15 and S-3-05 goals for statewide GHG reductions. The statewide GHG reduction goals adopted by the Legislature and expressed by the Governor’s EOs are based on limiting global warming to levels necessary to avoid potentially catastrophic climate change impacts.

**COMMENT LETTER 36: CITY OF SOLANA BEACH**

Comment Letter 36



**CITY OF SOLANA BEACH** [www.cityofsolanabeach.org](http://www.cityofsolanabeach.org)  
 635 SOUTH HIGHWAY 101 • SOLANA BEACH, CA 92075 • (858) 720-2400 • Fax (858) 720-2455

October 11, 2021

SANDAG Regional Plan EIR Sent Via Email: RegionalPlanEIR@sandag.org  
 C/O Kirsten Uchitel, Associate Planner  
 401 B Street, Suite 800  
 San Diego, CA 92101

**SUBJECT: DRAFT ENVIRONMENTAL IMPACT REPORT FOR THE 2021 REGIONAL PLAN**

The City of Solana Beach (City) appreciates the opportunity to review and comment on the San Diego Association of Governments (SANDAG) Draft Environmental Impacts Report (DEIR) for the Proposed 2021 Regional Plan (Proposed Plan). In addition to these comments on the DEIR, the City also attaches for inclusion and reference its comments on the Plan itself dated August 5, 2021.

36-1

As summarized in Table 7-2 and as discussed throughout the DEIR, significant and unavoidable impacts after mitigation were identified for seventeen (17) of the nineteen (19) resource areas analyzed. These include significant and unavoidable impacts after mitigation in "Regional Growth and Land Use Change" and also from "Transportation Network Improvements and Programs" in the areas of Aesthetics and Visual Resources, Agricultural and Forestry Resources, Air Quality, Biological Resources, Cultural Resources, Geology, Soils, and Paleontological Resources, Greenhouse Gas Emissions, Land Use, Mineral Resources, Noise and Vibration, Population and Housing, Public Services and Utilities, Transportation, Tribal Cultural Resources, Water Supply and Wildfire. While we recognize that the DEIR is a program level environmental review document, the level and extent of significant and unavoidable impacts even after mitigation for which a Statement of Overriding Considerations would have to be adopted by the SANDAG Board is concerning and, naturally, raises serious questions about the long-term viability of the Proposed Plan and its potential adverse impacts to the communities throughout the county. Generally speaking, the DEIR should more carefully consider these significant and unavoidable impacts and evaluate whether all potential mitigation measures have adequately been considered in order to reduce at least some of these impacts to a level of insignificance.

That said, please accept the following comments on specific sections of the DEIR:

36-2

**1. EXECUTIVE SUMMARY (ES)**

The first listed project objective for the DEIR is to "focus population and employment growth in mobility hubs and existing urban areas to protect sensitive

**RESPONSE TO COMMENT 36-1**

As noted in the comment, the EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects. Because the specifications of second-tier projects such as the timing, location, and size, associated with implementation of the Plan, are not known at this time, it cannot be concluded with certainty that the mitigation measures identified in the Draft EIR would sufficiently reduce impacts to less-than-significant levels. In addition, many Draft EIR mitigation measures for second-tier projects recognize that agencies other than SANDAG (e.g., local governments, transit districts, and Caltrans) are responsible for implementation, stating that such agencies "can and should" implement them. SANDAG can commit to feasible mitigation measures that are within its responsibility and jurisdiction. However, SANDAG will not be the agency for many of the second-tier projects that implement the proposed Plan. In those instances, SANDAG in its CEQA findings may find that those measures are within the responsibility and jurisdiction of another agency, and that such measures can and should be adopted by such other agency (Guidelines Section 15091(a)(2)).

The Draft EIR also recognizes that due to project or site-specific circumstances it may not be feasible for individual lead agencies to implement all of the "can and should" mitigation measures listed for a particular significant impact. Implementing agencies are required by CEQA to exercise discretion in selecting and imposing mitigation measures based on all relevant feasibility concerns, including costs and available funding, enforcement mechanisms, effectiveness as applied to the specific project in question, and collateral environmental or other effects that may result from implementation of the mitigation measure. How these factors may affect individual mitigation decisions for the many individual projects anticipated in the proposed Plan cannot be realistically assessed in a Program EIR for the entire proposed Plan.

As such, the EIR takes a conservative approach when making significant and unavoidable impact determinations. It does propose all potentially feasible programmatic mitigation measures for significant impact, and



some EIR mitigation measures have been strengthened in response to public comments on the Draft EIR.

**RESPONSE TO COMMENT 36-2**

Mobility Hubs are meant to be a general geographic area for concentration of future development and travel choices, but that does not mean that the entire area within the Mobility Hub will be developed. During the design of the elements of the Solana Beach Mobility Hub, project-specific biological field surveys and analysis will be conducted that will consider impact avoidance and minimization measures on sensitive biological resources, including southern coastal salt marsh and southern maritime chaparral.

36-2  
 cont.

habitat and natural resource areas." This objective seemingly ignores the fact that some areas where mobility hubs are proposed – particularly the Coastal Mobility Hub proposed for Solana Beach – are themselves replete with environmentally sensitive habitat areas (ESHA) and natural resources that must be protected. The City's 2018 updated ESHA Mapping for our Certified Local Coastal Program's Land Use Plan (LCP/LUP) identified 2,192.11 total acres of sensitive habitat and/or vegetation communities in Solana Beach, many of which the Proposed Plan and the DEIR are intended to protect. These include Southern Maritime Chapparal, Diegan Coastal Sage Scrub (described on page 4.4-64 of the DEIR as "one of the most sensitive vegetation communities in the County") and Southern Coastal Salt Marsh. This sensitive habitat is distributed throughout much of the Coastal Mobility Hub proposed for Solana Beach. While mitigation is identified to protect such habitat, like most impacts analyzed in the DEIR, even with mitigation this impact is significant and unavoidable. Absent additional mitigation for sensitive habitat within our Coastal Mobility Hub, the objective to focus population and housing in a mobility hub with significant sensitive habitat in order to protect that habitat is counterintuitive and effectively increases the impact within our City.

**Request:** The DEIR should be revised to address this discrepancy within the Solana Beach Mobility Hub and should place equal value on preserving the sensitive habitat and coastal resources – both physical and visual – within Solana Beach.

**2. PROJECT DESCRIPTION – MOBILITY HUBS (Section 2.5.1)**

36-3

The DEIR (and the Proposed Plan) describe Mobility Hubs as having "coverage areas" of 1, 2, or 4 miles from each node around which they are centered and are further described as "unique to each community based on community characteristics and travel needs." This uniqueness and stated objective to respect the character, scale and visual qualities of each Mobility Hub, although acknowledged and addressed throughout the DEIR including in Sections 4.1 (Aesthetics and Visual Resources), 4.11 (Land Use) and 4.14 (Population and Housing), is seemingly overlooked inasmuch as the DEIR identifies significant and unavoidable impacts for each of these analyzed resource areas due to the Sustainable Community Strategy's (SCS's) focusing of densification in these Mobility Hubs.

Additionally, Figures 2-35 and 2-36 (as well as Figures 2-20 and 2-21) illustrate the Mobility Hub Network. However, each Mobility Hub is very generally depicted and does not follow any specific geographic, visual or roadway boundaries. It is unclear how these amorphous mobility hub boundaries should be interpreted.

**Request:** The City requests that SANDAG staff work with City officials and their respective staffs to more clearly define these boundaries and provide more clear exhibits.

**RESPONSE TO COMMENT 36-3**

As stated in Chapter 2, *Project Description*, of the Draft EIR, potential locations for Mobility Hubs were identified for communities with a high concentration of people, destinations, and travel choices where densification is envisioned in the SCS, subject to the approval of local jurisdictions. As such, as part of the implementation of the proposed Plan, SANDAG will be working with the staff of the local jurisdictions to define the exact specifications of Mobility Hubs, including location and any other criteria to meet the unique characteristics and reflect the respective community transportation needs of each community. As noted above under Solana Beach 36-1, the significant and unavoidable determinations were based on a conservative approach based on a variety of factors related to determining the feasibility of mitigation measures in this first-tier Program EIR.

**3. AESTHETICS AND VISUAL RESOURCES (Section 4.1)**

36-4

Pages 4.1-9 of the DEIR accurately note that, under the California Coastal Act of 1976, scenic and visual qualities of the coast must be considered and protected as a visual resource. Additionally, page 4.1-10 notes that Section 30251 of the Coastal Act requires that permitted development shall be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural landforms, to be visually compatible with the character of surrounding areas and, where feasible, to restore and enhance the visual quality in visually degraded areas. Solana Beach is located entirely within the Coastal Zone while the entire western half of the City is also identified as a Coastal Mobility Hub in the Proposed Plan and DEIR. Therefore, the objective to focus jobs, housing and densification within this area as contemplated in the DEIR while also complying with the Coastal Act mandate to preserve scenic and visual qualities, protect views of the ocean and require new development to be compatible with the surrounding areas conflict with one another. More pointedly, the Proposed Plan is inconsistent with the Coastal Act in this regard. Not surprisingly, the DEIR determined that the Proposed Plan would, even after mitigation, have a significant and unavoidable impact effect in each of the following areas:

- AES-1** Have a substantial adverse effect on a scenic vista.
- AES-2** Substantially damage scenic resources, including but not limited to, trees, rocks, outcroppings, and historic structures within a state scenic highway.
- AES-3** Substantially degrade the existing visual character or quality of public views of the site and its surroundings, including adding a visual element of urban character to an existing rural or open space area, conflicting with regulations governing scenic quality.
- AES-4** Substantially degrade the existing visual character or quality of public views of the site and its surroundings by creating a new source of substantial light or glare that would adversely affect day or nighttime views.

This determination points to the significant challenges coastal cities like Solana Beach already face and will continue to face in light of the Coastal Mobility Hub designation in attempting to balance our local needs with both state and regional mandates and policies.

Additionally, Table 4.1-3 of the DEIR lists the Visual Resource Protection Plans and Regulations Governing Scenic Quality in the San Diego Region by Local Jurisdiction. In so doing, however, it fails to include the City's LCP/LUP Policies (2014) that mandate the protection of visual and scenic resources in compliance with the Coastal Act as well as our local Dark Sky Zones adjacent to the San Elijo Lagoon along the City's northern boundary and adjacent to the San Dieguito Lagoon at the southeastern boundary of the City.

**RESPONSE TO COMMENT 36-4**

Requested edits have been made to Table 4.1-3 to reference policies from Solana Beach's LCP/LUP regarding scenic quality as well as the Dark Sky Zones ordinance. In addition, the EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects, including Mobility Hubs. Development of Mobility Hubs that would occur as part of the implementation of the proposed Plan would undergo separate, project-specific environmental review, and any impacts on aesthetic and visual resources, including consistency with CCA policies related to preservation of such resources, would be evaluated and mitigated when the timing, location, and other specifications of a specific project have been defined. Draft EIR Section 4.1.2 describes the CCA policies that apply to coastal development to protect views to and along the ocean and other scenic coastal areas, and edits have been made to mitigation measures AES-2a and AES-2b to address coastal areas more specifically.

36-4  
 cont.

**Request:** The City requests that Table 4.1-3 be revised to include reference to our LCP/LUP Policies (2014) and our Dark Sky Zones as additional plans governing scenic qualities in our City. Further, the DEIR should provide a more detailed analysis of the inherent conflict between the Proposed Plan (specifically the Coastal Mobility Hub in Solana Beach) and the requirements of the Coastal Act to preserve scenic and visual qualities, protect views of the ocean and require new development to be compatible with the surrounding areas.

**4. AIR QUALITY (Section 4.3)**

36-5

Page 4.3-42 of the DEIR states that VMT, freight rail, and passenger rail activity is projected to increase between 2016 and 2035 and that reductions in emissions across the board are due primarily to federal and state regulations that reduce emissions from vehicles and locomotives over time. It goes on to state that, while passenger rail activity increases, "all passenger rail lines (both current and new) are assumed to be operating completely with modern, Tier 4 engines by 2035" concluding that, "while activity and fuel consumption increase, emissions are reduced, because Tier 4 engines emit fewer emissions per gallon of fuel consumed that the current locomotive fleet." Based on this, the Air Quality impact is determined to be less than significant in 2035. However, the DEIR does not explain the basis for the assumption that all passenger lines (both current and new) would be operating completely with modern, Tier 4 engines by 2035. If they are not, it stands to reason their emissions might not "trend down" by 2035 and, conversely, that significant, adverse impacts to Air Quality might instead result.

**Request:** Since reductions in emissions are based on an assumption that all rail lines will be operating with completely modern, Tier 4 engines by 2035, additional analyses should be conducted to assess Air Quality impacts if that assumption is not met and that a certain percentage of passenger rail lines are not operating with modern, Tier 4 engines.

**5. BIOLOGICAL RESOURCES (Section 4.4)**

36-6

In addition to the comments noted under the Executive Summary above, page 4.4-1 of the DEIR lists several agencies that identify sensitive vegetation communities in their ordinances and guidelines. Although this list does not include Solana Beach, as noted above, the City update its LCP/LUP ESHA Mapping in 2018 and the City's General Plan Conservation and Open Space Element also identifies policies to preserve sensitive habitat. Table 4.4-6 includes Relevant General Plan Policies and Biological Resource Protection Ordinances in the San Diego Region. Solana Beach is included in this list, however, the updated ESHA Mapping for the City's LCP LUP is not included.

Given the Significant and Unavoidable Impacts After Mitigation that are identified in the DEIR for Biological Resources, the City is concerned that focusing additional

**RESPONSE TO COMMENT 36-5**

See response to comment Del Mar 13-29. The air quality analysis assumes that all passenger lines will be operating with Tier IV or better engines by 2025. However, both the Coaster and Amtrak Pacific Surfliner lines are operating their full fleet with Tier IV locomotives today, which is ahead of the schedule assumed in the Draft EIR. Both Coaster and Amtrak have retired the older diesel locomotives that were assumed under the EIR's baseline conditions. Moreover, any new locomotive purchases will be Tier IV or better, in compliance with federal locomotive standards (40 CFR 1033). Also, mitigation measure AQ-2b ensures that all new train purchases shall be zero emission after 2035. The suggested additional analysis and mitigation measure are therefore not required.

**RESPONSE TO COMMENT 36-6**

The reference to the City's ESHA Mapping has been added to Table 4.4-6 in the Final EIR. Please also see response to comment Solana Beach 36-2. At the time of implementation of the elements of the Solana Beach Mobility Hub, project-specific biological field surveys and analysis will be conducted as applicable to address impact avoidance and protection of sensitive biological resources, including sensitive habitat.

jobs, housing and densification in the City's proposed Coastal Mobility Hub would further impact the 2,192.11 total acres of sensitive habitat and vegetation communities in Solana Beach, that the Proposed Plan and the DEIR are intended to protect.

36-6  
 cont.

**Request:** The City requests that Table 4.4-6 be revised to include reference to Solana Beach's updated ESHA Mapping associated with its Certified LCP/LUP. Additionally, the Proposed Plan and DEIR should analyze and make room for the preservation and protection of sensitive habitat and coastal resources (i.e., wetlands and bluffs) that are located within the proposed Solana Beach Coastal Mobility Hub.

**6. GEOLOGY, SOILS, AND PALEONTOLOGICAL RESOURCES (Section 4.7)**

Table 4.7-3 lists Local Policies Concerning Geologic and Seismic Hazards of local jurisdictions. On page 4.7-28 of the DEIR, Solana Beach's policies are listed, however, there is no mention of the City's Certified LCP/LUP which has an extensive list of Land Use Policies regarding the City's coastal and inland bluffs, coastal erosion, shoreline protection and protection of public's health, safety and welfare against coastal hazards and erosion.

36-7

**Request:** The City requests that Table 4.7-3 be revised to include specific policies of the City's Certified LCP/LUP (Update in 2014). Land Use Policies of the LCP/LUP that should be noted are those within Chapter 4 – Hazards & Shoreline/Bluff Development including those regarding General Development (Chapter 4, Section 1), Shoreline Development (Chapter 4, Section 2), Shoreline Erosion and Protective Structures (Chapter 4, Section 3), and Beach Sand Replenishment and Retention (Chapter 4, Section 4). The Proposed Plan should be analyzed against these policies for consistency.

**7. LAND USE (Section 4.11)**

Page 4.11-12 of the DEIR provides an overview of the California Coastal Act and page 4.11-17 contains a very brief discussion of Local Coastal Plans (Programs). While this discussion briefly describes and summarizes the intent of the Coastal Act and general location of the Coastal Zone, it does not provide any meaningful discussion about land use priorities and policies of the Coastal Act and its relationship to the Proposed Plan, which this section of the DEIR specifically analyzes. The entire City of Solana Beach is located within the Coastal Zone and is therefore subject to the provisions of the Coastal Act. As required under the Coastal Act, the City's Certified LCP/LUP (Amended 2014) LUP emphasizes visitor-serving and coastal dependent uses on and near the coast and throughout the City. The Proposed Plan's designation of much of our City within the Solana Beach Coastal Mobility Hub, including the entire western portion of the City closest to the coast, is expressly intended to focus more jobs, housing and densification in the City conflicts with several provisions of the Coastal Act that emphasize visitor

36-8

**RESPONSE TO COMMENT 36-7**

Table 4.7-3 has been updated with a discussion of policies related to geologic hazards from the Solana Beach LCP/LUP. While the Draft EIR did not individually analyze consistency with all of the local policies of all of the jurisdictions listed in Table 4.7-3, the Draft EIR states that existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 would require each improvement or project to be reviewed by appropriate regulatory agencies prior to construction and would require each improvement or project to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce impacts from geologic hazards. As such, any site-specific transportation network improvements and development projects occurring within Solana Beach would be subject to the policies identified in the City's LCP/LUP.

**RESPONSE TO COMMENT 36-8**

The identified sections of the Coastal Act have been added to the Regional and Local Laws, Regulations, Plans, and Policies discussion related to LCPs on Final EIR pages 4.11-12 and 4.11-13. Conflicts with land use plans, policies, or regulations are evaluated in the EIR on a program-level basis. As discussed for Impact LU-2, the forecasted development of the proposed Plan is based on the Series 14 Regional Growth Forecast SCS land use pattern, which is, in turn, based on the adopted general plans of the cities and County of San Diego and on the most recent planning assumptions, considering local general plans and other factors, as required by SB 375 (Government Code Section 65080(b)(2)(B)), including local coastal programs, which are components of local general plans. In a few cases, the SCS land use pattern may conflict with specific land use designations in general plans, but impacts of SCS implementation are already evaluated in other sections of the EIR, so these conflicts would not cause new significant impacts.

36-8  
 cont.

servicing, coastal dependent and recreational land uses over residential use. Therefore, a more detailed analysis of the Coastal Act's requirements and, more specifically, the areas in which land use conflicts may arise, should be provided. Coastal Act provisions that should be analyzed and/or considered include but are not limited to the following:

**Section 30212.5.** Wherever appropriate and feasible, public facilities, including parking areas or facilities, shall be distributed throughout an area so as to mitigate against the impacts, social and otherwise, of overcrowding or overuse by the public of any single area.

**Section 30213.** Lower cost visitor and recreational facilities shall be protected, encouraged, and, where feasible, provided. Developments providing public recreational opportunities are preferred.

**Section 30221.** Oceanfront land suitable for recreational use shall be protected for recreational use and development unless present and foreseeable future demand for public or commercial recreational activities that could be accommodated on the property is already adequately provided for in the area.

**Section 30222.** The use of private lands suitable for visitor serving commercial recreational facilities designed to enhance public opportunities for coastal recreation shall have priority over private residential, general industrial, or general commercial development, but not over agriculture or coastal-dependent industry.

**Section 30222.5.** Oceanfront land that is suitable for coastal dependent aquaculture shall be protected for that use, and proposals for aquaculture facilities located on those sites shall be given priority, except over other coastal dependent developments or uses.

**Section 30223.** Upland areas necessary to support coastal recreational uses shall be reserved for such uses, where feasible.

**Section 30255.** Coastal-dependent developments shall have priority over other developments on or near the shoreline. Except as provided elsewhere in this division, coastal-dependent developments shall not be sited in a wetland. When appropriate, coastal-related developments should be accommodated within reasonable proximity to the coastal-dependent uses they support.

36-9

Additionally, the City's Certified LCP/LUP contains Policies intended to implement the Coastal Act that should be considered that include but are not limited to the following:

**RESPONSE TO COMMENT 36-9**

Due to the programmatic nature of the EIR analysis, the EIR does not call out specific policies from local jurisdiction's LCPs/LUPs; thus, the specific Solana Beach LCP/LUP is not specifically called out in the analysis. Consistency of individual second-tier projects with these policies would be considered during project-specific CEQA reviews.

36-9 cont. **Policy 2.31:** Priority shall be given to the development of visitor serving and commercial recreational facilities designed to enhance public opportunities for coastal recreation. On land planned for visitor serving commercial and/or recreational facilities, priority shall be given to such uses over private residential or general commercial development. New visitor serving uses may not displace existing low-cost visitor serving uses unless an equivalent replacement is provided.

**Policy 2.33:** Coastal recreational and visitor serving uses and opportunities, especially Lower and moderate cost opportunities, shall be protected, encouraged, and where feasible, provided by both public and private means. Removal or conversion of existing lower cost opportunities, including overnight accommodations, shall be discouraged unless the use will be replaced with another use offering comparable visitor serving or recreational opportunities.

**Policy 2.34:** Priority shall be given to the development of visitor serving commercial and/or recreational uses that complement public recreation areas or supply recreational opportunities not currently available in public parks or beaches. Visitor serving commercial and/or recreational uses may be located near public park and recreation areas only if the scale and intensity of the visitor serving commercial recreational uses is compatible with the character of the nearby parkland and all applicable provisions of the LCP.

36-10 As noted above, both the Coastal Act and the City's LCP/CUP Policies prioritize visitor serving commercial and/or recreational land uses over residential use. The Proposed Plan's explicit focus on and prioritization of housing densification within the Solana Beach Coastal Mobility Hub clearly conflicts with these provisions of the Coastal Act and our Certified LCP/LUP. In a City like Solana Beach, a built-out city of only 3.4 square miles that is entirely located within the Coastal Zone, the ability to comply both with the Coastal Act and the Proposed Plan's objective to focus housing and jobs in the proposed Solana Beach Coastal Mobility Hub is and will continue to be a challenge. The DEIR should consider and/or analyze these conflicting objectives.

36-11 Table 4.11-5 of the DEIR lists the adoption and updates to the General Plans and Housing Elements of jurisdictions in the County. For Solana Beach, however, this table indicates that our Housing Element is "being updated as of December 2020." Our City Council approved our 6<sup>th</sup> Cycle Housing Element on April 14, 2021, and submitted it to the Department of Housing and Community Development (HCD) immediately thereafter. In response to comments from HCD, the City is preparing revisions to our Housing Element for approval by our City Council before the end of 2021.

**RESPONSE TO COMMENT 36-10**

Solana Beach is a major destination due to its commercial and recreational resources for visitors from both outside and within San Diego County. These trip-inducing factors contribute to the area's high propensity for Regional Mobility Hub designation.

Not all Mobility Hub areas are created equal, and they do not all require construction of a major transit center. Coastal Mobility Hubs in the North County area are envisioned to rely upon some transit services supported by an array of on-demand Flexible Fleets to help people complete short trips in and around the hub without needing to rely on a car. The suite of Flexible Fleets and supporting Mobility Hub amenities as included in the Final EIR can be tailored to meet the needs of people traveling to and within Solana Beach. SANDAG staff will continue to coordinate with Solana Beach on planning for appropriate Mobility Hub services, amenities, and supporting technology for this community.

**RESPONSE TO COMMENT 36-11**

The text in Table 4.11-5 has been updated to reference the current Housing Element status, as provided in this letter.



36-12 **Request:** Section 4.11 of the DEIR should include a more detailed description and analysis of provisions of the Coastal Act and local LCP Policies that conflict with the Proposed Plan's stated objective that jobs, housing and densification should be focused in designated Coastal Mobility Hubs. Where conflicts exist, the Proposed Plan should state that provisions of the Coastal Act should prevail.

Please update Table 4.11-5 of the DEIR regarding the status of the City's Housing Element.

**8. 4.13 NOISE AND VIBRATION**

The DEIR discusses noise and vibration associated with Phased Transit Leap improvements, which includes double-tracking at certain locations on the LOSSAN rail corridor along with increases in COASTER frequencies. The DEIR states that land uses considered to be sensitive to human annoyance caused by vibration are generally the same as those that would be sensitive to noise.

The City appreciates the analysis of noise and vibration resulting from improvements associated with regional growth and land use changes and transportation network improvements as well as the mitigation measures proposed to address these impacts. Despite this analysis and proposed mitigation, Significant and Unavoidable Impacts After Mitigation are identified in 2025, 2035 and 2050 for noise and vibration impacts (NOI-1 and NOI-2).

36-13 The DEIR discusses and analyzes the Generation of Excessive Groundborne Vibration or Groundbourne Noise Levels and similarly determines that improvements associated with regional growth and land use changes and transportation network improvements could generate an increase in groundbourne noise and vibrations. These impacts are also determined to be Significant and Unavoidable After Mitigation in 2025, 2035 and 2050 and could result both from construction activity and from ongoing operation of the transportation network under the Proposed Plan.

Absent from the analysis, however, is any discussion regarding the potential vibrational impacts to coastal bluffs, inland bluffs and other sensitive landforms through which the newly double-tracked LOSSAN rail corridor and the anticipated increased COASTER services do and will run. Similarly, when combined with the transportation network impacts, new construction activity anticipated within the City's Coastal Mobility Hub could create more severe groundborne vibration impacts to natural landforms and/or to existing development. The City of Solana Beach is characterized by extensive coastal and inland bluffs that are within close proximity to the LOSSAN corridor. The City routinely experiences coastal erosion and bluff failures that create a public safety hazard. Additionally, most of the City is designated within the proposed Solana Beach Mobility Hub which is intended to be the focus of additional jobs, housing and densification under the Proposed Plan. While mitigation measures are proposed to address these impacts, Section 4.13

**RESPONSE TO COMMENT 36-12**

Requested revisions have been made to Table 4.11-5 in Section 4.11, *Land Use*, of the Final EIR. In addition, due to the programmatic nature of the EIR analysis, the EIR does not call out specific policies from local jurisdiction's LCP/LUPs; thus, these specific Solana Beach LCP/LUP items are not specifically called out in the analysis. The EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects. As part of the implementation of the proposed Plan, individual projects that are part of the Plan, including Mobility Hubs, would be subject to project-specific environmental review and would include project-specific consistency analyses with applicable CCA and LCP policies. Project-design adjustments and mitigation measures would be identified to reduce impacts related to potential conflicts with applicable policies at that time.

**RESPONSE TO COMMENT 36-13**

Impacts from vibration associated with projects that would occur under the proposed Plan are described under Impact NOI-2 in Section 4.13, *Noise and Vibration*. The discussion is generic and outlines some of the projects that would occur during the time horizons referenced in the document. This analysis is not meant to clear projects that would require project-level analysis and does not include an exhaustive list of projects as the document is a program-level EIR. The analysis requested by the commenter for the referenced project would be included in the project-level environmental document. Language has been added to Section 4.13 to discuss generally the impacts of vibration-related impacts to coastal and inland bluffs.

and Section 7.2.8 of the DEIR should include discussion and analysis of specific impacts to coastal bluffs, inland bluffs and to the existing development within these areas.

36-13  
 cont. **Request:** The DEIR should include discussion and analysis of the potential impact of groundborne vibrations to coastal bluffs, inland bluffs and existing development from the construction and operation of the proposed transportation network and regional growth and new development contemplated and/or proposed under the Proposed Plan.

**9. POPULATION AND HOUSING (Section 4.14)**

36-14 Section 4.14.2 of the DEIR, Regulatory Setting, discusses federal, state, regional and local laws, regulations, plans and policies associated with the Proposed Plan and the DEIR. However, this section of the DEIR appears only to discuss a narrow set of regulations that directly relate to the Proposed Plan and DEIR. The list of regulations does not appear to be exhaustive. On an annual basis, the State Legislature passes, and the Governor signs a number of bills that apply directly to local jurisdictions. Increasingly, these bills are focusing on increasing housing throughout every city in the state and, in many cases, incentivize high density housing, streamlined permit processing, no parking and additional CEQA exemptions for such housing, particularly when located within close proximity to major transit stops or high quality transit corridors. Despite this, the DEIR does not include a meaningful discussion state housing legislation and, more specifically, how it may further impact development along the proposed transportation network and/or within the Mobility Hub Network.

36-15 Section 4.11 of the DEIR discussed local General Plans and Community Plans and states that infill development of new housing and employment land uses within established communities would typically occur in accordance with adopted general plans, community plans and or zoning ordinances. Additionally, on page 4.1-18 of Section 4.1, the DEIR states that "...all development or redevelopment projects would undergo further environmental and design review on a project-by-project basis to ensure that substantial adverse effects on scenic vistas are identified and avoided or reduced to the extent feasible." However, housing legislation proposed over the past several years has continuously sought to provide for ministerial or "by-right" housing which effectively eliminates the ability for local jurisdictions to review or condition such housing development. This year, Senate Bill (SB) 9 was signed by Governor Newsom which provides for the ministerial approval of housing development on single-family zoned property and also allows for the ministerial approval of a lot split of such parcels to provide additional housing. Not only does this eliminate the discretion of a city to review such projects to protect against adverse visual and aesthetic impacts, but it also sets the stage for future legislation to do the same. Additionally, by definition, a ministerial permit process does not require CEQA review. Therefore, the comment for the DEIR is not accurate as projects may be approved without project-by-project review. As noted above, other

**RESPONSE TO COMMENT 36-14**

The Regulatory Setting in Section 4.14, *Population and Housing*, discusses federal, State, regional, and local laws, regulations, plans, and policies pertaining to and relevant to the proposed Plan. While it is correct to say that housing legislation in recent years has sought to provide for ministerial housing, which may mean that future CEQA analysis would not occur on each and every specific development project, each jurisdiction has a local entitlement process to follow and specific ordinances, including design measures, that projects would be required to adhere to. Therefore, even for projects that are exempt from CEQA, review at a local level for compliance with the local jurisdiction's entitlement process and specific local ordinances, including design measures, would still occur. As such, future development occurring as part of the implementation of the proposed Plan would be evaluated at a local level on a project-by-project basis, whether the evaluation occurs as part of the CEQA process or as part of the local entitlement process.

**RESPONSE TO COMMENT 36-15**

While it is correct to say that housing legislation in recent years has sought to provide for ministerial housing, which may mean that future CEQA analysis would not occur on each and every specific development project, each jurisdiction has a local entitlement process to follow and specific ordinances, including design measures, that projects would be required to adhere to. Therefore, even for projects that are exempt from CEQA, review at a local level for compliance with local jurisdiction's entitlement process and specific local ordinances, including design measures, would still occur. As such, aesthetic impacts would be evaluated at a local level on a project-by-project basis, whether the evaluation occurs as part of the CEQA process or as part of the local entitlement process. The EIR does not dismiss aesthetic impacts but acknowledges that impacts would occur on a local level and would be evaluated at a local level on a project-by-project basis.

36-15  
 cont. recently adopted state housing legislation provides for streamlined review of projects located near major transit stops or high quality transit corridors. The DEIR should consider and evaluate additional state housing legislation for its potential impact on land use, population and housing and visual quality.

36-16 **Request 1:** The DEIR should expand its discussion of state legislation to include recently adopted housing legislation including those that incentivize housing development, housing density, streamlined permit review and/or CEQA exemptions.

**Request 2:** The City requests that the underlying source documents be provided for the population and job growth projections used in the DEIR. The numbers used in the DEIR appear to be inconsistent with numbers and projections used by SANDAG previously including during the RHNA process.

**10. TRANSPORTATION (Section 4.16)**

36-17 On page 14.16-13 of the DEIR, Pedestrian Facilities are discussed. The DEIR states that walking is a part of an active transportation network and identifies pedestrian facilities to primarily include sidewalks and crosswalks associated with arterials and roadways, as well as bridges and other connections across highways and rail facilities. The Active Transportation is an important element of the Regional Plan and is discussed in many sections throughout the DEIR. Compared to other modes of transportation as identified and discussed in the DEIR, Pedestrian Facilities, arguably, is the most impactful and important mode of transportation and yet, less than one page of the Transportation section is dedicated to Pedestrian Facilities. In that short section, the DEIR places the Safe Routes to School Program as the main strategy to address the Pedestrian mode of the Proposed Plan. While the Safe Routes to School Program needs to be discussed, the Pedestrian Facilities Section should be expanded with additional discussion and analysis.

**Request 1:** The DEIR should add stand-alone pedestrian bridges and pedestrian under-crossings into the Pedestrian Facilities category and include the required discussion for potential impacts and required mitigation measures for such facilities. The DEIR should identify the need for and incorporate Pedestrian Facilities into major corridor and transportation improvements where other modes of transportation have created barriers or made the pedestrian mode of travel less desirable or safe as compared to other modes of transportation.

36-18 **Request 2:** Additionally, the Lomas Santa Fe corridor is identified as a major transportation element which is divided into two segments by the I-5 freeway. The Pedestrian Facility in the east/west direction at the I-5 Interchange is inadequate to a point that the City, in collaboration with the Solana Beach School District, has placed crossing guards to assist pedestrians, often young school children, in crossing the interchange. This is particularly important at the northbound on-ramp

**RESPONSE TO COMMENT 36-16**

Regarding Request 1, please see responses to comments Solana Beach 36-14 and 36-15. Regarding Request 2, the proposed Plan’s Appendix F, Series 14 Regional Growth Forecast and SCS Land Use Pattern, details the development of the population and job growth projections that are reflected in the Draft EIR. The Series 14 Regional Growth Forecast aligns with the regional population projection from the California Department of Finance (DOF) released in January 2020. The California Department of Housing and Community Development issued the San Diego region’s Regional Housing Needs Assessment Determination on July 5, 2018, and used an earlier version of the DOF population projection.

**RESPONSE TO COMMENT 36-17**

In general, pedestrian facilities are more focused in localized areas and are not planned at the regional level. Due to its regional focus, the proposed Plan need not provide substantial detail on the pedestrian facilities that currently exist within the region or locally planned improvements to pedestrian networks under future year conditions. Additionally, the proposed Plan does not include any specific pedestrian-related infrastructure; instead, the proposed Plan includes grant funding opportunities for local jurisdictions to plan, design, and construct pedestrian improvements at the local level (see Table A.14 and A.17 of the proposed Plan). Therefore, because the pedestrian infrastructure funded by the proposed Plan will generally be planned, designed, and implemented by local jurisdictions, it has not been identified at this time and could not be summarized or included within the Draft EIR. Finally, it should be noted that subsequent, project-level, CEQA review will be required for the pedestrian infrastructure funded by the proposed Plan prior to such infrastructure’s implementation.

Please also note that an analysis of how the implementation of the proposed Plan will affect pedestrian travel within the region was conducted under Impact TRA-1. A summary of the pedestrian analysis result, including trip generation, average trip length, and mode split is provided for each Horizon Year in Tables 4.16-8 (Year 2025), 4.16-12 (Year 2035), and 4.16-16 (Year 2050).

**RESPONSE TO COMMENT 36-18**

As an initial matter, Request 1 relates to the contents of the proposed Plan, not the adequacy of the analysis within the DEIR. The proposed

Plan aims to create safe and well-connected routes for pedestrians and bicyclists. The intention of the network in the Plan is a framework that facilitates trips associated with regional purposes designed to enhance neighborhood connections to schools, employment centers, and other everyday destinations. At the regional scale, the regional transportation network does not include details regarding the types of bicycle and pedestrian facilities to be included within specific corridor projects, and the analysis of those projects will require future planning and coordination with local jurisdictions, community members, and other stakeholders to determine such details, all of which would be conducted at the project level.

In addition to specific projects and corridors, the Plan includes funding for “Complete Streets in Mobility Hubs,” which will include active transportation improvements on local streets within the hubs that will facilitate these kinds of connections. The intention is to make trips less than 3 miles more attractive for walking and biking. Local jurisdictions also have access to Safe Routes to Schools programs and funding, which can assist with infrastructure, outreach, and other elements. Appendix A of the proposed Plan includes *Mobility Hubs* and *Policies and Programs* sections that describe investments that would benefit school sites and school access. Within the *Mobility Hub* investments, programs aim to make streets safer for people who walk and bike by investing in traffic calming and pedestrian improvements. Under *Policies and Programs* the proposed Plan includes Vision Zero programming that prioritizes safety through roadway design while working with cities to develop community engagement programs that identify local street safety issues and provide technical guidance to resolve those issues through investment, policies, and programs.

Request 2 states that the Draft EIR should incorporate a mitigation measure to improve pedestrian access along Lomas Santa Fe at the I-5 interchange. The issues described at the east/west direction at the I-5 Interchange, however, describe an existing condition, not an impact of the proposed Plan. This comment is therefore directed towards the content of the proposed Plan, not the adequacy of the EIR’s mitigation measure for the significant impacts *caused* by the proposed Plan. The comment will be considered by the SANDAG Board of Directors when it considers adoption of the proposed Plan

36-18  
 cont.

location where pedestrian crossing is uncontrolled. The City requests that the DEIR incorporate a mitigation measure that improves pedestrian access along Lomas Santa Fe at the I-5 interchange.

**11. WATER SUPPLY (Section 4.18)**

36-19

The DEIR concentrates its discussion and analysis on the San Diego County Water Authority (SDCWA). While it generally discusses SDCWA member agencies, there is little discussion about adequate water supply at the local level within each jurisdictions' respective water district(s). Given the ongoing and worsening drought and severely low water levels in the state's reservoirs as well as at Lake Mead and Lake Powell, additional analysis should be conducted on local water districts and water supply, particularly those that serve the Proposed Plan's Mobility Hub Network.

**Request:** The DEIR should include more detailed analysis of SDCWA Member Agencies' local water supplies, particularly those serving areas located within the Proposed Plans' Mobility Hub Network.

**12. WILDFIRE (Section 4.19)**

36-20

On page 4.19-18, the DEIR states that the western portion of the [San Diego] region is also at high risk for fire hazards as it contains hundreds of miles of WUI (Wildland Urban Interface) due to the multitude of canyons throughout the area. Solana Beach is no exception as our entire northern boundary fronts the San Elijo Lagoon, with the southeastern boundary adjacent to several finger canyons emanating from the San Dieguito Lagoon across Via de la Valle. Consequently, an extensive are of the northern portion of Solana Beach is within a Very High Fire Hazard Severity Zone (VHFSZ Map). Thought not easily discernible in Figures 4.19-3 and 4.19-4 of the DEIR, much of this area overlaps with the Proposed Plan's Solana Beach Mobility Hub.

Again, the DEIR determined that there will be Significant and Unavoidable Impacts After Mitigation for all three significance criterion (WF-1, WF-2 and WF-3) in 2025, 2035 and 2050. These impacts are associated both to the risks of wildfire itself and to the exposure of pollutant concentrations of wildfire smoke. Page 4.19-18 of the DEIR also notes that insufficient water supply, which is discussed in Section 4.18 and which also experiences Significant and Unavoidable Impacts After Mitigation, "may also contribute to an increased risk of wildland fire hazard."

**Request:** Given that the City's existing VHFSZ areas overlap with the Solana Beach Mobility Hub, the DEIR should assess and/or analyze whether including such areas within a designated Mobility Hub increases the risks to the public.

**RESPONSE TO COMMENT 36-19**

The Draft EIR analyzes at a program level the effects of the planned transportation network, and the resulting patterns of land use and development, on a regional basis. The analysis incorporates the population growth projected for the County's cities and unincorporated areas projected by SANDAG Series 14 statistics. The water supply analysis examines the adequacy of the region's future water supply assuming future projected population levels. The availability of future water supplies to meet this future demand is assessed using the legally mandated UWMPs prepared by the agencies supplying water to the region, the SDCWA and the MWD. For the SDCWA service area, the EIR does not analyze the water supply of particular geographic areas or jurisdictions; instead, it analyzes the adequacy of supply on a regional basis. It should be noted, however, that the water planning of the SDCWA's 24 member agencies is incorporated into the SDCWA UWMP. This planning includes both supply and demand.

The proposed Plan designates areas that, due to planned investment in transportation infrastructure and a potential for increased employment and residences, are potential Mobility Hubs. As described in the Chapter 2 of the EIR, Mobility Hubs are proposed for communities with a high concentration of people, destinations, and travel choices where densification is envisioned in the SCS, *subject to approval of local jurisdictions*. In order for a Mobility Hub to become a reality a very large number of plans and projects would need to be proposed over many years. These plans and projects would be subject to local discretionary review, including review pursuant to CEQA. As part of this plan and project-level review, the adequacy of local water supplies, storage capacity, and conveyance infrastructure would be evaluated. The results of these analyses would determine what water infrastructure investments would be necessary in order for a Mobility Hub to meet its ultimate growth potential in terms of jobs and residences, or if less intensive future development is warranted as a result of limited water supplies or inadequate infrastructure.

**RESPONSE TO COMMENT 36-20**

The EIR concludes that transportation network improvements and programs associated with the proposed Plan would expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildland. Revisions have

been made to Section 4.19, *Wildfire*, regarding the 2025 (Final EIR page 4.19-21), 2035 (Final EIR page 4.19-24), and 2050 (Final EIR page 4.19-25) as follows:

Risks would be exacerbated in areas where designated Mobility Hubs, characterized by a higher density of jobs and residences, would develop within and adjacent to VHFSZs.

Also, please see response to comment Solano Beach 36-19 regarding project-specific review of projects implementing Mobility Hubs; such reviews would consider and mitigate wildfire impacts.

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36-21

Once again, the City of Solana Beach greatly appreciates the opportunity to review and comment on the DEIR. We look forward to coordinating with you further on this and appreciate SANDAG's consideration of the City's comments as noted above.

If you have any questions or comments, please feel free to contact Community Development Director Joseph Lim at [jliri@cosb.org](mailto:jliri@cosb.org) or 858-720-2434 or me at [gwade@cosb.org](mailto:gwade@cosb.org) or 858-720-2444.

Sincerely,



Gregory Wade  
City Manager

Attachment 1: Draft 2021 Regional Plan Letter dated August 5, 2021

C: Lesa Heebner, City of Solana Beach Mayor and SANDAG Board Member  
David Zito, City of Solana Beach Council Member and SANDAG Board Alternate  
Joseph Lim, City of Solana Beach Community Development Director

### RESPONSE TO COMMENT 36-21

Thank you for your comments on behalf of the City of Solana Beach. SANDAG appreciates Solana Beach's input on the EIR and the proposed Plan.



Attachment 1



**CITY OF SOLANA BEACH**  
 635 SOUTH HIGHWAY 101 • SOLANA BEACH, CA 92075 • (858) 720-2400 • Fax (858) 720-2455

[www.cityofsolanabeach.org](http://www.cityofsolanabeach.org)

August 5, 2021

Attn: 2021 Regional Plan  
 SANDAG  
 401 B Street, Suite 800  
 San Diego CA, 92101

Via Email: [SDForward@sandag.org](mailto:SDForward@sandag.org)

**SUBJECT: DRAFT 2021 REGIONAL PLAN**

The City of Solana Beach appreciates the opportunity to review and comment on the San Diego Association of Governments (SANDAG) Draft 2021 Regional Plan (Draft Plan). It is clear that much time and effort went into this important document. Submitted for your consideration are the following comments:

- **Mobility Hubs** – Page 19 of Chapter 2 of the Draft Plan, the Sustainable Communities Strategy (SCS), describes planned "Mobility Hubs" as areas or communities in the region with "a high concentration of people, destinations, and travel choices" that "offer on-demand travel options and supporting infrastructure that enhance connections to high-quality Transit Leap services." While the SCS seems to acknowledge that these Mobility Hubs can vary both in size and transit availability and can "span one, two or a few miles based on community characteristics," the SCS and the Draft Plan do not separately categorize or discuss these Mobility Hubs based on these unique characteristics despite having done so previously as well as in Appendix T (Network Development and Performance). Pages 15 through 18 of Appendix T of the Draft Plan – Network Development and Performance – contains a Propensity Analysis for both Transit Leap Services and Mobility Hubs. These analyses identified which transit routes were most likely to meet the needs of transit riders now and in the future and which communities were most suitable for Mobility Hubs. While it should be noted that Solana Beach ranked at the lower end of both (see Figures 12 and 14), these analyses resulted in the apparent establishment of five (5) distinctive types of Mobility Hubs – Coastal, Gateway, Major Employment Center, Suburban and Urban Core – with Solana Beach identified in Figure 15 as a Coastal Mobility Hub. However, the SCS contains no meaningful discussion of these distinctive and unique Mobility Hub areas referring to them only in Figure 2.5 of the SCS where projected future growth is illustrated. The dramatic difference in projected future growth for each of these distinct Mobility Hub Areas, with Coastal Mobility Hubs well below the other four Mobility Hub Areas in both the percentage of future housing and future jobs (5% and 2%, respectively), clearly demonstrates their

36-22

**RESPONSE TO COMMENT 36-22**

Thank you for providing the City of Solana Beach’s letter providing comments on the proposed Plan. Responses to these comments can be found beginning from ID L142 in Appendix P.2.

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Solana Beach Comments  
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uniqueness with respect to jobs, housing and access to high-quality transit and the extent to which each area should be relied upon (or not) to satisfy the region's future growth.

The adopted 2021 Regional Transportation Plan (Adopted Plan) and the SCS should contain a detailed discussion of the five (5) Mobility Hub Areas and a description of the unique characteristics and transit needs for each – both now and in the future.

Additionally, by virtue of the fact that the Solana Beach Train Station is within 2 ½ miles of the cities of Del Mar, Encinitas and San Diego and the County of San Diego, this regional Coastal Mobility Hub Area in the Adopted Plan should, for purposes of planning for future housing and job growth, extend into and cover the City of Del Mar and the Del Mar Fairgrounds and areas of the cities of Encinitas and San Diego and the County of San Diego immediately adjacent to Solana Beach.

- **Transit Leap Services** – As noted above, the Propensity Analysis discussed in Appendix T for both Transit Leap Services and Mobility Hubs determined that Solana Beach and its Train Station were at the lower end in the region both in meeting the needs of transit riders now and in the future and for suitability as a Mobility Hub. While the City acknowledges that the presence of the Train Station in Solana Beach might make it reasonable to include as a potential future Mobility Hub in the Adopted Plan, during the recent Regional Housing Needs Assessment (RHNA) allocation process, the City also made it clear that, both now and in the near term, the Train Station does not currently provide adequate Coaster or Amtrak headways, nor does it provide meaningful connections to other transit services to be considered a Mobility Hub now. Indeed, despite the North County Transit District (NCTD) Board recently voting to increase Coaster service beginning in October 2021, such a designation is still largely aspirational. While, again, the City acknowledges that the Draft Plan and the Adopted Plan are just that – a plan for the future – Appendix A of the Draft Plan – Transportation Projects, Programs, and Phasing – appears to support this position. Table A.5 (Interstate 5 North Coastal Corridor) identifies one Transit Leap project (TL40) – *Rapid 473* – for implementation in the year 2035. Similarly, Table A.9 (State Route 56) identifies one Transit Leap project (TL026) – *Rapid 103* – for implementation in the year 2050. These 15 to 30-year forward-looking Transit Leap projects, while helpful for the future, do not appear to satisfy the near-term objectives of a Coastal Mobility Hub.

In order to justify the designation of the Solana Beach Train Station as a Coastal Mobility Hub, both now and in the future, more immediate Transit Leap service connections should be considered for inclusion in the Adopted Plan.

36-22  
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**Appendix B: Implementation Actions** – Appendix B provides detail on commitments and key actions to implement elements and strategies of the Draft Plan. Key to this objective is the involvement of and coordination with each member agency as they are most knowledgeable of the needs of their respective communities. Indeed, Near-term Implementation Action No. 2 in Table B.1 identifies the need to partner with local governments to develop five initial Comprehensive Multimodal Corridor Plans (CMCPs). Therefore, the City requests that the following minor edits to Appendix B (page 16) under “Land Use and Regional Growth” be included:

“The 2021 Regional Plan vision for land use focuses on development and growth in ~~Mobility-Hub areas urbanized areas near jobs~~ to preserve San Diego’s open space and support transportation investments by reducing vehicle miles traveled (VMT). Mobility Hubs are ~~the an~~ opportunity to provide housing to address the Regional Housing Needs Assessment. ~~Land use authority is reserved to local jurisdictions because they are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan through understanding of the unique needs of their communities and geographies.~~ Because land use authority is reserved to local jurisdictions, SANDAG will leverage partnerships with cities and the county through the Smart Growth Incentive Program and other grants to provide funds for transportation-related improvements and planning efforts that support smart growth in Mobility Hubs to realize ~~this their~~ vision for ~~their~~ communities. SANDAG will continue its existing grant programs, partner with member agencies on state funding opportunities, and provide data and technical support to assist local jurisdictions with land use planning efforts in line with the 2021 Regional Plan.”

- **Regional Housing Needs Assessment** – Following adoption of the Draft RHNA allocation by the SANDAG Board in September 2020, appeals of the allocation were filed by the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach. In order that these appeals are correctly noted for the record, there are two locations in the Draft Plan to which a clarifying footnote and additional language should be added to the Adopted Plan. Specifically, the City requests the following for the Adopted Plan:
  - On page 33 of the Draft Plan, after the sentence: “The SANDAG Board of Directors adopted the RHNA Plan on July 10, 2020, with the final housing unit allocation” the following footnote should be added:
 

*\* In September 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court challenging, among other things, the Board’s adoption of the RHNA Plan. SANDAG demurred to the cities’ Petition and the demurrer was sustained by the court in February 2021. The petitioning cities have*

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*appealed the ruling on the demurrer to their Writ Petition, and that appeal remains pending in the Fourth District Court of Appeal.*

- On page 14 of Appendix K (Regional Housing Needs Assessment Plan), the following paragraph should be added to the end of this page/section:

*On September 24, 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court, Case No. 37-2020-00033974-CU-MC-CTL, against SANDAG and SANDAG's Board of Directors seeking an order requiring that SANDAG give those cities a fair hearing on their RHNA appeals and decide the cities' appeals in a legal manner without bias and without the use of the weighted voting mechanism. Specifically, the petitioning cities asked the court to order: (1) that the final RHNA allocation approval by SANDAG be rescinded; (2) that SANDAG's denial of the cities' RHNA appeals be rescinded; (3) that the appeals be remanded to SANDAG for fair consideration; and (4) that SANDAG be prohibited from utilizing a weighted vote on the cities' RHNA appeals. On February 5, 2021, SANDAG's demurrer to the Petition for Writ of Mandate was sustained by the Superior Court. The petitioning cities have appealed the ruling on the demurrer to their Writ Petition. That appeal remains pending in the Fourth District Court of Appeal. So long as the litigation is pending, the Board's adoption of the RHNA Plan cannot be considered final.*

Once again, the City of Solana Beach greatly appreciates the opportunity to review and comment on the Draft Plan. We also appreciate SANDAG's consideration of our comments and requested changes for inclusion in the Adopted Plan as noted above.

If you have any questions or comments, please feel free to contact Community Development Director Joseph Lim at [jjlim@cosb.org](mailto:jjlim@cosb.org) or 858-720-2434 or me at [gwade@cosb.org](mailto:gwade@cosb.org) or 858-720-2444.

Sincerely,



Gregory Wade  
City Manager

- C: Lesa Heebner, City of Solana Beach Mayor and SANDAG Board Member  
David Zito, City of Solana Beach Council Member and SANDAG Board Alternate  
Joseph Lim, City of Solana Beach Community Development Director

36-22  
cont.

**COMMENT LETTER 37: SOUTHWEST WETLANDS INTERPRETIVE ASSOCIATION**

Comment Letter 37

**From:** Bill Tipperts <[billtipperts@gmail.com](mailto:billtipperts@gmail.com)>  
**Sent:** Monday, October 11, 2021 1:13 PM  
**To:** Kirsten Uchitel; Mike McCoy  
**Cc:** Robert Miller; Yvonne Oden; Gary Brown; Mayda Winter  
**Subject:** Comments on the RTP/SCS (San Diego Forward: The Regional Plan) Draft EIR

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Ms. Uchitel:

37-1

I am submitting these comments on behalf of the Board of the Southwest Wetlands Interpretive Association (SWIA), which has advocated for and worked to conserve native habitats in San Diego and southern California for over four decades. We appreciate the efforts by SANDAG to present a new approach and set of concrete elements to make our region less autocratic, reduce associated GHG emissions, improve social/environmental justice and reduce impacts to natural lands. The significance of potential impacts from the proposed Plan, and reasonable ways to improve it to reduce impacts, suggests that a new alternative plan is desirable and feasible. Our letter proposes the framework for that alternative.

Regards,

Bill Tipperts (Board Member, SWIA)

**RESPONSE TO COMMENT 37-1**

Thank you for your comment on behalf of the Southwest Wetlands Interpretive Association (SWIA). SANDAG appreciates SWIA's proposal regarding a framework for a new alternative. Please refer to response to comment SWIA 37-11 for further elaboration regarding this comment.





Southwest Wetlands Interpretive Association  
700 Seacoast Drive, Suite 108  
Imperial Beach, CA 91932

11 October 2021

Kirsten Uchitel, Associate Planner  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

(submitted 11 October 2021 via email to Kirsten.Uchitel@sandag.org)

Subject: Draft EIR for San Diego Forward: The 2021 Regional Plan (RTP/SCS)

Dear Ms. Kristen Uchitel,

37-2 The Southwest Wetlands Interpretive Association (SWIA) is a non-profit organization dedicated to helping preserve and enhance wetlands throughout southern California – and also to supporting land uses and planning to conserve upland habitats and species. SWIA provides the following comments on the Draft EIR for SANDAG's RTP/SCS. After decades of incremental changes to our transportation system and associated land use/development, the RTP/SCS Plan presents important elements for a blueprint to transform how our region accommodates projected growth in our region's population, housing, and jobs.

Given the length (2330 pages) and complexity of the EIR/Appendices, we are limiting our comments and recommendations for changes to reduce impacts to several components: (1) changes to the proposed transportation infrastructure; (2) need for additional funding (regional habitat conservation fund) to address impacts to habitats and species; (3) a new alternative is necessary to address/reduce significant deficiencies in the Plan and impacts from its implementation.

General Comments

37-3 SANDAG's proposed Plan (the RTP/SCS) attempts to strike a balance between what is optimal and what is achievable, having to contend with the historical failures of previous plans to address the region's transportation needs and allied concerns. As stated in the EIR (Page ES-1): "The proposed Plan includes a blueprint for a regional transportation system, serving

### RESPONSE TO COMMENT 37-2

SANDAG appreciates SWIA's overall support for the Plan. Please refer to the responses to comments below for further discussion.

### RESPONSE TO COMMENT 37-3

Regarding significant and unavoidable impacts, the EIR prepared for the proposed Plan is a first-tier Program EIR. "Second-tier projects" that would implement the proposed Plan include site-specific transportation network improvements and development projects. Many Draft EIR mitigation measures for second-tier projects, recognizing that agencies other than SANDAG (e.g., local governments, transit districts, and Caltrans) are responsible for implementation, state that such agencies "can and should" implement the measures. See Master Response 2 for further discussion of these mitigation measures.

SANDAG can commit to feasible mitigation measures that are within its responsibility and jurisdiction. However, SANDAG will not be the lead agency for many of the second-tier projects that implement the proposed Plan. In those instances, SANDAG in its CEQA findings may find that those measures are within the responsibility and jurisdiction of another agency, and that such measures can and should be adopted by such other agency (Guidelines Section 15091(a)(2)).

The Draft EIR also recognizes that due to project- or site-specific circumstances, it may not be feasible for individual lead agencies to implement all of the "can and should" mitigation measures listed for a particular significant impact. Implementing agencies are required by CEQA to exercise discretion in selecting and imposing mitigation measures based on all relevant feasibility concerns, including costs and available funding, enforcement mechanisms, effectiveness as applied to the specific project in question, and collateral environmental or other effects that may result from implementation of the mitigation measure. How these factors may affect individual mitigation decisions for the many individual projects anticipated in the proposed Plan cannot be realistically assessed in a program EIR for the entire Plan.

As such, the EIR takes a conservative approach when making significant and unavoidable impact determinations. Further elaboration regarding specific comments is provided below.

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37-3 cont. existing and projected residents and workers within the San Diego region (Figure 2-1) that further enhances quality of life and offers more mobility options for people and goods. The proposed Plan looks ahead to 2050, and accommodates more than 430,000 new residents, approximately 440,000 new jobs, and over 280,000 new housing units. The underlying purpose of the proposed Plan, in summary, is to develop a Regional Plan that addresses the many regional transportation challenges that are deeply connected to larger societal issues that impact everyone's quality of life, including economic and social inequities, climate change, public health, and safety."

We concur with the purpose and many components of the proposed Plan but it also contains deficiencies and would result in many Significant and Unavoidable Impacts (summarized on Pages 7-12 to 23). In light of those findings and our identified concerns, we provide the following specific comments.

Specific Comments

37-4 As the EIR describes, the proposed Plan would not put the region on the trajectory to reduce total VMT -and associated GHGs - to meet the state's long-term GHG reduction targets. While the Plan is a welcome break from former "freeway/roadway-centric" RTPs, it does not ensure the necessary land use changes nor the shift to a functional transit/active transportation system that is needed to rapidly reduce our reliance on vehicular use and put the region on a GHG emissions reduction trajectory that aligns more closely with State targets.

37-5 Transportation: The EIR frames a fundamental purpose of the RTP/SCS (Page ES-2) as: "Under Senate Bill (SB) 375, the regional transportation plan must include an SCS consisting of land use, housing, and transportation strategies that, if implemented, would allow the region to meet its regional targets for greenhouse gas (GHG) emissions reductions from passenger vehicle use established by the California Air Resources Board (CARB)." GHG emission reductions. Rather than framing that statement as "...if implemented...", we believe the GHG emissions reductions are a strict requirement and that the final Plan and its EIR certification must acknowledge that requirement. The sentence should be rewritten as: "Under Senate Bill (SB) 375, the regional transportation plan must include an SCS consisting of land use, housing, and transportation strategies that, ~~if~~ will be implemented, ~~would allow to ensure the region~~ meets its regional targets for greenhouse gas (GHG) emissions reductions from passenger vehicle use established by the California Air Resources Board (CARB)."

The 5 Big Moves (Pages 2-38, et seq.) describe the proposed transportation system and sequencing for its major components. Notably, the Plan relies on the addition of managed

**RESPONSE TO COMMENT 37-4**

As an initial matter, this comment relates to the content of the proposed Plan, not the DRAFT EIR. The proposed Plan significantly reduces per capita VMT; however, total VMT increases through the life of the proposed Plan. VMT growth is predominantly due to the population and employment growth within the region, notwithstanding that the SCS land use pattern and the proposed transportation network improvements and programs in the proposed Plan would help to reduce VMT growth. That said, the increase in VMT, from baseline Year 2016 conditions, was identified as a significant impact under Threshold TRA-2 in the EIR.

The proposed Plan exceeds the SB 375 target of 19 percent reductions of GHG by 2035 and the Board Resolution for a 30 percent reduction of GHG emissions from all on-road transportation by 2035. However, the proposed Plan's GHG emissions would be inconsistent with the State's ability to achieve the goals of EO B-55-18 and EO S-3-05. As discussed in additional detail in Section 4.8.4 in the EIR, mitigation measures would help reduce regional GHG emissions by reducing VMT, increasing use of zero-emission fuels, sequestering carbon from the atmosphere, and other measures; they would reduce inconsistency of the proposed Plan's GHG emissions with the State's ability to achieve the SB 32, EO B-55-18, and EO S-3-05 GHG reduction goals. However, full implementation of the changes required to achieve these goals is beyond SANDAG's and local agencies' current jurisdiction and authority. As such, they were identified as significant and unavoidable.

While the proposed Plan results in significant impacts related to VMT and GHG, anticipated reductions in per capita VMT and GHG, along with proposed mitigation measures, would reduce inconsistency of the proposed Plan with the State's ability to achieve VMT and GHG goals, and puts SANDAG on a trajectory that more closely aligns with regulatory targets.

**RESPONSE TO COMMENT 37-5**

SB 375 language is quoted accurately, and SB 375 does not require regional planning agencies like SANDAG to guarantee emissions reduction targets will be met, so no change to the DRAFT EIR is warranted. That being said, GHG reductions necessary to meet State targets are expected to be achieved through a coordinated effort by, at minimum, State, regional, and local agencies, organizations, and



stakeholders, and is well beyond the scope and jurisdiction of SANDAG alone. Therefore, while it is SANDAG's intention to follow through with this plan in an attempt to ensure that regional GHG emissions reductions targets are met, due to the scope of the efforts, it would not require to commit in certainty.

A better transportation system that is less reliant on the automobile is a fundamental component of the proposed Plan. The investments in Managed Lanes will support high speed transit service to ensure time competitive trips as compared to automobile use. The proposed Plan places emphasis on maximizing the use of existing facilities to add corridor capacity to ease congestion while also trying to meet State and federal GHG and air quality targets. The proposed Managed Lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools, and low-emission vehicles with appropriate decals. The system of Managed Lanes and supporting connectors support Transit Leap, Flexible Fleets, and HOVs to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes. The Regional Plan is updated every 4 years, providing opportunities to reflect changes in the network in the future.

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lanes, whether from converted general purpose lanes or created from freeway shoulder/ROW, particularly in the short-to-midterm years. New lanes rarely meet their objectives because they often initiate "induced (travel) demand" that quickly produces the congestion (and GHG emissions) that the added lanes were intended to reduce.

The proposed transportation system approach, including infrastructure projects, pricing, and related policies places too much reliance on managed lanes to transition away from the region's dependence on vehicular use. Induced demand (i.e., Downs-Thomson Paradox) is not adequately addressed in the EIR. Studies of induced demand and possible measures to reduce its effects and how it may be addressed, such as the following studies, suggest that induced demand may be controllable but the entire transportation infrastructure system, and especially social policies and pricing - and viable transit options - must be integrated and established concurrently. Advancing transit options and reducing the addition of new lanes is a better approach.

1. [https://www.sciencedirect.com/science/article/pii/S0191261515300175?casa\\_token=LNZdh-Bex7AAAAAA:nLiQvaHtRsjxQ5wJXfrvS74WJb3-F6E196jhKTzvGEaoSWWhJEVIgrAaC1pNjLElOvZ53q2\\_TRU](https://www.sciencedirect.com/science/article/pii/S0191261515300175?casa_token=LNZdh-Bex7AAAAAA:nLiQvaHtRsjxQ5wJXfrvS74WJb3-F6E196jhKTzvGEaoSWWhJEVIgrAaC1pNjLElOvZ53q2_TRU).
2. [https://www.sciencedirect.com/science/article/pii/S0965856416304669?casa\\_token=oa6kKwueit0AAAAA:sRPJCO4hIAdac9zEPWl9YW33-wqv\\_4RltdPTW5s5qufxBlzgmJiE\\_SDIWwZ7Y-hnb7NeVkyug](https://www.sciencedirect.com/science/article/pii/S0965856416304669?casa_token=oa6kKwueit0AAAAA:sRPJCO4hIAdac9zEPWl9YW33-wqv_4RltdPTW5s5qufxBlzgmJiE_SDIWwZ7Y-hnb7NeVkyug).
3. [https://www.sciencedirect.com/science/article/pii/S0739885920301074?casa\\_token=VGpZcCrJdTAAAAA:vAVRiNVMVHB0taSM9vdIfrqAKdn1wbr9IU\\_-22B7nO9gT0V08YDcrTiuHOg\\_5nDDUi\\_FRIfUVs](https://www.sciencedirect.com/science/article/pii/S0739885920301074?casa_token=VGpZcCrJdTAAAAA:vAVRiNVMVHB0taSM9vdIfrqAKdn1wbr9IU_-22B7nO9gT0V08YDcrTiuHOg_5nDDUi_FRIfUVs).

Concurrent with those changes, we support immediate pilot testing of flexible fleet options to complement this emphasis on advanced transit. That should not incentivize or facilitate standard rideshare, which are shown to increase VMT, rather it should focus on services and technologies that promote zero emission, multi-passenger ridership.

We strongly recommend the Plan be modified to reduce the number of managed lanes, initiate roadway pricing immediately (and to the extent possible, applying revenues to transit projects and reduced ridership fares), and increase electric bus and BRT services and associated transit options as a transition while fixed guideway and other major transit infrastructure are constructed. The Plan should advance the timelines of all major transit infrastructure.

**RESPONSE TO COMMENT 37-6**

SANDAG is required to analyze induced demand impacts of the proposed Plan, which are documented in Appendix D of the proposed Plan. The activity-based model and other analyses used to inform the proposed Plan have been through SANDAG's peer review process and are documented in the technical methodology submitted to CARB, which is also included in Appendix D. Where possible, the proposed Plan proposes repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools and low-emission vehicles with appropriate decals. The system of managed lanes and supporting connectors support Transit Leap and high occupancy vehicles to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes. As such, investment in managed lanes would be beneficial to transit usage. It would not shift investment from additional transit projects and advancing transit options is not feasible because, as discussed in Master Response 1, the request to switch funding from roadways to transit fails to recognize that there are regulatory constraints on directing roadway funds to transit, and on when money becomes available during the lifespan of the proposed Plan, meaning funding programs typically are approved or collected on an annual basis and much funding cannot be advanced.

SANDAG also is currently working with the Social Equity Working Group to develop near-term solutions to address transit service improvements, amenities, and subsidized transit fares. Appendix U, *Cost Estimation Methodology*, Table U.2, in the proposed Plan, captures the transit fare subsidies to riders throughout FY2026–FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U of the proposed Plan.

The Regional Plan and its SCS are iterative planning documents that are typically updated every 4 years to account for new data, analysis, policy, and experience.

**RESPONSE TO COMMENT 37-7**

The deployment of Flexible Fleets such as e-bikes, shuttles, or ridesharing is envisioned as part of the proposed Plan to provide convenient and affordable options in different communities. SANDAG is developing a Flexible Fleet Implementation Strategic Plan to identify

near-term opportunities for Flexible Fleet pilots that support mobility, equity, and sustainability goals.

**RESPONSE TO COMMENT 37-8**

Please see Master Response 1 explaining why this type of alternative was not considered in detail in the EIR.

SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the proposed Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, in addition to providing fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, has been added to Appendix A in the Final Plan.

The proposed Plan includes increased service spans for the trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.

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37-9 As a related concern, the EIR does not adequately address an issue that was raised many times during the Plan's preparation: More clear and definitive mechanisms are needed in the Plan to ensure that its actions - particularly those that rely upon the local jurisdictions for land use zoning, development, and other supportive actions - are implemented (and monitored and corrected/adjusted, as necessary) in accordance with the Plan's expectations. The metrics for monitoring Plan implementation must be more specific; for example, are the locations and numbers of future population, jobs and housing developments (units) in accord with the Plan (i.e., meeting the expected allocations in the mobility hubs/smart growth areas) by the time periods (e.g., are annual increases consistent with the RHNA), are the primary transportation route improvements being constructed on the anticipated timelines and matching with the new development/growth, etc. Those and other monitoring parameters must be collected, analyzed and reported on a timely (annual or at least biannual) basis and corrective measures undertaken when/where necessary.

The potential impacts from implementing the Plan while population, housing, and job growth are not aligning with the transportation infrastructure would be a potentially fatal flaw unless the Plan incorporates new mechanisms - that are agreed-to by the jurisdictions per formal agreements - to ensure conformance.

37-10 **Biology:** The EIR acknowledges potentially significant and unavoidable impacts to biological resources, including to wetlands, sensitive species, and movement corridors/wildlife connectivity. Pages 4.4-61 to 79 describe the substantial adverse effects on riparian habitat, wetlands and other sensitive natural habitats, their potential significance, and possible mitigation for unavoidable impacts. Pages 4.4-79 to 95 describe the proposed Plan's anticipated impacts to sensitive and rare, threatened and endangered species, their potential significance, and possible mitigation for unavoidable impacts. Pages 4.4-95 to 106 present comparable descriptions of the anticipated impacts to corridors and linkages that are essential to the continued survival of wildlife (and plants), their potential significance, and possible mitigation for unavoidable impacts. We concur with the analyses and findings that, even with mitigation, those potential impacts to all of these biological resources would be significant (and unavoidable). It is particularly important to highlight that SANDAG has no land use authority, so it cannot ensure that the impacts from land use/development - and climate change effects - will not be greater than what was assumed and analyzed. For those reasons, we strongly recommend adding a funding mitigation measure that would provide the region's extant - and future - preserved conservation lands (i.e., not just the project-specific mitigation lands) sufficient regional habitat conservation funding to address unanticipated impacts to rare, threatened and endangered species from growth/development and associated climate change effects.

**RESPONSE TO COMMENT 37-9**

Please refer to Master Response 1 for explanation regarding why this element was not considered in detail in the alternatives.

**RESPONSE TO COMMENT 37-10**

Please refer to Master Response 1 for discussions regarding including a regional habitat conservation fund in the alternatives.

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37-11

**Alternatives:** As stated in our introductory comments, the proposed Plan contains many reasonable components. And we concur that Alternative 3 is the Environmentally Superior Alternative of the three analyzed alternatives. However, the EIR fails to describe and analyze a range of reasonable alternatives (CEQA Guidelines, Section 15126.6), including one that would prioritize transit/active transit over managed lanes, specify and institute a much more rigorous monitoring system of the transportation system's buildout and performance; add a regional habitat conservation fund; and ensure enforcement of the jurisdictions' compliance with the Plan. **Based on the deficiencies we identify in the proposed Plan, and the significant impact findings for that Plan in this EIR, we strongly recommend that a new alternative be prepared and adopted, consistent with our recommendations, as the preferred Plan.**

Our contact for this comment letter is Bill Tippetts ([billtippetts@gmail.com](mailto:billtippetts@gmail.com) or 619-822-4323), who is available to discuss it with SANDAG.

Sincerely,



Mike McCoy  
President



Bill Tippetts  
Board Member

Cc: SWIA Board

**RESPONSE TO COMMENT 37-11**

The comment asserts that the range of alternatives evaluated in the EIR does not meet CEQA's requirement to evaluate a reasonable range of potentially feasible alternatives because the EIR does not include an alternative that :

- Prioritizes transit/active transit over Managed Lanes
- Institutes a much more rigorous monitoring system of the transportation system's buildout and performance
- Adds a regional habitat conservation fund; and
- Ensures enforcement of the jurisdictions' compliance with the Plan.

Please see Master Response 1 explaining why this type of alternative was not considered in detail in the EIR.

**COMMENT LETTER 38: UNITED STATES FISH AND WILDLIFE SERVICE**

Comment Letter 38



**United States Department of the Interior**  
 U.S. FISH AND WILDLIFE SERVICE  
 Ecological Services  
 Carlsbad Fish and Wildlife Office  
 2177 Salk Avenue, Suite 250  
 Carlsbad, California 92008



In Reply Refer to:  
 FWS-SDG-22B0003-22CPA0003

October 8, 2021  
 Sent Electronically

Kirsten Uchitel  
 Associate Regional Planner  
 San Diego Association of Governments  
 401 B Street, Suite 800  
 San Diego, California 92101

Subject: Comments on the Draft Environmental Impact Report for the San Diego Forward: 2021 Regional Plan, San Diego County, California

Dear Kirsten Uchitel:

38-1

The U.S. Fish and Wildlife Service (Service) has reviewed the Draft Environmental Impact Report (EIR) for the San Diego Association of Government's (SANDAG) San Diego Forward: 2021 Regional Plan (Plan) in San Diego County, California. The comments provided in this letter are based on information provided in the Draft EIR, our knowledge of sensitive and declining species and habitats, and our participation in regional conservation planning efforts.

The primary concern and mandate of the Service is the protection of public fish and wildlife resources and their habitats. The Service has legal responsibility for the welfare of migratory birds, anadromous fish, and endangered animals and plants occurring in the United States. The Service is also responsible for administering the Federal Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*), including habitat conservation plans (HCP) developed under section 10(a)(1) of the Act.

**PROJECT DESCRIPTION**

38-2

San Diego Association of Government has prepared the Draft EIR in accordance with the California Environmental Quality Act (CEQA) to analyze the significant environmental impacts of the Plan, which is an update to the San Diego Forward: 2015 Regional Plan, adopted in October 2015, and the 2019 Federal Regional Transportation Plan, adopted in October 2019. The Plan updates the Regional Comprehensive Plan (RCP) for the San Diego region and the Regional Transportation Plan (RTP)/Sustainable Communities Strategy (SCS). The Plan includes a blueprint for a regional transportation system to serve existing and projected workers and residents within the San Diego region up to the year 2050. The Plan includes the following objectives:

1. Focus population and employment growth in mobility hubs and existing urban areas to protect sensitive habitat and natural resource areas.

**RESPONSE TO COMMENT 38-1**

Thank you for the U.S. Fish and Wildlife Service's (USFWS) review of the Draft EIR and participation in the environmental review process. Detailed responses to USFWS' comments are provided in subsequent discussions below.

**RESPONSE TO COMMENT 38-2**

The summary of the proposed project description is acknowledged.

Kirsten Uebittel (FWS-SDG-22B0003-22CPA0003)

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38-2

2. Provide transportation investments that support compact land development patterns and reduce sprawl.
3. Meet greenhouse gas emissions targets established for the San Diego region by the California Air Resources Board (CARB) and the SANDAG Board of Directors.
4. Provide transportation investments and land use patterns that promote social equity.
5. Provide transportation investments and land use patterns that reduce vehicle miles traveled and improve air quality.
6. Provide multi-modal access to employment centers and key destinations for all communities.
7. Enhance the efficiency of the transportation network for moving people and goods through the deployment of new technologies.

As required by Senate Bill (SB) 375, the regional transportation plan includes an SCS intended to align regional transportation, housing, and land use planning to attain regional greenhouse gas (GHG) emission reductions from passenger vehicle use established by the CARB. The Plan would implement the "5 Big Moves," which consists of Complete Corridors, Transit Leap, Mobility Hubs, Flexible Fleets, and Next Operating System throughout the 11 Major Travel Corridors in the San Diego region: South Bay to Sorrento; Central Mobility Hub; State Route 125 (SR 125); Interstate 15 (I-15); Interstate 5 (I-5) North Coast Corridor; State Route 94 (SR 94); Interstate 8 (I-8); Coast, Canyons, and Trails; State Route 56 (SR 56); San Vicente; and North County.

**Service Comments**

We offer the following comments on the Draft EIR to assist SANDAG in avoiding and minimizing the Plan's potential impacts on sensitive resources:

**General Comments**

38-3

1. San Diego Association of Government has been a leader in the development and implementation of regional HCPs in San Diego County. The Plan is an opportunity for SANDAG to continue in that leadership role by supporting the completion of the remaining habitat conservation plans and the establishment of regional funding to support implementation of those plans. Appendix AA of the Plan outlines the Regional Habitat Conservation Vision for the County, including the need for regional funding. As stated in this appendix, the need was estimated to be approximately \$3.0 billion in 2011. The current plan (Appendix A, Table 17) includes \$565 million for nature-based climate solutions which may provide some funding for implementation tasks associated with the regional HCPs. However, there are few details included in Appendix B that describe how and what this funding will be used; therefore, it is difficult to evaluate how this measure might contribute to the regional need. Furthermore, the Plan only addresses a portion of the estimated \$3.0 billion needed. The nature-based climate

**RESPONSE TO COMMENT 38-3**

As an initial matter, this comment relates to the content of the proposed Plan, not the Draft EIR.

Appendix AA of the proposed Plan describes the history and status of the HCPs within the region. Each local jurisdiction that signed an Implementing Agreement for their HCP was granted "take" authorization for impacts on endangered and threatened species. The local jurisdiction's commitment was to fund the local costs for acquisitions, management, and monitoring. Funds to cover these local costs will be raised on a regional or plan area basis as outlined in the Implementing Agreements.

The transportation network and the land use pattern proposed in the SCS do not impact the ability of the local jurisdictions to seek a regional funding source, and therefore there is no impact under CEQA and no required mitigation. SANDAG will continue its existing grant programs, partner with member agencies on State funding opportunities, and provide data and technical support to assist local jurisdictions with land use planning efforts in line with the proposed Plan. To meet the region's habitat conservation goals, the proposed Plan identifies approximately \$3 billion for habitat-related efforts. This includes \$2,087 million for an enhanced habitat conservation, management, and monitoring program (see Land Use and Habitat programs in Appendix B of the proposed Plan), a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (see Climate Adaptation and Resilience programs in Appendix B of the proposed Plan and mitigation measure GHG-5c in Section 4.8 of the EIR), and \$300 to \$500 million of land acquisition and restoration for habitat mitigation of transportation projects (incorporated in project costs presented in Appendix A of the proposed Plan)..



Kirsten Uchitel (FWS-SDG-22B0003-22CPA0003)

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- 38-3 cont. solutions mentioned in Appendix B should be linked to the Regional Habitat Conservation Vision described in Appendix AA. We recommend that the Plan be updated to include a sixth “big move” that addresses completion and funding of San Diego’s regional HCPs, including incentives for jurisdictions to complete their HCPs and a commitment to address the full need for regional funding. These actions would help offset cumulative impacts associated with urban development including the associated transportation projects outlined in the Plan.
- 38-4 2. We recommend that the Draft EIR include an analysis of the potential effects to all the regional HCPs, not just the permitted plans. The conservation design (i.e., preserves and habitat linkages) has been completed for all of the Natural Community Conservation Planning Program (NCCP)/HCPs throughout San Diego County.
- 38-5 3. We recommend that the Draft EIR address how the proposed lane management changes, including any tolled express lane options, will affect Vehicle Miles of Travel (VMT) and include a discussion of how the proposed move to managed lanes is consistent with updated CEQA guidelines pursuant to SB 743.
- 38-6 4. Please note that the proposed Otay Ranch amendment to the South County Multiple Species Conservation Program (MSCP) has been withdrawn and should be removed from the text and impacts analysis in the Draft EIR.
- 38-7 5. The Plan includes a network of off-street bikeways and trail alignments, many of which are located along riparian areas and wildlife movement corridors. Recreational activity has been associated with shifts in the composition of natural communities from native to nonnative species, declines in the distribution and density of native wildlife species (Reed and Merelender 2008), reduction in the diversity and abundance of wildlife species (Banks and Bryant 2007), reduction in the density and diversity of bird communities (Szaro 1980; Blakesley and Reese 1988), alterations in the spatial and temporal use of habitat by wildlife (George and Crooks 2006; Cardoni *et al.* 2008), increases in the vigilance and flight of wildlife (Taylor and Knight 2003), and increases in the measured physiological stress response of wildlife (Arlettaz *et al.* 2007). We request that the plan conduct a thorough analysis of impacts to wildlife connectivity and address how the plan will provide for the movement of wildlife in response to global climate change and prevent habitat fragmentation resulting from these trail alignments.
- Specific Comments*
- 38-8 1. We have the following comments regarding Figures 2-33 and 2-34 (2035 and 2050 Transit Network):
- a. Figure 2-34 (2050 Transit Network) includes a depiction of a single California High Speed Rail alignment. We recommend that alternative alignments be identified for the California High Speed Rail project that further avoid and minimize impacts to sensitive biological resources and to regional HCP planning efforts. In North San Diego County, the alignment along I-15 has the potential to significantly impact

**RESPONSE TO COMMENT 38-4**

The EIR addresses draft NCCP Subarea Plans and any updates to these plans when the respective jurisdiction implements the Draft Subarea Plan through ordinances, planning guidelines, or local directives, or when there are signed agreements between the jurisdiction and the Wildlife Agencies (i.e., for the North County and East County MSCPs). However, the CEQA analysis only considers adopted HCPs pursuant to CEQA guidance (see CEQA Guidelines question IV.e and Section 15125(d)(e)) and the criteria identified in the EIR. The word “approved” has been changed to “adopted” throughout the document when referencing NCCPs and HCPs. (See *Chaparral Greens v. City of Chula Vista* (1996) 50 Cal.App.4th 1134.).

**RESPONSE TO COMMENT 38-5**

The tolling lanes and Managed Lanes included in the proposed Plan were coded into SANDAG’s ABM2+, which was the main tool used to conduct the VMT analysis and identify VMT-related impacts under Threshold TRA-2. As such, the effects of the proposed tolling lanes and Managed Lanes were accounted for in the VMT impact analysis of the proposed Plan, as shown in Tables 4.16-6, 4.16-10, and 4.16-14. Please note that the Draft EIR provides a programmatic analysis of the proposed Plan and is only intended to evaluate the impacts of the proposed Plan as a whole. The Draft EIR does not analyze the effect of individual improvements or specific changes to the region’s transportation network and/or land uses patterns. Subsequent project-level CEQA analysis will be required to isolate and identify the impacts associated with the individual components of the proposed Plan prior to their implementation.

It should be noted that measure RTP-1 of the California Air Pollution Control Officers Association (CAPCOA) *Quantifying Green House Gas Mitigation Measures, August 2010* identifies that the implementation of cordon pricing and/or tolling to get in and out of central business districts can reduce VMT by a magnitude of 7.9–22.0 percent. The determination of the specific percentage can vary from location to location based on factors such as pricing levels and the associated levels of congestion. As noted previously, this level of analysis was included within the ABM2+ results and was therefore accounted for within the

VMT analysis conducted for the proposed Plan; however, the VMT reductions were not calculated for individual facilities.

Finally, as identified under Threshold TRA-2, implementation of the proposed Plan will result in a conflict and/or is inconsistent with CEQA Guidelines Section 15064.3 by not achieving the substantial VMT reductions needed to help achieve statewide GHG reduction goals. As such, the Draft EIR discloses that implementation of the proposed tolling lanes and Managed Lanes, in conjunction with the implementation of rest of the proposed Plan, would result in a significant impact.

**RESPONSE TO COMMENT 38-6**

The references to the Otay Ranch and Quino checkerspot amendments have been removed from the Final EIR.

**RESPONSE TO COMMENT 38-7**

The EIR is a programmatic document that assesses projects on a large scale. Threshold BIO-3 in Section 4.4, *Biological Resources*, addresses impacts on wildlife movement corridors on a programmatic level based on best available data. The implementation of projects under the proposed Plan will require subsequent CEQA review, and the effects of an individual project on wildlife movement corridors, including the potential for habitat fragmentation, will be analyzed in the project-specific CEQA document.

**RESPONSE TO COMMENT 38-8**

The California High Speed Rail project has been added to Appendix A of the proposed Plan, and SANDAG will track its progress as it is developed by the State; however, it is not a project that would be designed or constructed by SANDAG or other entities within the region. Regarding specific project-level impacts (e.g., Commuter Rail), the proposed Plan is a high-level, programmatic document. Specific details regarding impacts and mitigation are not known at this time but will be covered when future projects go through project-level environmental review.

	Kirsten Uchitel (FWS-SDG-22B0003-22CPA0003)	4
38-8 cont.	<p>the Pre-approved Mitigation Area (PAMA) of the draft North County MSCP, as well as designated critical habitat for the coastal California gnatcatcher. The PAMA in this area forms "stepping stones" of habitat for the gnatcatcher along I-15 to connect populations of gnatcatchers in San Diego County to populations in Riverside County. Farther south, the alignment appears to pass through the Carroll Canyon and Rose Canyon areas. We recommend avoiding impacts to wildlife connectivity in these areas, as well as federally endangered willowy monardella [<i>Monardella viminea</i> (<i>M. linoides</i> subsp. v)], federally threatened coastal California gnatcatcher [<i>Polioptila californica californica</i>; gnatcatcher], vernal pool habitat and associated species, and the Multi-Habitat Planning Area (MHPA) of the MSCP.</p>	
38-9	<p>b. Figures 2-33 and 2-34 include new additions to the existing Commuter Rail alignments, including a new line that travels between Sorrento Valley, La Jolla, Kearny Mesa, Mission Valley, City Heights, and National City. We recommend that SANDAG design the proposed new alignment to avoid natural resources and the MHPA to the maximum extent practicable, and preferably remain within existing highway corridors.</p>	
38-10	<p>c. Figure 2-34 appears to show the proposed "Miramar Tunnel," but also removes the existing railroad alignment known as the "Miramar Curve" between Sorrento Valley, Miramar, and Rose Canyon. It is our understanding that the Miramar Tunnel alternative would not necessarily allow for the removal of the Miramar Curve alignment.</p>	
38-11	<p>d. Figure 2-34 appears to show the railroad shifting slightly inland of the existing alignment for the Del Mar Tunnel north of where it passes through Los Peñasquitos Lagoon. Under this alternative, the railroad would be double-tracked through the lagoon, which would result in significant impacts to lagoon hydrology, listed species, and sensitive habitats. It is our understanding that SANDAG is evaluating several tunnel alignment alternatives, and we strongly recommend that the other alignment alternatives be included in the figures and impacts analysis. Selection of the more inland tunnel alignments (Crest Canyon or I-5 tunnel alternatives) would result in a significant environmental benefit by allowing for the removal of the existing railroad berm from the lagoon. This alignment alternative would prevent the impacts associated with adding a second track to the existing alignment and allow for a significant improvement to lagoon hydrology and restoration of saltmarsh that supports the federally endangered light-footed Ridgway's (=clapper) rail [<i>Rallus obsoletus</i> (=longirostris) <i>levipes</i>] and other sensitive species.</p>	
38-12	<p>2. We recommend that Figure 4.4-15 (Regional Wildlife Movement Corridors) be expanded to include Multiple Habitat Conservation Program (MHCP) connectivity, specifically the gnatcatcher stepping stones through Oceanside. The description of the MHCP should be expanded to include at least the same level of detail as the MSCP. The North County linkage up I-15 should be included in Figure 4.4-15 and described in the text. There is</p>	

**RESPONSE TO COMMENT 38-9**

Regarding specific project-level impacts (e.g., Commuter Rail), the proposed Plan is a high-level, programmatic document. Specific details regarding impacts and mitigation are not known at this time but will be covered when future projects go through project-level environmental review.

**RESPONSE TO COMMENT 38-10**

The inclusion of the Miramar Tunnel is intended as a replacement of the Miramar Curve to meet future transit needs. Future use of the Miramar Curve corridor is unknown but not assumed as part of the alignment of future proposed Plan transit projects.

**RESPONSE TO COMMENT 38-11**

Specific details regarding the review of project alternatives, impacts, and mitigation of those impacts are not known at this time but will be covered when the tunnel alignment alternatives go through project-level environmental review.

**RESPONSE TO COMMENT 38-12**

The MHCP cores and linkages map has been added to Figure 4.4-16 of the Final EIR.

The Santa Ana-Palomar linkage across I-15 is also included in Figure 4.4-15 (species-specific linkage) as part of the model prepared by Jennings et al. (2020).

No GIS data exist yet for the potential Jacumba-Sierra Juarez linkage. This linkage was identified in concept by South Coast Wildlands (SCW) and The Nature Conservancy (TNC), but was never modeled. TNC is planning to model this linkage in the future as part of their Las Californias Binational Conservation effort. The model developed by Jennings et al. (2020) includes the U.S. side of the Jacumba-Sierra Juarez linkage, which is included in Figure 4.4-15 of the EIR.

	Kirsten Uchitel (FWS-SDG-22B0003-22CPA0003)	5
38-12 cont.	also a north/south linkage with Mexico near Jacumba that should be included in the figure and text.	
	3. Under the heading "Multiple Species Conservation Program" (starting on page 4.4-48), we have the following suggested edits:	
	a. On page 4.4-48, please note that the MSCP was approved in 1997 and the updated document was printed in August 1998.	
	b. We recommend revising the first sentence on page 4.4-49 as follows: "The USFWS and CDFW have issued permits (50-year permit term) to five of the nine jurisdictions within the MSCP plan boundary."	
38-13	c. On page 4.4-49, we recommend revising the second half of the paragraph as follows: "While the County is not yet implementing the North County MSCP, it has completed the conservation design and identified priority areas for conservation that are being considered in the CEQA analysis of development projects within the North County MSCP planning area. While a planning effort for the eastern portions of the San Diego region was considered by the County of San Diego in 2008, the East County MSCP planning efforts have slowed because of staffing constraints. Preliminary conservation design was been completed for this area and identified focused areas for conservation that are considered during CEQA analysis as described above for the North County."	
	d. On page 4.4-49, paragraph starting with "In March 2021:" Please note that wetland habitats are covered by all the plans, but take of certain covered species within those habitat types is not covered. Therefore, we recommend removing the third sentence in this paragraph.	
	4. We recommend the following edits to Table 4.4-5 (page 4.4-50):	
38-14	a. Please note that the Vernal Pool HCP was only permitted by the Service, not the California Department of Fish and Wildlife (CDFW). We also recommend removing the first sentence in the description of the Vernal Pool HCP, as the planning agreement is not relevant, and we recommend adding that the Vernal Pool HCP has the same plan boundaries as the City's subarea plan.	
	b. Reference to the Otay Ranch and Quino checkerspot butterfly amendments should be deleted as these proposals have been withdrawn.	
38-15	5. We recommend revising Figure 4.4-16 to show all the different planned preserve areas in one color with symbology (i.e., hatching) indicating what has already been conserved.	
38-16	6. The section entitled "San Diego Gas & Electric Subregional NCCP" (page 4.4-53) should be updated to note that the Service and CDFW are coordinating with San Diego Gas and Electric (SDG&E) on an amendment to their HCP/NCCP.	

**RESPONSE TO COMMENT 38-13**

The text has been revised as suggested; the third sentence in the paragraph starting with "In March 2021" has been removed from the Final EIR.

**RESPONSE TO COMMENT 38-14**

Table 4.4-5 has been revised as suggested in the Final EIR.

**RESPONSE TO COMMENT 38-15**

Figure 4.4-16 has been revised as suggested in the Final EIR.

**RESPONSE TO COMMENT 38-16**

The text has been revised as suggested in the Final EIR.

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- 38-17 7. On page 4.4-62, we recommend defining “conserved” to clarify the difference between areas where impacts will be avoided vs. areas that are truly conserved with site protection instruments, management, and monitoring.
- 38-18 8. Tables 4.4-7, 4.4-8, and 4.4-9 (Estimated Direct Impacts on Vegetation Communities and Regulated Aquatic Resources within the San Diego Region) include estimated impacts to sensitive vegetation communities. Please provide a description of the types of projects that would result in such significant impacts to marsh (54.5 acres) due to regional growth and land use change by 2025.
- 38-19 9. Tables 4.4-7, 4.4-8, and 4.4-9 identify almost all the natural vegetation communities that would be impacted by the Plan, with the exception of desert dunes, desert scrub, and forest/woodland, as “sensitive vegetation communities... that may require mitigation.” It is unclear why these specific vegetation communities would be considered not sensitive or why impacts to these communities would not be offset in a manner similar to the other vegetation communities.
- 38-20 10. Figure 4.4-17 (Undeveloped to Developed Land Use Conversions) shows a large amount of development in Otay Mesa, Chula Vista, and Warner Springs. We are familiar with the proposed development projects reflected on the map for Otay Mesa and Chula Vista, which, with the exception of potential impacts to the federally endangered Quino checkerspot butterfly (*Euphydryas editha quino*), were addressed by the MSCP. But development in the Warner Springs area has not yet been addressed through a regional planning effort or other consultation or permitting processes with the Service. Because the Warner Springs area is not adjacent to urban centers and regional transportation corridors, we recommend that the Plan include a description of proposed development in this area and its consistency with the Plan’s objectives.
- 38-21 11. Under the heading “Transportation Network Improvements and Programs: Direct Impacts” for 2025 (page 4.4-68), the text references significant vegetation impacts due to the new four-lane toll road SR 11/Otay Mesa East Port of Entry (POE) from SR 125 to Mexico. This project is already under construction, and it is unclear if the resulting impacts, which were already addressed under CEQA, are included in this analysis.
- 38-22 12. BIO-1d (page 4.4-78): We recommend including consistency with the San Diego Management and Monitoring Program’s (SDMMP) Management Strategic Plan.
- 38-23 13. The analysis for BIO-2 (page 4.4-79) appears to rely on known species occurrences. Given the lack of comprehensive surveys, we recommend also conducting an analysis using modeled habitat (e.g., County of San Diego Species Models) to evaluate potential impacts to sensitive species.
- 38-24 14. The proposed mitigation measures BIO-2b and BIO-2c (page 4.4-91) are limited to species covered under approved NCCPs/HCPs. We recommend including species that would be covered under draft plans as well. We also recommend including species addressed under the County’s Resource Protection Ordinance.

**RESPONSE TO COMMENT 38-17**

The text has been revised. The following footnote has been added on Page 4.4-62:

The term “conserved” reflects the projected conservation of habitats and biological resources as identified in the HCPs. Hard-line preserves cannot be developed and impacts will be avoided. When allowed development occurs in other preserve dedications such as the PAMA, FPA, or MHPA, the conservation component required by the respective HCP will be implemented through the dedication of conservation easements or other site protection instruments that require the conservation, management, and monitoring of the conserved resources in perpetuity.

**RESPONSE TO COMMENT 38-18**

The impacts on marshes (including coastal salt marsh) occur due to land use changes as a result of regional land use changes rather than specific projects. Specifically in the City of National City, the programmatic proposed Plan footprint shows commercial development that may affect the Sweetwater and E-Street marshes. However, this is due to the programmatic nature of the footprint, which shows an approximate impact area rather than a project-specific footprint, because the project designs have not yet been developed. Project design, impact avoidance and minimization measures, and subsequent CEQA analysis will consider avoidance or mitigation of any impacts on conserved lands, sensitive coastal salt marsh habitat, and special-status species.

**RESPONSE TO COMMENT 38-19**

The County of San Diego requires mitigation for the vegetation communities included in the collapsed categories of desert dunes, desert scrub, and forest/woodland. Because all vegetation communities in Tables 4.4-7 through 4.4-9 are sensitive, in the Final EIR, the word “sensitive” has been added to vegetation communities in the table titles, and asterisks and footnotes have been removed. Any impacts on these vegetation communities would be offset based on the County’s *Report Format and Content Requirements for Biological Resources* (2010) mitigation ratios.

**RESPONSE TO COMMENT 38-20**

This comment addresses the proposed Plan and is not related to the adequacy of the Draft EIR. The SCS Land Use Pattern does not contemplate new residential development in the Warner Springs area. The area identified by the comment in and around Warner Springs contains one parcel with 15 sub-parcels. The assignment of the land use type is based on the logic of the forecast model to roll unique sub-parcel based land uses to the predominant land use at the parcel level. In this case, commercial and office use (Resort) was assigned to one of the sub-parcels, and Spaced Rural Residential was assigned to 14 sub-parcels based on the County's General Plan where these sub-parcels were designated under "Rural Lands RL-80." While the land use designation changed, no new housing units are projected for this area in the SCS Land Use Pattern.

**RESPONSE TO COMMENT 38-21**

As discussed in Chapter 4, the proposed Plan has a baseline of 2016, which is 2 years older than would be typical in past Regional Plan EIRs. In general, physical conditions as they existed in 2016 are used as the baseline for the impact analysis of this EIR, corresponding with the release of the NOP on November 14, 2016, and the start of EIR preparation. Therefore, SR 11 is included in analysis of this EIR because it was part of the 2016 baseline. The EIR provides a programmatic analysis; the CEQA document prepared for SR 11 provides more in-depth, project-specific analysis of the project's impacts and mitigation measures.

**RESPONSE TO COMMENT 38-22**

The following text has been added to the Final EIR on page 4.4-79:

The management plans can and should be consistent with the SDMMMP MSP (SDMMMP 2017), and describe management in perpetuity....

**RESPONSE TO COMMENT 38-23**

Modeled habitat for sensitive species has been added to and included in the analysis in the Final EIR, and has also been added to EIR Appendix E-7, Table E-7-6.

**RESPONSE TO COMMENT 38-24**

Please see response to comment USFWS 38-4.

Reference to the County's Resource Protection Ordinance has been added to mitigation measures BIO-2b and BIO-2c in the Final EIR.



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- 38-25 | 15. Under the heading “Impact Analysis; 2025; Regional Growth and Land Use Change; Direct Impacts” (page 4.4-97), the text indicates that the corridors identified by the Las Californias Binational Conservation Initiative between the United States and Mexico would not be significantly impacted by regional growth and land use change. We recommend clarifying whether solar and wind power development projects, which may be needed to support urban development, are included in the scope of this plan.
- 38-26 | 16. The MCSP linkages are included in Table 4.4-13, 4.4-14, and 4.4-15 (Forecasted Encroachments Into Wildlife Movement Corridors and Linkages within the San Diego Region), but the other subarea plans are not included. We recommend including the linkages for the other subarea plans as well.
- 38-27 | 17. Table 4.4-16 (page 4.4-108); We recommend including the other permitted jurisdictions under the MSCP, as well as the draft preserves for North and East County.
- 38-28 | 18. Appendix E-4 (page E-58) includes the Vernal Pool HCP as a draft plan. However, it has been approved and permitted as noted in the text. In addition, the boundaries of the North County and East County plans have been updated. Please contact the County of San Diego for additional information.

We appreciate the opportunity to comment on the Draft EIR. If you have any questions regarding this letter, please contact Lauren Kershek<sup>1</sup> or Sally Brown<sup>2</sup>.

Sincerely,

**JONATHAN  
SNYDER**  
Jonathan D. Snyder  
Assistant Field Supervisor  
U.S. Fish and Wildlife Service

Digitally signed by  
JONATHAN SNYDER  
Date: 2021.10.08  
10:46:19 -0700

<sup>1</sup> Lauren\_Kershek@fws.gov

<sup>2</sup> Sally\_Brown@fws.gov

**RESPONSE TO COMMENT 38-25**

Solar and wind power developments are future land uses to be approved by the local jurisdictions and would be addressed on a project-specific CEQA level; project-specific analysis would evaluate impacts on wildlife movement corridors and consistency with Habitat Conservation Programs and Plans.

**RESPONSE TO COMMENT 38-26**

Wildlife Movement Corridors and Linkages were identified in the umbrella MSCP and MHCP documents and were adopted by the subarea plans; ergo, the subarea plan cores and linkages are the same as those identified in the umbrella documents. Table 4.4-15 has been revised to add the MHCP core and linkage areas (BCLA) in the Final EIR.

**RESPONSE TO COMMENT 38-27**

The permitted jurisdictions with preserves that were not included in the South County MSCP and City of San Diego MHPA, the MHCP (FPA/BCLA) and Chula Vista MSCP Preserves, have been added to Tables 4.4-16, 4.4-17, and 4.4-18. The other approved jurisdiction’s preserve designs were captured by the MSCP preserves. Because the EIR only addresses approved NCCPs (see response to comment USFWS 38-4), the Draft North and East County MSCPs are not evaluated in this document.

**RESPONSE TO COMMENT 38-28**

Appendix E-4 of the EIR has been revised to remove the Vernal Pool HCP since it has been approved. Please also see response to comment USFWS 38-4.

Kirsten Uchitel (FWS-SDG-22B0003-22CPA0003)

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**COMMENT LETTER 39: KARIN ZIRK**

Comment Letter 39

From: "Karin Zirk, Ph.D." <[me@karinzirk.com](mailto:me@karinzirk.com)>  
 Date: October 10, 2021 at 10:27:19 AM PDT  
 To: Denise Friedman <[denisewfriedman@icloud.com](mailto:denisewfriedman@icloud.com)>, [derekstattin@hotmail.com](mailto:derekstattin@hotmail.com)  
 Subject: RE: Sponsor Save Marian Bear Park  
 Reply-To: [me@karinzirk.com](mailto:me@karinzirk.com)

39-1 [ SANDAG is proposing increasing the number of lands on Hwy 52 which will gobble up some of Marian Bear Park. Plus they want to have designated carpool connector lanes from I-5 and I-805 to Hwy 52 which will further encroach on the park and end up destroying more oaks, sycamores and upland habitat.

39-2 [ You can find the petition at <https://www.change.org/p/save-marian-bear-park>

Warmly,

Karin Zirk, Ph.D. (she/her/hers)  
 Executive Director  
 Friends of Rose Creek  
 \*\*\* Connecting Our Communities \*\*\*  
<http://www.saverosecreek.org>

**RESPONSE TO COMMENT 39-1**

This is a comment on the content of the proposed Plan, and does not raise issues on the adequacy of the Draft EIR. The impacts of the proposed Plan on recreational facilities are discussed in Section 4.15 of the EIR.

The proposed Plan includes freeway improvements along I-5 and implementation of the Coastal Rail Trail in this area for the 2035 horizon. In addition, the SR 52 bikeway from I-5 to Santo Road would impact Marian Bear Memorial Park. Although SANDAG appreciates the concerns expressed in this comment, the improvements are required to accommodate planned population growth and related transportation improvements identified in the proposed Plan.

The implementation of projects under the proposed Plan will require subsequent CEQA review, and the project-specific impacts and mitigation measures will be identified in that subsequent CEQA document, including the implementation of mitigation measures identified in Section 4.4, *Biological Resources*, of the EIR.

**RESPONSE TO COMMENT 39-2**

Please see response to comment Zirk 39-1 above. The implementation of projects under the proposed Plan will require subsequent CEQA review, and the project-specific impacts and mitigation measures will be identified in that subsequent CEQA document.

**COMMENT LETTER 40: UNIDENTIFIED WEB COMMENT**

Comment Letter 40

**Commenter:** Not Provided  
**Agency:** Not Provided  
**Contact Information:** Not Provided  
**Date Received:** 9/17/2021  
**Comment:**

- 40-1 | The EIR should consider a net-zero GHG emission alternative within the confines of current feasibility. Another alternative could be to maximize GHG emission reductions using expected levels of funding.
- 40-2 | The EIR should also consider the regional plan's consistency with agency's mode share targets using modeled mode share for the regional plan as compared to the mode share targets. For example, the City of San Diego sets specific mode share targets for transit by 2035 within transit priority areas. The regional plan should be consistent with these mode share targets or at least expressly discuss the inconsistency within the EIR.

**RESPONSE TO COMMENT 40-1**

As the Draft EIR explains (page 6-1), SANDAG considered public input provided during the EIR scoping process, and used this input to develop the reasonable range of alternatives. Public input requested alternatives that reduce GHG emissions, air quality impacts, and VMT. The alternatives selected for detailed consideration incorporate many of the major transportation investments and policy options that commenters suggested.

As of July 2021, the State has yet to develop or adopt an overarching plan that provides the framework for how California will achieve carbon neutrality by 2045. It is anticipated that achieving this goal would require a combination of GHG emissions reduction and GHG emissions removal strategies; however, it is unknown at this time what combination of reduction and removal strategies will be pursued in California to achieve this goal.

Many features currently included in the proposed Plan (e.g., the SCS, increased transit, and active transportation investments) have the effect of reducing GHG emissions that might otherwise occur. Mitigation measures presented in this EIR are additional feasible GHG reduction measures not included in the proposed Plan that SANDAG would or other agencies could implement.

SANDAG has direct responsibility for planning for achieving passenger vehicle GHG reduction targets through the development and implementation of an SCS pursuant to SB 375. The proposed Plan includes an SCS and demonstrates that, if the proposed Plan is implemented, the San Diego region would achieve its SB 375 target for 2035. Analysis performed by SANDAG and included in the SCS documentation for the proposed Plan demonstrates that the San Diego region has achieved its SB 375 target for 2020 (Appendix H of this EIR).

In addition, the proposed Plan incorporates several demand management strategies such as teleworking, private pooling programs, vanpool programs, carshare programs, and transit fare subsidies. The land use strategy in the proposed Plan consists of the SCS land use pattern, which considers jobs-housing balance, mixing of uses, and

transit-oriented development. Please see Section 4.8 for more information about these strategies.

Please see Master Response 1 for further explanations why the EIR did not consider a “net zero emissions alternative” in detail. Similar reasons explain why an alternative that maximizes GHG emission reductions using expected levels of funding was not considered in detail.

**RESPONSE TO COMMENT 40-2**

SANDAG’s ABM2+ estimates the mode shift performance of the proposed plan. The mode share estimates from ABM2+ are reported for the entire region.

Data on mode share is provide in Appendix T, Table T6.2 of the proposed Plan. Other agencies’ mode share targets are specific to their plans. For the City of San Diego, the City’s climate action plan acknowledges that additional strategies must be implemented in addition to the proposed Plan to achieve the City’s mode share targets.

Section 4.16, *Transportation*, discussed mode share. Because the proposed Plan identifies and proposes transportation network improvements at a regional level,

plan consistency was reviewed against other regional plans and policies. (Draft EIR page 4.16-30.) Consistency with specific local plans regarding mode share targets would be done on a project level.

## COMMENT LETTER 41: UNIDENTIFIED WEB COMMENT

Comment Letter 41

**Commenter:** Not Provided  
**Agency:** Not Provided  
**Contact Information:** Not Provided  
**Date Received:** 9/20/2021  
**Comment:**

41-1

Electric vehicles and battery power has destroyed more trees, rainforests and jungles than any used resource used for power.

### RESPONSE TO COMMENT 41-1

Thank you for your comments and consideration of the proposed Plan. This comment does not appear to be a comment about the content or analysis of the Draft EIR or the proposed Plan, and as such, no response is required. However, please see Section 4.8, *Greenhouse Gas Emissions*, for more information about greenhouse gases and the proposed Plan.

**COMMENT LETTER 42: BRUCE HIGGINS**

Comment Letter 42

**Commenter:** Bruce Higgins  
**Agency:** Retired  
**Contact Information:** brucehiggins1253@gmail.com  
**Date Received:** 8/28/2021  
**Comment:**

42-1 This is the wrong plan for the San Diego region. It focuses on spending \$ Billions on rail that is not currently used by the population. The existing rail system is slow, is inconvenient, and runs at the wrong times. There are major problems with the routing. This so called plan envisions new routing but does not address how that would happen. It also calls for instituting a plan of per mile charges for force people on the the rail system. That appears to be illegal on its face. It will also call for managing were people are allowed to live so that they can access the inconvenient transportation system. Such a plan is completely backwards of how transportation should work.

42-2 The sponsoring agency SANDAG has zero credibility with the voters as they have admitted fraud with the last series of bond issues. As a result the chances of the bond plan passing to fund their grand plan is very small. Most of this work will therefore be wasted.

It is evident that SANDAG and it's manager intend to push this White Elephant through to a vote. When it is defeated, fire Mr. Ikhtrata, and start over. Construct a new plan that is responsive to the region and the actual needs of the population.

**RESPONSE TO COMMENT 42-1**

Thank you for your comments and consideration of the proposed Plan. This Plan has been carefully researched and tailored to be specific to the unique challenges, land uses, resources and communities of the San Diego region.

As an initial matter, this comment relates to the contents of the proposed Plan, not the analysis within the Draft EIR.

Regarding “new routing,” the EIR prepared for the proposed Plan is a first-tier Program EIR. “Second-tier projects” that would implement the proposed Plan include site-specific transportation network improvements and development projects. For subsequent project activities, a site-specific environmental review would be the responsibility of the implementing agency prior to project implementation.

The Vision of the proposed Plan is “A fast, fair, and clean transportation system and a resilient region.” The proposed Plan sets three primary goals to achieve this Vision:

- The efficient movement of people and goods.
- Access to affordable, reliable, and safe mobility options.
- Healthier air and reduced GHG.

The general concept for the proposed Plan was informed significantly by early work on the 2019 Regional Plan, which led to the 2019 Federal RTP. This work included a four-phased approach: concept development, network development, network refinement, and transportation system validation. Additional information about the four phases can be found in Appendix T of the proposed Plan.

Based on regional travel data, SANDAG identified critical regional nodes for travel connections for trips taken to and from the top 15 employment centers in San Diego County. See Section 2.2.1, *Development of the Proposed Plan: A Data Driven Process*, of this EIR for more information about these areas and elements.

In addition, the proposed Plan incorporates several demand management strategies such as teleworking, private pooling programs, vanpool programs, carshare programs, and transit fare subsidies. The land use strategy in the proposed Plan consists of the SCS land use



pattern, which considers jobs-housing balance, mixing of uses, and transit-oriented development. Please see Section 4.8 for more information about these strategies.

SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and GHG emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.

The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.

**RESPONSE TO COMMENT 42-2**

This comment is not related to the adequacy of the Draft EIR, or the contents of the proposed Plan, and no further response is given.

**COMMENT LETTER 43: BRENT TANNER**

Comment Letter 43

**Commenter:** Brent Tanner  
**Agency:** Aggregate Technologies  
**Contact Information:** btannerr@gmail.com  
**Date Received:** 9/30/2021  
**Comment:**

43-1

URGENT REQUEST: Environmental Review  
 Dear SANDAG and respected SANDAG counsel commissioners,  
 My name is Brent Tanner. As the owner of a large development (a 620 unit project currently under construction) in your area, I'm very grateful for San Diego County's past and current efforts at environmental stewardship. However, I do have some concerns going forward, specifically regarding the environmental impact of concrete, and I believe a review of the most recent developments in materials science and environmentally friendly concrete offers great potential for enhancing San Diego County's efforts at minimizing its carbon footprint.

The natural process for producing Portland cement, the main reactive component in concrete, is among the most carbon-unfriendly of all essential materials, with approximately one ton of CO2 released for every one ton of cement made. That becomes very significant when you consider the vast infrastructure applications of concrete in modern life. The environmental cost of traditional concrete becomes difficult to avoid because of the basic chemistry of one of its primary components: limestone plus heat equals calcium oxide plus carbon dioxide. But what if there was an alternative?

Recent innovations in particle-size optimized cement means we can produce concrete that uses 25% less Portland cement<sup>1</sup> which means a 25% lower carbon footprint per cubic yard of concrete poured. Not only that, this concrete product resists salt, chloride, and other elements far better than traditional concrete because it incorporates limestone powder and other mineral fillers<sup>1</sup> to create cement paste which has a higher solids density and reduced porosity, which creates superior salt resistance and durability. That means it's longer-lasting, and that means you save cost and reduce carbon over the long haul.

Why should San Diego lead the way on environmentally-green (or "reduced carbon") cement? Because it's an opportunity to create an impact across the country and across government and business. More than half of all cement is purchased by government entities. Think road projects, bridges, airports, hydroelectric dams. So, where the government leads, everyone else follows. When reduced carbon concrete becomes the standard in your county, for at-or-near the cost of traditional solutions, you'll become recognized as the leaders in green concrete use, and you will inspire others to follow suit.

Bill Gates has indicated that he believes green concrete would cost 243% more than traditional concrete, but it can in fact be produced for around the same price because the cost of mineral fillers should be the same or less than the cost of Portland cement they partially replace. But even if that were not so, it would still be worth paying a small premium for the meaningful environmental benefits.

<sup>1</sup> Covered by ACI 211.7R-15 "Guide for Proportioning Concrete Mixtures with Ground Limestone and Other Mineral Fillers" also covered by ASTM C1797-17 "Standard Specification for Ground Calcium Carbonate and Aggregate Mineral Fillers for use in Hydraulic Cement Concrete".

1

**RESPONSE TO COMMENT 43-1**

As an initial matter, this comment relates to the proposed Plan and does not address the adequacy of the Draft EIR. The potential use of low carbon concrete is discussed in Section 4.8 of the Draft EIR and is incorporated into mitigation measure GHG-5e: "Implement sustainable construction measures through construction bid specifications, including. . . [u]se lighter-colored pavement, binding agents that are less GHG-intensive than Portland cement, and less-GHG intensive asphalt pavements" (page 4.8-50).

43-1  
cont.

San Diego needs more efficient concrete. With the availability of green concrete that uses 25% less Portland cement, therefore producing concrete with 25% lower carbon footprint and reduced environmental impact, it becomes clear that your imperative is to explore securing a procurement that meets this new, attainable goal. Such a procurement would align well with SANDAG's Sustainable Communities Strategy (SCS).  
This innovation is the direction the concrete industry is headed...wouldn't San Diego rather be leading than following? Please contact me immediately to discuss how using green concrete can begin making a significant difference for San Diego and for the whole country.

Best Regards,  
Brent R. Tanner

**COMMENT LETTER 44: CRAIG FORMAN**

Comment Letter 44

**Commenter:** Craig Forman  
**Agency:** Not Provided  
**Contact Information:** craigforman@live.com  
**Date Received:** 8/28/2021  
**Comment:**

44-1 [ Unsure where to leave this comment. An increase in the sales tax to pay for improvements is regressive and (a) will force lower income individuals into less populated areas of the county with less expensive rents but less public transportation and (b) affect retired and unemployed individuals. Maybe suggest a greater sharing % of the exploding property tax assessments which will not increase taxes, just allocate more of it to public transportation?

**RESPONSE TO COMMENT 44-1**

As an initial matter, this comment relates to the proposed Plan, and not the Draft EIR.

The funding strategy for the proposed Plan includes over 30 different funding sources, including local sales tax revenue and property taxes from an Enhanced Infrastructure Financing District (EIFD) surrounding the Central Mobility Hub project. An EIFD works by diverting future increases in property tax revenues that will result from the project due to the increasing property values.

## COMMENT LETTER 45: JOHN WOTZKA

Comment Letter 45

**Commenter:** John Wotzka

**Agency:** Public speaker, self, Regional Transportation Committee and research of energy issues.

**Contact Information:** johnwotzka@gmail.com

**Date Received:** 8/31/2021

**Comment:**

45-1

Hope you are keeping up with the developments in Floating Offshore Wind coming into the area and the jobs that will be created with this technology for ports and renewable energy manufactures. Examples are being shown on the East Coast too including the Great Lakes. There are endless examples of both of these technologies in Europe, Asia and most parts the rest of the World. The U.S. is behind but will adjust to what it will need. High Speed Rail is another area where there will be jobs the long term future and it will improve the health of the people of California with cleaner air and many jobs for the manufacture of the HSR systems.

### RESPONSE TO COMMENT 45-1

Thank you for your comments and consideration of the proposed Plan. This comment does not appear to be a comment about the content or analysis of the Draft EIR or the proposed Plan, and as such no response is required.

**COMMENT LETTER 46: JAMES FERGUSON**

Comment Letter 46

**Commenter:** James Ferguson  
**Agency:** Not Provided  
**Contact Information:** jpf.morpheus@gmail.com  
**Date Received:** 8/28/2021  
**Comment:**

46-1 | I have reviewed the executive summary and concur with its priorities. We must reduce vehicle miles traveled, and attendant emissions. Public transportation infrastructure and housing development patterns that eliminate sprawl, enhance compact business/residential access, and reduce GHG emissions are essential for our future, sooner rather than later. It is very difficult to 'retrofit' after a long history of laissez faire development policy. But, we must begin.

**RESPONSE TO COMMENT 46-1**

Thank you for your comments and consideration of the proposed Plan.  
Thank you for your support.

**COMMENT LETTER 47: CRAIG NELSON**

Comment Letter 47

**Commenter:** craig nelson  
**Agency:** Citizens business bank  
**Contact Information:** cnelson\_madison@hotmail.com  
**Date Received:** 8/31/2021  
**Comment:**

47-1 Every bus I see is EMPTY , you will never get people of SD to ride the inefficient , nasty slow bus. Period. I dare you to publish the actual %23 of riders per mile driven. It would be cheaper and better on the environment if you bought every single side a Prius vs. driving empty buses around in circles. DUMP IKY

**RESPONSE TO COMMENT 47-1**

Thank you for your comments and consideration of the proposed Plan.

As shown in Section 4.16, *Transportation*, of the EIR, there is currently an average of 257,891 daily transit trips (page 4.16-32). The number of trips is projected to increase to 416,061 in 2025, to 805,642 in 2035, and to 944,876 in 2050. Transit Mode Share would increase from 1.7 percent in 2016 to 5.6 percent in 2050 (Draft EIR page 4.16-41).

**COMMENT LETTER 48: PHILIP MUNIZ**

Comment Letter 48

**Commenter:** Philip Muniz  
**Agency:** Not Provided  
**Contact Information:** boutittow@gmail.com  
**Date Received:** 8/28/2021  
**Comment:**

48-1 | Charging people to drive per mile is completely ridiculous and we will vote against it and vote you out of office

**RESPONSE TO COMMENT 48-1**

As an initial matter, this comment relates to the proposed Plan, and not the Draft EIR.

The proposed Plan incorporates a variety of value pricing and user strategies as tools to improve mobility by encouraging changes in travel behaviors while generating revenue to address the region's aging infrastructure and expand travel options. Specifically, the proposed Plan explores a network of Managed Lanes, a mileage-based road usage charge, a fee on the fares charged for rides provided by Transportation Network Companies, and further subsidization of transit fares.

Strategies such as these are in different phases of planning, design, pilot, and deployment in different areas of the region and are also being explored at the State and federal level. SANDAG will rely on coordination with the other MPOs in California along with Caltrans to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers. Meanwhile, the design of these strategies, such as the fee structure and distribution of revenue, should be specifically developed for the San Diego region's unique environment and priorities.

SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.

The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed



program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.

**COMMENT LETTER 49: JUSTIN WONG**

Comment Letter 49

**Commenter:** Justin Wong  
**Agency:** Not Provided  
**Contact Information:** pustin14@gmail.com  
**Date Received:** 9/3/2021  
**Comment:**

49-1 I would like to receive info about expanding NCTD Transit options to Miracosta

**RESPONSE TO COMMENT 49-1**

Thank you for your comments and consideration of the proposed Plan. The proposed Plan includes Rapid 477, which would run from Carlsbad Village to SR 76 via College Boulevard and would serve Mira Costa College. In addition, the Plan proposes Flexible Fleets as a variety of on-demand services that could offer mobility options for Mira Costa College.

**COMMENT LETTER 50: JUSTIN WONG**

Comment Letter 50

**Commenter:** Justin Wong  
**Agency:** Not Provided  
**Contact Information:** pustin14@gmail.com  
**Date Received:** 9/3/2021  
**Comment:**

50-1 I would like to receive info about expanding NCTD Transit options to Miracosta

**RESPONSE TO COMMENT 50-1**

See response to the duplicate comment above (49-1).

## COMMENT LETTER 51: ELIZABETH FATTAH

Comment Letter 51

**Commenter:** Elizabeth Fattah  
**Agency:** Not Provided  
**Contact Information:** elizfattah@yahoo.com  
**Date Received:** 10/11/2021  
**Comment:**

51-1

Route 52 should not be expanded to more lanes. Use the money for public transit and making it easier and cheaper for people to use Public Transportation. We are in a climate crisis which means that we need to sequester carbon, not to add more to the planet

### RESPONSE TO COMMENT 51-1

As an initial matter, this comment relates to the proposed Plan, and not the Draft EIR. It will be considered by the SANDAG Board of Directors when it considers approval of the proposed Plan.

Also note that, as included under mitigation measure GHG-5c in Section 4.8, SANDAG shall implement, or provide funding to implement, projects that restore or enhance native habitats to increase rates of carbon sequestration over baseline conditions.

Appendix P.2

**Comments and Responses on the Draft Regional Plan**

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# Appendix G Attachment 7

## San Diego Forward: Draft 2021 Regional Plan Public Comments and Responses

San Diego Forward: The Draft 2021 Regional Plan (2021 Regional Plan) was released for public review and comment on May 28, 2021. The public comment period concluded on August 6, 2021. Comments were submitted via the [SDForward.com](https://www.sdfwd.com) website, email, voicemail, public meetings hosted by SANDAG, and letters (via email and mail).

SANDAG promoted the public comment period via community presentations, websites, social media, radio, email updates, and newspaper notices. Public notices were published in English and Spanish, and in additional languages by request. During the public comment period, SANDAG held a series of public meetings as opportunities for community members to learn more and voice their comments on the draft 2021 Regional Plan. In June, SANDAG coordinated six virtual open houses which each focused on one of the region's subregions. Two virtual public hearings were held in July. After several months of public outreach, SANDAG garnered more than 17 million impressions and received 1,431 public comments on the draft 2021 Regional Plan. The following attachments include all public comments received during the public comment period<sup>1</sup> and the corresponding responses from SANDAG. Comments are separated into tables by source.

1. Attachment 7A: Website-Sourced Public Comments and Responses
2. Attachment 7B: Email-Sourced Public Comments and Responses
3. Attachment 7C: Voicemail-Sourced Public Comments and Responses
4. Attachment 7D: Public-Meeting-Sourced Public Comments and Responses
5. Attachment 7E: Letter-Sourced Public Comments and Responses

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<sup>1</sup> Comments received after the close of the public comment period on August 6, 2021, were still recorded and will be responded to. These responses will be included as an item attachment in the SANDAG Board of Directors December 10, 2021, meeting agenda.





# Appendix G Attachment 7A: Website-Sourced Public Comments and Responses

The table below contains all comments received through the online form that was available on [SDForward.com](http://SDForward.com) during the public comment period for the draft 2021 Regional Plan. Comments and corresponding responses are sorted by commentor name, if provided, in alphabetical order.

Table G7A: Draft 2021 Regional Plan Responses to Comments – Website Sourced

Draft 2021 Regional Plan Responses to Comments – Website Sourced				
ID	Commentor Name	Agency	Comment	Response
W1	Abdulla Gagy	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	We want to be sure that this will not compete with Uber, Lyft and taxis. Many of our refugees are drivers to support their families and use it as extra income since they don't make very much money. This is a wonderful way for people to get where they need to go with someone who speaks their language that they are comfortable with. Thank you for keeping the ride sharing programs and increasing them.	SANDAG intends to design and launch Flexible Fleet services that provide greater mobility choices and improve quality of life in the San Diego region.
W2	Abraham Navarrete	National Latino Research Center	I participated in the NLRC Youth Empowerment info session. I think we can include our public transportation system by including Roundabouts-Improves traffic flow, supports community. I like the idea of the big 5 moves, however, I am concerned on how this will be accomplish. Sounds to go to be true.	The 2021 Regional Plan includes funding for complete streets improvements in Mobility Hub areas, which could support the design and implementation of roundabouts. Appendix B describes the near-term and continuing actions to implement the Regional Plan.
W3	Abraham Navarrete	National Latino Research Center	I participated in a community youth talk with the NLRC to learn about the regional plan. One of my concerns is safety, in this plan it should include more safety figures. For example, there should be like a guard walking around to make buses safe, two people. I think that we should have implemented this plan earlier (why are we so late to do so?) because we youth rely on public transportation and it needs improvements.	SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.
W4	Abraham Navarrete	National Latino Research Center	I learned about this plan in our summer program with the YEP team at the NLRC. I use public transportation such as the bus. The bus is down the street from my house, and it takes me 5-10 minutes to get to school-middle school. I really like this plan, however, I have a concern on navigating this new system and the technology-I feel that I might get lost.	SANDAG understands your concern. Our primary goal is for technology to make transportation easier and better for people. When new technologies are planned and designed, we will seek extensive input from the public to ensure that these solutions are user friendly and make it easier for all people to access and use transportation information and services.
W5	Abraham Navarrete	National Latino Research Center	I was able to learn about the plan in our YEP class with NLRC. My biggest concern with this plan is safety. I feel like young girls sometimes feel unsafe, especially if they're alone. How is safety being implemented? We need safety for youth as we rely on transportation to get to school or other places.	SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements. SANDAG will be working hard with the help of all of our passengers and representatives to ensure that this plan gets implemented.
W6	Abraham Navarrete	National Latino Research Center	I was able to learn about the plan in our Thursday youth class with the NLRC. I think the plan is a good starting point. Many options for us to travel to places. I think the plan is good for the environment (it will reduce pollution). Also, I think we can improve system and make sure we are accountable to keep them clean/ cleaner.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W7	Abraham Navarrete	National Latino Research Center	I was able to learn about the regional plan in our Friday summer class with YEP. I like the 2021 Regional Plan, it is very interesting but it feels unrealistic, it will need so much time to get there.	Thank you for your comment and support for the 2021 Regional Plan. Implementation of the plan will take place over 30 years. Appendix B describes the near-term and continuing actions to implement the plan.
W8	Abraham Navarrete	National Latino Research Center	I like the Mobility Hub interesting idea.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W9	Abraham Navarrete	National Latino Research Center	I used to take public transportation when I went to CSUSM. I have a car now which at the moment is more reliable then our public transportation. I believes there is a need for a drastic change in our current system. At the moment we have a big issue with public transportation is travel time. From experience I know that if the bus is 1- or 5-minutes late people lose that other form of transportation, the other connecting bus because they would leave, and this causes people to wait for the next one making them late (for work/ school/ etc.). Not reliable.	The Regional Plan includes new services which will operate at higher speeds then traditional transit. Commuter rail routes have been designed to be grade separated which will allow them to circumvent street crossings and reduce conflict with cars. Additionally, existing transit would be upgrade with grade separations at major crossings and more service throughout the day.

## Draft 2021 Regional Plan Responses to Comments – Website Sourced

ID	Commentor Name	Agency	Comment	Response
W10	Abraham Navarrete	National Latino Research Center	From the plan I support that we include a bike lane, and safer, and more space for pedestrians. I still think we need more improvement for our youth, who use skateboards.	Hello Abraham, thank you for your comments. The bike network shown in the plan is the Adopted Regional Bike Network, which was adopted in 2010. As an early action out of the Regional Plan, SANDAG will develop a new Active Transportation Plan. Although the original plan considered topography, we will take a fresh look in the new one. With the ever increasing popularity of e-bikes, scooters, skateboards, and other micromobility modes we do feel it is important to build bike network that works for all users and provide as many network connections as possible.
W11	Abraham Navarrete	National Latino Research Center	At times our youth are criminalize, and put in situations that are not safe for them. How is this plan going to make sure this won't be an issues any longer?	SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements. SANDAG will be working hard with the help of all of our passengers and representatives to ensure that this plan gets implemented.
W12	Abraham Navarrete	National Latino Research Center	I personally feel that this is a great plan, however, I have a concerned about gentrification how is this plan and SANDAG going to be accountable for housing to be affordable to our communities? For our communities to not have to move out to different county because they can't afford? Notes, we have seen this happening in San Marcos and other cities in San Diego County, it is not fair!	In this round of the Regional Plan, social equity was at the forefront of the Regional Plan. One of the plan's near-term priority implementation actions includes a Regionwide Displacement Study (Appendix B) in order to ensure our housing efforts do not lead to the displacement of current low-income residents in communities where housing growth occurs. Additionally, SANDAG is in the development of a regional housing incentive grant program which could be include the ability to fund local plan updates in Mobility Hubs, two of which are the Oceanside and Vista Transit Centers.
W13	Abraham Navarrete	National Latino Research Center	Furthermore, I have a concern about the technology part of the plan. This plan assumes that we all are in the same knowledge and understanding for technology-which is not.	SANDAG understands your concern. Our primary goal is for technology to make transportation easier and better for people. When new technologies are planned and designed, we will seek extensive input from the public to ensure that these solutions are user friendly and make it easier for all people to access and use transportation information and services.
W14	Abraham Navarrete	National Latino Research Center	Lastly, I do not recall hearing anything in regards safety-ICE agents coming to our community public centers. How is this issues addressed in the plan? We have seen this multiple times in our transportation centers, on the Sprinter and this is a huge concern for our community.	<p>Transit station security and operations are a function of MTS and NCTD. MTS's website states that they have been making changes to its security policies and practices, to ensure their operations are in line with best in practice policies. Recent measures include increased training for internal and contract security staff, updated use of force policy, conducting an outside audit, using more visible and customer friendly uniforms, and more. Details can be found at <a href="https://www.sdmts.com/inside-mts/news-release/mts-makes-significant-changes-use-force-policy">https://www.sdmts.com/inside-mts/news-release/mts-makes-significant-changes-use-force-policy</a> and <a href="https://www.sdmts.com/inside-mts/news-release/new-uniforms-mts-security-teams-aim-increase-trust-and-public-safety">https://www.sdmts.com/inside-mts/news-release/new-uniforms-mts-security-teams-aim-increase-trust-and-public-safety</a>.</p> <p>NCTD's website states that they contract with the San Diego Sheriff's Office and local law enforcement agencies to patrol and provide law enforcement and security services at our transit centers. Your comment was shared with Dennis Desmond (denis.desmond@sdmts.com) and Robert Calix (rcalix@nctd.org) from MTS and NCTD respectively.</p> <p>SANDAG's Public Safety Committee provides a forum for which regional public safety issues and concerns can be addressed. NCTD and MTS serve on the Public Safety Committee as advisory members. Information regarding the Public Safety Committee can be found at: <a href="https://www.sandag.org/index.asp?committeeid=66&amp;fuseaction=committees.detail">https://www.sandag.org/index.asp?committeeid=66&amp;fuseaction=committees.detail</a></p>
W15	Adam Deutsch		I appreciate that Complete Corridors is a priority, with an emphasis on DEDICATED space, which means protected bike lanes. The entire plan, beyond that, is resting on major investments in Transit and mobility technology, but encouraging people to use bikes is much more cost effective and is generally easier to do. I think that should be a higher priority than tech we don't have.	Successful implementation of the 2021 Regional Plan relies on a combination of safe travel infrastructure, frequent and convenient mobility services, and technology to enhance transportation services and operations. Dedicating space for those travel options that help reduce automobile dependence combined with supportive policies and incentives for multimodal use are a key focus of plan implementation – everything from active transportation to ADA-accessible ridesharing options.
W16	Adam Deutsch		Ridehailing is dubious. Though it might seem like an ecofriendly option on the surface, it's really just more cars on the road. The goal should be to have a transit system that makes using ANY car	Fast and frequent transit is a key component of the 2021 Regional Plan. Commuter rail services along our urban corridors provide a sustainable alternative for longer regional trips; Light Rail will operate on higher frequencies and expanded service times; and

**Draft 2021 Regional Plan Responses to Comments – Website Sourced**

ID	Commentor Name	Agency	Comment	Response
			seem unnecessary or even inconvenient. One should be able to get where they're going by walking, bus, trolley, or bike in a time that's less than double going by car.	NextGen Rapid will provide a more reliable Rapid bus service. Flexible Fleets, which include on-demand mobility options like ridehailing, complete the transit network by providing connections to transit or serving areas where traditional transit services may not be suitable. Flexible Fleet services provide greater mobility choices in the San Diego region that ultimately helps to reduce the reliance on private vehicles.
W17	Adam Titone	Bicycle shop manager	Bicycles have become more popular recently. Our electric bicycle shop has grown significantly, we have local customers asking us where and how to park bicycles safely, where the safest place to ride is and how to deal with conflicting vehicle traffic. We have noticed the lack of quality bicycle parking and infrastructure. Our customers use a number of modes of personal transportation via bike lanes and those lanes are in need of improvements. We hope the city can connect with local businesses that gets local folks moving for insight. I have requested a bike rack on our block for general use and have not received any response on if that will take place.	<p>We have noticed the uptick in bicycle activity as well, as you can see in our InfoBit on biking during the Pandemic:  <a href="https://www.sandag.org/uploads/publicationid/publicationid_4704_27994.pdf">https://www.sandag.org/uploads/publicationid/publicationid_4704_27994.pdf</a>                      We also appreciate your concerns regarding the quality of bicycle parking and infrastructure. SANDAG's 2021 Regional Plan includes an Active Transportation vision focused on creating a regional network of bicycle facilities that are safe and comfortable for users of all ages and abilities. You can explore the network in our web-based data viewer :  <a href="https://sandag.maps.arcgis.com/apps/Cascade/index.html?appid=897af882e8c14b1e996c33e48bc15347">https://sandag.maps.arcgis.com/apps/Cascade/index.html?appid=897af882e8c14b1e996c33e48bc15347</a>                      As noted in Appendix L, while SANDAG has been working since 2011 to implement this network, including the \$200 million Bike Early Action Program. The 2021 Regional Plan takes these efforts further by redefining the project types as On-Street Facilities or Off-Street Facilities, which encompass a variety of flexible and context sensitive designs like protected bikeways, traffic-calmed bike boulevards, and off-street paths.</p> <p>Regarding bike parking, we work to include visible and convenient bike parking in every one of our active transportation projects. That said, our plan is a plan for the whole region, and our efforts are regional. For local discussions with individual cities, we recommend working with city staff. We are happy to help connect you to the right people if we can, although we do not have control over the process of local jurisdictions.</p>
W18	Alex Ortega Jr	San Diego Miramar College	<p>First off, I would like to say that I am for the Big 5 project and would plead that it is recommended as soon as possible. North County desperately needs improved public transportation to help ease the traffic congestion that occurs at the 5 and 15 junctions with the 78 freeway.</p> <p>As a North County San Diego Native, my question for SANDAG is why has there not been a proposal for the use of an above ground rail system? I understand that due to the frequency of earthquakes it is difficult to plan anything underground for a subway system, but looking at what has been done in the Bay Area with the BART system, would it not make sense for San Diego to implement something similar? Of course finances are always an issue but looking at the Bay Area, San Diego will undoubtedly grow to the same population size. Instead of looking at a temporary solution, incorporating a rail system that would run all over San Diego County would be getting ahead of the curve.</p>	The 2021 Regional Plan is the first of its kind in San Diego County to include such a vast, interconnected rail system that is separated from vehicle traffic. Future studies will need to be conducted to determine if these services will be above or below ground but the high speed connection these services will provide is included in the Plan.
W19	Alex Vit		<p>20 year old here. Will be a user of these new transportation projects.</p> <p>As can be seen from Figure 2.4 on page 24 of the plan, there are very few bus services (and no high-quality Rapid bus services) in the Del Mar - Solana Beach - Encinitas area. As these are suburbs and transit connections suck, it's useless to try to get from my house in Encinitas to somewhere like UTC via public transportation. Hell, you can't even get from my house to the Encinitas Coaster Station on a bus because it would take 6 times as long as it would driving (1 hour versus 10 minutes), despite the journey being 4 miles. Would be cool to have some high-capacity/good East-West connections in the Encinitas area (or other townships) to get people from their homes to the Coaster Station and/or Solana Beach Amtrak Station. Bonus points if the busses are electric.</p> <p>I highly support the effort to grade separate the commuter rail network. Better for pedestrians, bikers, and congestion. It would really be worthwhile to COMPLETELY grade separate and electrify the entire proposed high-speed commuter rail network. In fact, electrifying, double tracking, and grade separating the existing LOSSAN corridor should be prioritized as a project. Currently, my friends and I like to travel to Los Angeles, but we feel limited in our ability to do so.</p>	A major focus of the North Coast Corridor investments are the upgrades and services along the Coaster corridor with some connecting Rapid services. Please see the online data viewer at <a href="http://SDForward.com/envision">SDForward.com/envision</a> to view the projects. The details on the frequency and service spans also will be added to the Final Plan for this corridor and others. The California High Speed Rail project has been added to Appendix A and SANDAG will track its project as it is developed by the state. Also, the transit agencies continue to electrify their fleet per state mandates and SANDAG continues to make progress on the Central Mobility Hub to provide greater access to the airport. Those projects are listed in Appendix A under the "Central Mobility Hub" table.

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			<p>We hate sitting in traffic but we and we would like to take the Amtrak more often, but given the prices of the tickets, we always figure it's just not worth it to take the train; the price of gas split between two people is equal to the price of a ticket, and the time it takes to get to our location is usually lower with an automobile. I am willing to pay quite a bit more in taxes/government debt for services to be upgraded (even more than they already are) on this railway line.</p> <p>Also (again referring to Figure 2.4 here), why are there no commuter rail lines on the California High-Speed Rail route from downtown SD to Escondido? Or even Temecula? Seems like a wasted opportunity, it's not like those intercity trains are going to be running 24/7. A lot of people would stand to benefit from that, I would think that SANDAG would just have to construct stations along the line and use quickly-accelerating high-speed trains as well. With a Sprinter extension to the CA High-Speed Rail line, couldn't the city create a market for tourists to take public transport to the Wild Animal Park as well?</p> <p>The sooner MTS stops buying diesel busses and Coaster/Amtrak stop buying fully diesel trains the better. There are so many alternatives out there nowadays; so many companies produce electric busses and many companies also produce (high-speed!) dual-mode locomotives that are future-proof. Plus they're so much more comfortable - I go to school in a city where they have electric busses, they're a much more dignified experience than noisy diesel busses that throw everyone back in forth in their seat when they change gears.</p> <p>I'm also willing to pay a lot in taxes for a direct tram from the airport to the proposed multimodal hub. It would be cool to not have to drive all the way to the airport from Encinitas and all the way back just to drop someone off (or be dropped off myself). Lots of unnecessary GHG emissions and time wasted.</p>	
W20	Alexa Kaplan	N/A	<p>There are plans for way too many new homes in Mira Mesa. I am concerned about lack of infrastructure and mass transit prior to the building of new homes. Please make sure there will be enough transit for the 50,000 new people expected to move into Mira Mesa. The planning groups plan for walkability and transit options other than cars, so I would like to ensure that these transit options exist by the time these huge numbers of new people arrive.</p>	<p>The 2021 Regional Plan includes new RAPID transit lines proposed on Mira Mesa Blvd and Carroll Canyon Rd in addition to existing Rapid on I-15. The two new RAPID lines would connect with the commuter rail service in Sorrento Valley. Bike and Flexible Fleet services are also accommodated within the Mira Mesa area and within the proposed Mira Mesa Mobility Hub.</p>
W21	Alexander Han	Sunrise Movement SD	<p>For the final plan, I urge this Board to (1) maximize emissions reductions, (2) prioritize investments in the communities on the frontlines of environmental injustice and the climate crisis, and</p> <ul style="list-style-type: none"> <li>-Improve the Bus System</li> <li>-Create a Blue Line Express</li> <li>-Provide 24 Hour Service by 2025</li> <li>-Have a Purple Line Serve Central City Heights</li> <li>-Create Youth Opportunity Passes (YOP): Provide No-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. -Connect youth to school, work, internships, and other early-career opportunities.</li> <li>-Electrify Bus Fleet by 2030</li> <li>-Identify Anti-Displacement strategies</li> <li>-Improve the transit Bathroom network</li> <li>-Create an Emergency Ready Transit System</li> </ul>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail</p>



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				<p>Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p> <p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p> <p>MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
W22	Alexander Wenzel		<p>As a data scientist, software developer, and resident of San Diego who commutes 100% by public transit, I strongly encourage SANDAG to consider an open source model for the proposed Next OS system. As motivation for this proposal, consider the One Bus Away (OBA) app which MTS and NCTD use in order to provide scheduling and real-time arrival information to passengers. OBA is an open source project that originated in academia and which in turn relies on the open source Google Transit File System (GTFS) format for describing a transit system and computing vehicle arrival times and delays. Due to the existence of this robust open source project and data schema, MTS and NCTD need not worry about developing (and maintaining) their own app from scratch in-house. While infrastructure as critical as the Next OS ecosystem will need some form of institutional control by local governing bodies such as SANDAG, an open source model would</p>	<p>Thank you for the comment. We concur and envision the Next OS to be an open source solution.</p>

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			<p>allow members of the community, including local academic institutions and volunteers with the necessary skillset and motivation to make their community a better place, to contribute to the process of feature development and bug fixing that is needed for a robust system such as that proposed for Next OS. For example, although my career is in bioinformatics and genomics, I am passionate about improving public transit in our region and would happily spend my Saturdays fixing Next OS bugs for free, if given the chance. Additionally, as Next OS aims to control a vast segment of the regional transportation ecosystem, its security is of paramount importance. History has shown that open source projects tend to be more secure, so creating an open source environment for Next OS would go a long way towards protecting our region from threats as we seek to build a greater digital integration of our transportation system. Finally, making Next OS open source would lower the barrier to entry for other regions in the country to mold similar systems for their own needs based on Next OS. The causes of our climate problems are not contained within county lines, so our success is inextricably tied to the efforts at mitigation and adoption throughout the rest of the country. Making Next OS an open source standard around which other cities, counties, and regions can build their own smart transit systems is itself a major investment in reaching our own climate goals. In closing, I urge SANDAG to build Next OS as an open source project to leverage the ample talent in our region, engage with the community transparently throughout the development process, and ensure the robustness and overall success of the future system.</p>	
W23	Alison Aragon	Pro Kids, First Tee - San Diego	<p>I urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated. Let's help the leaders of tomorrow, today!</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p>
W24	Aliya Cunningham	The San Diego LGBT Community Center	<p>I am a supporter of The San Diego LGBT Community Center and I am writing to urge the Board to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated. I believe that every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our region's equitable economic recovery.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W25	Alla Valdespino		<p>I agree with SANDAG's approach to try and make a fast, fair and clean transportation system for San Diegans. However, I believe that SANDAG and NCTD need to really look at the reasons why people don't use public transportation today. People need to rely on cars because public transit doesn't reach where people that need it are, and there aren't accessible bus connections to important destinations such as the DMV, healthcare, or to work places like in factories and major retail. I live in North County San Diego, it is an issue here. Over the years, ridership has decreased, because bus lines get taken away, modified, or times aren't convenient for people. The 335 bus route was removed, leaving only the one way 334 route. The 306 and 318 routes don't run as frequently as people need, and the timing with the 318 bus is inconvenient for a lot of people. There aren't any convenient bus connections to many major retailers where people work, as well as in industry parks or resort hotels (like in Carlsbad). In addition, SANDAG and NCTD should have a voice when advocating for affordable housing near public transit, because the fact of the matter is that people that live in luxury apartment housing will never use public transport for everyday trips and errands because they can afford a car. Therefore, low-income individuals and underrepresented minorities should be given the priority when it comes to planning housing near major transit hubs. I also believe that SANDAG and particularly NCTD need to work on their outreach efforts to try and increase ridership, because their current efforts are honestly pathetic. They need to market their routes by promoting popular destinations that transit connects to, and make it accessible for people to be able to reach said destinations. SANDAG also needs to be particularly attentive to the needs of pedestrians and bikers' safety. Major transportation hubs should be safe for pedestrians and bikers, where cars are forced to slow down, and watch where people are going. Take a look at the Vista Transit center. The intersections that surround the</p>	<p>The 2021 Regional Plan used comprehensive data analytics to establish where people live, where they work, and what activity centers they were traveling to. Based on this analysis, new routes and modes of transportation were developed. Trunk line transit is connected to Mobility Hubs and Flexible Fleets that provide the first and last mile access that has previously been missing.</p> <p>Your comment was forwarded to North County Transit District (NCTD).</p>

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			transit are very busy and people are almost always getting run over by cars that that making right turns. Thank you.	
W26	Ana Ardon		I'm in full support of the new vision but I have several concerns about its implementation of social equity framework. The report does not directly address the unique experiences of Latinos and immigrant communities. For example, immigration enforcement has had detrimental effects in our quality of life and the use of transportation options. Local elected representatives in North County have vocalized their lack of support for the plan which may lead to fragmented efforts (some cities benefiting more than others from these advances), leaving communities of color at a disadvantage. Gentrification is another concern. In the city of Vista there has been a boom in housing development that has increased housing cost exponentially. Apartment units near the transit center cost around \$3,000 a month. I hope these issues are considered as the plan becomes a reality.	One of the Plan's Near-Term Priority implementation actions includes a Regionwide Displacement Study (Appendix B, pg B-3). One objective is to understand the dynamics of housing growth without causing displacement. Additionally, SANDAG is currently developing a housing incentive program. This program will fund local plan updates and increasing affordable housing in transit-rich areas with infrastructure, services, and jobs. Please see Appendix B: Implementation Actions for more details.
W27	Andi MacLeod		I urge you strongly to prioritize no-cost travel passes for 24-and-under riders on public transit. With school and jobs to get to, and the economic hardships experienced by many in the pandemic, young people need the extra boost they will get from no-cost travel passes. Approve them on the 6th and make San Diego a place where young people can Live Well too!	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W28	Andrea Dee		I write in support of the completion of the inland rail trail.	We are committed to complete this project and invite you to check out the project webpage at Keep San Diego Moving, sign up for updates if you have not already, <a href="https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx">https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx</a>
W29	Andrea Mendoza Vasconez		I'm writing to urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated. Youth is a time for habit formation. It is essential to instill the habit of using public transportation among our youth because of all the associated environmental, economic and health benefits. I urge you to follow the lead of many other counties that have successfully prioritized youth for transit subsidies. Thank you!	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W30	Andrew Frank		<p>I understand why the growth of electric vehicles has an impact on revenues from gasoline taxes, and I understand that to some extent electric vehicles get a "free ride". However, your use tax under consideration is not the way to resolve it -- have you checked with SDGE for a way to add a fee on electricity for eVehicle charging?</p> <p>Why should I pay San Diego ANYTHING if I choose to go on a cross-country trip in my car? Would only local miles count? How would you do that?</p> <p>Why should commuters from OC and Temecula get a free ride ... do you have a way to charge them? How about tourists, truckers, moving companies, etc., and all of the other vehicles that are not registered here?</p> <p>I do not like the idea of yet another tax -- it is a tax, no matter what you call it -- but I abhor one that is inherently inequitable and not well thought out.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p>
W31	Andrew Simmerman	KIPP SoCal Public Schools	<p>I would like to start with sharing gratitude to SANDAG staff and the Board of Directors for the considerable efforts, research, and intentionality in engaging with so many community members and partners - particularly in the most transit impacted communities - throughout the entire Regional Plan process.</p> <p>I represent a school organization (KIPP SoCal Public Schools and KIPP Adelante Preparatory</p>	SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights,

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			<p>Academy at 426 Euclid Ave.) that serves students in Barrio Logan and Southeast San Diego, with 90% of our students qualifying for free or reduced price lunch. Access to equitable, quality and affordable public transportation is critical for the students and families that we serve and there are numerous aspects of the Regional Plan that make us excited for the future opportunities it will present for our families and our communities that have been systemically under resourced.</p> <p>As you obtain feedback regarding the Regional Plan, KIPP SoCal Public Schools is advocating for:</p> <ul style="list-style-type: none"> <li>- Funding for free youth passes given to youth to age 24.</li> <li>- A Mobility Hub in southeast San Diego, preferably at the Euclid Trolley Station that will offer our students and residents more reliable transportation choices</li> <li>- Grade separations for the Orange Line, especially at Euclid to increase trolley speeds and headways (it's a big area of support from the community)</li> <li>- Fiber optics underground to ensure we are ready for the state of the art Transportation System that is in the design stage, (IOS systems) and to more appropriately address the digital divide in our "Redlined communities".</li> <li>- Covering on our MTS bus stops (structures).</li> <li>- Considering 24 hr. service on the lines that are taking our families to work.</li> <li>- Focusing on transitioning to an all electric buses in the first 2-3 years of implementation</li> <li>- Improving the frequency and reliability of our bus routes</li> <li>- Ensure all of our streets are designed with the "Complete Streets" designs</li> </ul> <p>Thank you in advance for your consideration of the above implementations.</p>	<p>and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>Southeast San Diego is part of the South Bay to Sorrento Mobility Hub. For more information regarding Mobility Hubs please see: <a href="https://www.sandag.org/index.asp?subclassid=83&amp;fuseaction=home.subclasshome">https://www.sandag.org/index.asp?subclassid=83&amp;fuseaction=home.subclasshome</a></p> <p>The City of San Diego coordinated with SANDAG to adopt a Euclid Avenue Master Plan. The Master Plan includes an existing conditions report, and mobility report. The Master Plan describes the implementation of complete streets, mixed use development, and more. The Euclid Avenue Master Plan details the City's intent to improve pedestrian and cyclist safety; as well as improve connectivity to the Trolley and Euclid Transit Center. For more information regarding the Euclid Avenue Transit Center, please visit: <a href="https://www.sandiego.gov/planning/community/cpu/encanto/egmp">https://www.sandiego.gov/planning/community/cpu/encanto/egmp</a></p> <p>The Regional Plan includes a variety of new commuter rail services that will provide higher speed transit with reduced travel times. Additionally, existing transit is envisioned to be upgraded with grade separations that allow for faster travel times and more frequency throughout the day.</p> <p>The transportation system envisioned in the 2021 Regional Plan relies on a vast network of digital infrastructure to connect and manage the transportation system. For Complete Corridors, NextOS, Flexible Fleets, Transit Leap, and Mobility Hubs to succeed, a robust broadband and telecommunications network is essential. The Plan includes an investment in the backbone fiber infrastructure needed to support the transportation network however SANDAG is also developing a Regional Digital Equity Strategy &amp; Action Plan to support the expansion of broadband county-wide. The Strategy &amp; Action Plan will define strategies for expanding broadband and internet connectivity in the San Diego region to support quality of life, transportation, and equity.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a></p>
W32	Andrew Sturm	Casa Familiar	<p>The first major feedback that I have is in regards to short term solutions for public / shared transportation in the South Bay - specifically San Ysidro - to better connect us with the rest of San Diego and specifically to employment and entertainment centers, via public transportation. The future plans that are outlined in the plan, are solid but they will take a very long time to implement and we need better public transportation access now. It has actually been a critical need for many years. What plans are you pursuing that get us from now until the more long term</p>	<p>The 2021 Regional Plan envisions several projects and programs to better connect communities throughout the region, including communities in the South Bay. Several areas throughout the South Bay are identified within the network of Mobility Hubs outlined in the plan. These facilities will expand multimodal transportation options and connect the adjacent community to the regional system. A near-term action of the Regional Plan is the planning and conceptual design work for the future San Ysidro</p>



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			<p>solutions are in place? What about dedicated lanes for Bus Rapid Transit on existing freeways at peak times, for example?</p> <p>The second major feedback is regarding the traffic congestion at the border and how the resulting air pollution from that is creating very poor health outcomes in San Ysidro and Tijuana. What solutions do you have for mitigating this in the short term. How can SANDAG as a regional entity help to apply pressure on the federal government to address the poor air quality their policies and processes are creating and how can you be a part of the solution with more and better public transit options that are available at the border? Not just in 10 years or 20 years - but this year or next year.</p>	<p>Mobility Hub. This effort will also prime a suite of near-term improvements that includes trolley capacity enhancements and pedestrian safety and connectivity measures for early action. Better connecting bus Rapid services to San Ysidro will be a focus of that planning work as well.</p> <p>Regarding the second question, SANDAG is aware of the environmental concerns and disadvantages border communities like San Ysidro and Tijuana face, as it relates to air pollution stemming from vehicle delay at the Port of Entry. With the implementation of the 2021 Regional Plan SANDAG anticipates higher levels of non-motorized mode-share to occur for crossborder trips as cleaner and more efficient transportation options come online. Also, SANDAG maintains working relationships with government entities at all levels in both the U.S. and Mexico, and pursues partnerships to address concerns and collaborate on joint efforts. SANDAG will continue to coordinate on a binational level to raise awareness and expedite transportation projects that serve the border. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W33	Angelica Reyes	National Latino Research Center	<p>Me gustaría que el transporte público que pase mas de 25 mins, mas frecuente como este plan. ***</p> <p>I would like public transportation to pass more frequently than every 25 minutes, like this plan.</p>	<p>El Plan Regional incluye mejoras significativas a la frecuencia del transporte. Se está planificando que todos los medios de transporte del transporte público operen cada 10 minutos. ***</p> <p>The Regional Plan includes substantial frequency improvements. Transit is planned to operate every 10 minutes on all modes.</p>
W34	Angeline Kaufman	The San Diego LGBT Community Center	<p>I am writing to urge the board to amend Appendix A of the 2021 Regional plan to declare that no-cost transit passes for youth ages 24 and under receive priority when transit fare subsidies are allocated.</p> <p>I believe that every San Diegan deserves access to high-quality transportation and economic mobility, especially going people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our regions equitable economic recovery.</p> <p>When young people have access to no-cost transit passes, they are better able to access work, school, medical care, and resources otherwise not accessible. I know that my family and I cannot get help because of transportation (work and medically) both of my parents have no car and currently no job because of transportation. Having free public transportation would help my family as well as others with finding jobs.</p> <p>I urge the board to take bold action to build a healthier, prosperous, and just future in San Diego. Please amend the plan to include youth opportunity passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W35	Anita Bandrowski	UCSD	<p>Really looking forward to upgraded bike lanes and micro-mobility improvements in 92122.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>. The 2021 Regional Plan data viewer can be used to explore Regional Plan projects in your area.</p>
W36	Anjali Vaidya		<p>I support no-cost transit passes for young people 24 and under.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W37	Ann Miller		<p>The proposed mileage tax on vehicle's to replace the gas tax needs to be assessed to all drivers including tourist, visitors, traffic from South of the border etc. it can be done by a chip on your windshield attached to your credit card. If you don't have one a booth at the entrance of significant roadways can provide one via 'credit card'. This should be assessed on ALL users not just San Diego residence. And should motorcycles and bicycles be included because they use the roadways as well?</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group are paying more</p>

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				than their fair share. The initial thinking is to fairly charge users of San Diego roadways regardless of where they reside.
W38	Anna Harley-Trochimczyk		I want to express strong support for the commuter rail plans, especially connecting dense residential areas like Hillcrest and North Park to job centers in UTC and Sorrento Valley. Sorrento Valley is one of the most impacted areas of the region in terms of commute traffic and the existing trolley lines and Coaster lines are not really accessible at all to the Uptown communities. Additionally, the plan for a trolley line that encircles Balboa Park would be huge! It would be useful for tourism as well as residents to easily get around without a car. Bus service connecting downtown and North Park right now is so slow. Managed lanes along the various highways are another important piece of the puzzle, but the vision towards new transit options like a commuter rail and new trolley lines is where the biggest shifts in habit will happen. These are what are necessary for residents to be truly car-free, as opposed to managed lanes which would hopefully encourage carpooling but that still keeps people in their cars.	<p>We appreciate your support and feedback.</p> <p>The Mid-City Trolley Line (Purple Line) is included as the first major new rail project in the Plan and will serve the north-south travel needs in Sorrento Mesa, National City, Kearny Mesa, and University Heights. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is completing a more detailed ridership analysis of this route. The analysis is studying an alignment that would include stations in City Heights and at San Diego State University (west campus). Also, transit subsidies are a component of the proposed Final Plan and implementation of those subsidies would include a consideration of low-income and youth populations.</p> <p>The 2021 Regional Plan envisions a system of complete corridors with managed lanes that support Rapid bus service and Flexible Fleets to improve options to driving a car.</p>
W39	Anne Barron	Peace Resource Center of San Diego	Pls include environmental justice everywhere in the county's RTP & prioritize impacted (EJ) communities and list the projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025. I ask that an equity specific project list be included in Appendix A.	SANDAG will include the projects that benefit EJ communities in Appendix A in the proposed Final 2021 Regional Plan. This information was published in Appendix H Attachment 3 of the Draft but will be moved to Appendix A and updated.
W40	Anne Barron	Peace Resource Center of San Diego	Time for 24-hour service on popular transit routes to connect late night and early morning workers to their job. Clarify the language in both Appendix A and Chapter 2 to specify 24 hr. service on popular transit routes and present a clear implementation schedule.	The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.
W41	Anush Badii	UCSD	Air Quality and Congestion Relief both go hand in hand, it is a well-known fact that there is a 100-gram reduction in generation of Green House Gas per mile when an average vehicle travels at 50 MPH versus 30 MPH. Multiply that by the number of miles driven in San Diego at 30 MPH yearly which is about 4 Billion miles yearly in San Diego County and you get 400,000 Tons of GHG that was generated due to congestion. Congestion relief is possible through the implementation of correct ramp metering procedures. The current ramp metering method deployed by Caltrans was invented almost 50 years ago and is deficient in addressing the nonlinear nature of traffic flow. Here at UCSD, we have developed a new ramp metering paradigm "Particle Filter- Model Predictive Control" that will increase the traffic flow rate and speed, and decrease the travel time. As such it will also reduce or eliminate the 400,000 Tons/year of unnecessary generation GHG from San Diego's environment. I recommend that you contact Dr. Ramesh Rao the director of Qualcomm Institute at UCSD for a detailed presentation on this matter.	<p>These are the types of system efficiency enhancements that are envisioned for the region as part of the Complete Corridors proposed strategies complimented with the Next OS that will serve as the brain to help managed such strategies in an integrated and multi-modal approach. In addition to corridor-wide and adaptive ramp metering other strategies include Dynamic Lane Management, Smart Intersection Systems and Active Travel Demand Management Systems. As technology components of the Regional Plan advance toward implementation SANDAG will actively engage with technology leaders to implement best practices.</p> <p>Your comment was forwarded to Caltrans.</p>
W42	Araceli Hernandez	El Cajon Collaborative/Barrio Logan College Institute Parent Spanish	Communication is sometimes hard when I try to find out about buses and the schedule. Can they make a phone app in Spanish we can use when we need to catch a bus? (We talked about technology and apps in the future including Pronto) Thank you so much for the new Pronto. I look forward to all the Plan coming true.	<p>The Next Operating System includes comprehensive improvements that are focused on making schedule identification and fare payment easier. As new apps are rolled out they will be available in Spanish.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>
W43	Arden Santos	Self	Just remember; many people were forced out of San Diego proper to North County where we are already paying Fastrack fees and expensive gas prices. Many of us commute into the city so as you "decide" on all our bicycle lanes and scooter lanes there are those of us who travel over an hour a day to our jobs down the 15. Charging us MORE money is out of the question.	Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.

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				<p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
W44	ariana federico	Mid-City CAN	<p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego. No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities.</p> <p>Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.</p> <p>I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W45	Arnold Durbin	Resident, Borrego Springs	<p>Back in the 1980's, we were promised that the trolley system would provide a rapid, convenient transit system that would be highly-utilized and result in urban villages popping up around the stations. Forty years later, we're being told that the previous system is slow and underutilized because density around the stations hasn't been as robust as planners imagined and the system isn't as rapid in design. SD Forward isn't so much as a bold vision as it is a repackaging of the same arguments taxpayers and residents were told in previous generations. If one train system didn't pan out as envisioned, what's so different and unique about this one? I'm not totally against exploring alternatives to increasing lane miles, but I'm also pragmatic and a realist and the SD Forward plan needs a better argument for constituents like me. I want to know the costs: How long will it be before the system as envisioned is paid off? How long we will be taxed, fee'd, tolled or fined? The Coronado Bridge eventually paid for itself, but it doesn't seem clear to me that this project ever will. The bridge began construction the year I was born and it was paid off sometime when I hit my 40's. I want to know if my grandchildren and their grandchildren will be paying for this new system, or will they be told that the system doesn't work as it was envisioned, much like the trolley system is now.</p> <p>Another glaring omission from this plan is its neglect of the backcountry rural areas. Hwy 67 needs to be upgraded into a regional byway - it has clear commuter patterns that make it unsafe, unpleasant and inefficient. Ramona needs to be better connected to Poway and Lakeside - and I'm not advocating for Ramona's needs as much as I am for a broad swath of the backcountry. Borrego Springs, Santa Ysabel, Julian - we all use Ramona as a hub to get further into the urban areas of the county. By not safely connecting Ramona to the urban highway network, this plan jeopardizes the safety and well being of a lot backcountry rural communities. We need a safer and less stressful means to access medical and professional services and goods in San Diego's urban markets! As a homeowner in Borrego Springs, I often choose to spend my tax and spending power in Temecula because the highway 79 is perceived as being safer than Hwy 78 or Hwy 67. I'd prefer to keep my tax dollars in SD County, but it looks like this plan won't</p>	<p>The transit system envisioned in this Plan responds to updated growth projections and focuses on high-speed services that will connect jobs and offer service with similar travel times as autos. Previous plans focused on access but not necessarily speed of travel and equivalency with other options, thereby making these planned services much more desirable to the traveling public.</p> <p>In terms of the costs, the Plan includes revenue assumptions from a variety of sources that are anticipated during the life of this Plan. In other words, the revenues match the costs for all projects and programs in the Plan through 2050. The Plan includes improvements on State Route 67 and other rural routes that were derived from the Intraregional Tribal Transportation Study, 2018. <a href="http://sandag.org/itts">sandag.org/itts</a></p>

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			likely result in that. One final note: As an enrolled member of one of San Diego’s sovereign Native American nations, I take offense at this plan using our people as an example of our ecological insight and geographical knowledge in the introduction, then completely ignores these communities in this plan. SD’s native communities are now major employers that contribute to the economic powerhouse that is San Diego County’s economy. Those workers will need safer and better alternatives and this plan doesn’t even mention the county’s tribes except acknowledging that we were here first. This plan does nothing to improve connections between San Diego’s sovereign Indian lands and the County. Where’s the equity in this plan for rural and backcountry residents? I assume some part of our tax dollars will pay for this plan and you need to provide more concrete ways that we will benefit. We need more than just “additional shoulder space and straightened curves” on our rural highways. We need actual bike lanes - not just improved shoulders! Bike lanes will benefit urban residents more as they are the ones that come up here and ride in the open country. There’s not many rural residents that trust our drivers enough that they’d ride a bike on Hwy 78 or 79.	
W46	Autumn Ortiz	Community Interface Services	Transportation access and flexibility is vital for individuals in San Diego. Particularly in North County. I support the proposed “5 Big Moves” RTP and want to see more flexible options implemented in North County as quickly as possible!	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .
W47	Barbara Green		Transportation needs to be easily accessible, which means affordable, so I think this is definitely a step in the right direction.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .
W48	Becky Thimm	So. Bay Eco Justice	It would have been nice if info about this meeting had been put out a few days BEFORE the day of the meeting! I did not get this until AFTER the meeting was over. Being at the North or Central San Diego County doesn’t really meet the needs of the South County area.	All recording of our public work shops and meetings can be found at: <a href="https://sdforward.com/about-san-diego-forward/calendar">https://sdforward.com/about-san-diego-forward/calendar</a>
W49	Beth N		I am strongly opposed to a mileage tax or other fees to fund this. First of all, I don’t know how it would be implemented ( I don’t want anyone tracking my mileage- that is an invasion of privacy), and second of all, we have seen how the gas tax that we paid for years has not been used to build more highway infrastructure as promised. Until you use the money to build the roads as promised before, I would oppose any additional fees or taxes for the transportation projects. No bait and switch. You do not deserve any more tax dollars.	Thank you for your comment.
W50	Blair Overstreet	Center on Policy Initiatives	As a long-time resident of San Diego, and a former member of City Heights Area Planning Committee, I’d like to see greater investment in sustainable transit solutions and access for those that most need it. For that reason, I’m asking you to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive TOP PRIORITY when Transit Fare Subsidies are allocated. Youth will have access to education and opportunities that increase in our investment in the economic and long-term health of our community.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W51	Bob Nelson	Oceanside Resident / Architect	As a 34 year resident of Oceanside and having commuted by car, bicycle and train to employment in San Diego and Orange County Cities and by Train and bicycle via the Coaster, Sprinter, AMTRAK, METROLINK and the MTS Trolley System I have experience with the issues in transportation and have worked with many EIR’s. A major general concern with this Regional Plan is that it seems to be San Diego and Tijuana Border centric and does not deal with the million plus residents of Southwest Riverside County and the three million residents of Orange County as well as the rest of the LA Region that impacts transportation and mobility in San Diego County. While most of the Vision Deals with transportation improvements for commuting within Southwest San Diego County the Plan ignores the fact that Tourism and Commuting also occurs from and to Riverside and Orange Counties. The I-5 corridor is most heavily impacted Thursday through Sunday between south Orange County and Del Mar. The I-15 is also becoming more congested due to the congested I-5 on weekends. It also ignores the commuters from SW Riverside and North San Diego County on the 76 Expressway that travel to south Orange County. The 76 is the primary route to the Beaches from SW Riverside County, and a primary route to the Casinos on the 76 east of the I-15. It is listed as a ‘Rural Route’ in the plan but is actually a much more impacted route between the I-5 and I-15. The congestion is already impacting parallel and some north / south roads. The commuter Trains have very limited schedules on the weekends and midday and are shut down several weekends every year for maintenance on weekends making them an unreliable	Appendix J of the draft 2021 Regional Plan includes information on SANDAG’s approach to planning within the context of the megaregion and the importance of strategies that leverage partnerships with all neighboring jurisdictions to advance regional goals related to the environment, economy, and quality of life. Implementation of the 2021 Regional Plan will involve close coordination with partners in Orange, Riverside, and Imperial County to align priorities and projects to facilitate and improve mobility for these interregional flows. The SR 76 is an important facility for regional travel. Appendix A highlights several straightening, intersection, shoulder widening, and other facility improvements to address corridor safety and efficiency. The LOSSAN Rail Corridor improvements include full completion of double tracking to the Orange County Line that benefits Amtrak Pacific Surfliner, NCTD COASTER, Metrolink, and BNSF Freight trains. These capacity improvements allow for more trains to operate north of Oceanside to Orange and Los Angeles Counties and beyond. Although outside of the SANDAG region, siding tracks are planned in South Orange County by OCTA and Metrolink. New cleaner EPA Tier 4 diesel locomotives have entered service on Amtrak, COASTER, and Metrolink trains operating in San Diego County. There are many emerging technologies in the rail industry for zero-emission trains that should become commercially viable within the horizon of the regional plan. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .



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			<p>option. Double tracking will help but the San Clemente to Laguna Niguel area is mostly single track with limited options to double track. This bottleneck should be addressed in the plans as it might affect the adequacy of the SANDAG Vision. The trains are also a fairly significant health hazard that is not discussed. while the Diesel Locomotives on the commuter trains are slowly being replaced with cleaner air versions they are still toxic to passengers at Stations from fumes, heavy metals from braking into stations and very loud engines and brakes, damaging regular customers hearing. Trains also run as fast as 70 MPH through some stations with passengers on platforms a few feet away, 3'+. The APCD should be consulted to explore the real impacts of these vehicles on the Health of the Communities they serve. Additional comments will be sent on another form.</p>	
W52	Bob Nelson	Oceanside Resident / Architect	<p>These are additional comments to my previous: AT-030 has a name referring to Alta Loma Bridge. It is actually Loma Alta Bridge at Buccaneer Park in Oceanside. I would recommend routing the Bike Trail under the train bridge and then south along Broadway to Cassidy street rather than the existing trail crossing at grade at Cassidy, a safer connection.</p> <p>For AT-068 Camp Pendleton Trail between Oceanside and Las Pulgas Road the routing should be a separated trail versus having to go along the two lane Stuart Mesa Road as this route is not allowed by the Marines at night and also requires an ID check. This has many long distance riders and bicycle travelers having to use the shoulders of I-5, which is very dangerous. When freeway drivers see cyclists on the road edge they often panic brake, especially at night with those cyclists using flashing tail lights.</p> <p>Another recommendation on the Bicycle Plans; A connection Trail route should be included from the Melrose Avenue Sprinter Station / Inland Rail Trail to the Guajome Regional Park and the San Luis Rey River Trail. This is a shorter and much safer connection than the Vista Way Connection indicated, although the bike lanes on Vista Way should be completed within the City of Vista. A Goal of the entire Bicycling plans should be to eliminate bottlenecks and preferential treatment of motorized vehicles over cycling facilities. Particularly at chokepoints at freeway crossings and conformance with bike share lanes and bike lane widths with CALTRANS standards, EG: bike lanes should be wider than minimum 5' width when speed limits exceed 35 MPH and 5' widths of paving outside of gutters, and Bike share lanes should have a 30 MPH Maximum Speed Limit I believe. Many areas also have bicycle lanes deleted in favor of vehicle right turn lanes. These issues make bicycling too dangerous for most people.</p>	<p>As an early action our of the Regional Plan, SANDAG will be developing a new Active Transportation Plan. The plan will take a fresh look at the network and the options to make it safe and comfortable to use active transportation. SANDAG prioritizes community engagement and will develop these connections in partnership with the community so that we can make sure the routes take people where they want to go.</p> <p>Even sooner, I'd encourage your organization to be involved with the efforts of the North County CMCP if you are not already <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail</a></p> <p>SANDAG follows national and international best practices in bikeway design to create safe facilities for users of all ages and abilities. Multiple studies show that most people feel safer in protected bikeways, and when well designed, they are safer than any other type of bike facility. The focus of our efforts is on people who may be "interested but concerned" in riding a bike alone or with family. For those who do not feel comfortable riding in protected bikeways, the California Vehicle Code allows people to bike in the roadway with traffic. While protected bikeways are a great solution in many cases, we know they are not always the best solution. Every project goes through a detailed and context sensitive design process which results in decisions regarding the best facility, which may include protected bikeways, buffered bikeways, shared use paths, or shared streets with significant traffic calming elements. The Regional Plan also includes funding for upgrading existing bikeways that may not meet current best practices in maintenance or bikeway design.</p> <p>Your comment was forwarded to agencies that oversee these facilities.</p>
W53	Brett Fisher	Interfaith Community Services	<p>Transportation access for clients is a vital necessity. I/we support the proposed "5 Big Moves" RTP and want to see "flexible fleets" implemented in North County as quickly as possible! My your comment is via The Alliance.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>. The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.</p>
W54	Brian Nixon		<p>Need additional miles of Protected Bikeway(off street) and those proposed should be completed decades prior to 2050. All freeway projects and new major roads should also include protected bikeways being built. Protected bikeways should also be considered from residential areas to employment centers along existing non freeway corridors.</p>	<p>The projects from the active transportation network were laid out and prioritized based on the analysis performed in Riding to 2050, SANDAG's Adopted Regional Bike Plan. While the deadline year for build out is 2050, this just means it would be proposed to be completed by that time. Many projects will likely be completed earlier. This is especially true as new funding sources come available. Additionally, as an early action out of the Regional Plan, SANDAG will be developing a new Regional Active Transportation Network in which projects will be reassessed and reprioritized based on data and community engagement. There are also opportunities for the development of protected bike network vis "Complete Streets in Mobility Hubs" funding, which is intended to fund retrofits to facilitate short trips of less than 3 miles in a safe and comfortable way to make it easier and more attractive to choose active transportation. Finally, the intention of the network proposed in this plan is a regional framework which facilitates strips associated with regional purposes (trips to school and work, trips within Mobility Hubs, trips to major destinations, and others). The regional network compliments the much more extensive networks which local jurisdictions plan and construct on their own streets.</p>
W55	Bruce Higgins	Retired	<p>Wrong plan for this region, it is out of touch with existing transportation needs, and seeks to force people to adapt to the plan by fees, taxes and assessments, rather than adapting the plan</p>	<p>Thank you for your comments.</p>

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			<p>to the needs of the people.</p> <p>The plan to pay for this is DOA. We have paid for our roads once through taxes and bonds, we are not going to pay a per mile tax to pay for this pipe dream. The plan envisions very expensive equipment that will never be used to its potential (High Speed Rail) and then asks us to shoulder a 30 yr. tax burden to pay for this white elephant.</p> <p>My other objection is without the social engineering this plan envisions, the plan does not work. If the voters reject major portions of the plan, the whole house of cards collapses of its own weight, and there doesn't seem to be a plan B.</p> <p>I would start of one now, because I don't think this will fly. You might consider how to implement things in sections as SANDAG gains credibility, right now you have none. You lied to the voters the last time, why should we trust you again?</p>	
W56	Carlos Ramon		I believe youth passes should be a high priority. The ability to access transit for school would be a major win for families.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W57	Carol Lewis	El Cajon Collaborative	I have been involved in outreach for the Regional Plan for several years. This is the first time I have seen social equity written into every aspect of the Plan. Thank you for the process of developing a Social Equity Statement and I look forward to seeing how SANDAG continues to develop strategies to maintain community involvement and equity into every project that is currently being developed and those into the future. Thank you for making outreach so much more enjoyable this time around since it is so inclusive of our underserved communities.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
W58	Carol Lewis	El Cajon Collaborative	Having a train and a transit center in El Cajon has been the biggest surprise to everyone. Thank you for including El Cajon and East Region into so much of the plan and we hope that SANDAG will be equitable to bringing these projects to this community first since we have been so underserved in the past.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
W59	Carolyn Chase		You refer to “high speed” and “fast” transit services in several places. What are the definitions for “high speed” and “fast”? Light Rail cannot be consider “fast” or “high speed” - busses in regular transit lanes cannot be considered “fast” or “high speed.” The definition for “High Speed Rail” is even not very high speed. What portion of the transit network would be high speed - and what would those speeds be? Also the section on COVID-19 is poor. It does not acknowledge that significant ridership is down and fewer people will be willing to change to transit. Finally, where are the stats about how many drivers would have to change to transit to reduce their climate impacts and considering the increasing change to electric cars that will transform the emissions of the fleets within the next decade significantly.	<p>Vehicle type, detailed ridership, and more detailed station-by-station routing would be explored through advanced planning of regional rail lines. This regional scale approach presents the vision for a more connected and high speed network that better addresses future population, housing and employment growth.</p> <p>The planned network includes vast, interconnected rail system that is separated from vehicle traffic. Future studies will need to be conducted to determine if these services will be above or below ground. The Regional Plan's Commuter Rail system is planned for speeds up to 110 MPH using vehicles that are zero-emission.</p> <p>The Regional Plan supports investments in the electrification of cars, trucks and buses and their supporting infrastructure (e.g., EV charging stations and hydrogen fueling stations). These electric vehicle investments are one of the ways SANDAG is working to reduce climate impacts and improve local air quality. Appendices A (Table A.17) and B show SANDAG's proposed EV commitments. Innovation and advanced technologies will be critical to meeting regional GHG reduction goals in 2035 and 2050.</p>
W60	Carolyn Woodbury		Please prioritize school age youth and low income riders on public transportation. Free or very low cost (like 25 cents) rides. This will help get cars off the roads and make it possible for students to stay after school, go to libraries and to see their friends , regardless of their parent's income.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.

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W61	Catherine Eng	Sd Lgbt center	<p>Hey @everyone SANDAG is discussing their 2021 plan and this is an opportunity to pass an important measure that affects youth's access to free public transportation. Below are all the details you will need to submit an e-comment. The deadline to comment is TODAY, Friday August 6th at 5PM. Please share this!</p> <ol style="list-style-type: none"> <li>1. Go to the e-comment website: <a href="https://regionalplancomment.sandag.org/">https://regionalplancomment.sandag.org/</a></li> <li>2. Enter your information</li> <li>3. Organization: The San Diego LGBT Community Center</li> <li>4. Chapter: General Comment</li> <li>5. Appendix Type: Appendix A Transportation Projects, Programs, and Phasing</li> <li>6. You can create your own comment or use the sample comment below</li> </ol> <p>I am a supporter of The San Diego LGBT Community Center and I am writing to urge the Board to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>I believe that every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our region's equitable economic recovery.</p> <p>When young people have access to no-cost transit passes, they are better able to access school, work, medical care, and resources otherwise not accessible. [PLEASE SHARE A STORY OF HOW NO-COST TRANSIT PASSES WOULD CHANGE YOUR LIFE FOR THE BETTER.]</p> <p>I urge the Board to take bold action to build a healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity Passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W62	Cathryn Rathsam	Peace Resource Center and SD 350	<p>Thank you for this important plan! It's vital to the health and wellbeing of our communities and our planet. There must be an independent oversight committee from the community, not instituted from Sandag. We need to serve the economically disadvantaged areas first. There needs to be oversight of the security guards and police as well, to insure everyone feels safe while traveling, without sexual harassment. There should be a simple, orderly, non-invasive way to insure that people have a pass or card, as in Europe, eliminating the need to have guards and police checking. It should be very economical for families and those with limited incomes. Clean bathrooms should be easily accessible. I wish you all the best in the implementation of these plans.</p>	<p>SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.</p> <p>Oversight of public agencies is important and SANDAG welcomes public review of its work and processes. Federal and state agencies regularly review SANDAG and there are two ongoing local oversight processes with the Office of the Independent Performance Auditor and the Transnet Independent Taxpayers Oversight Committee. MTS has unveiled the Pronto card to make transit payments much easier. Transit subsidies are included in the Plan to assist everyone but with programs specifically for low-income populations first. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p>
W63	Cecilia Villareal	El Cajon Collaborative/Barrio Logan College Institute Parent Spanish	<p>I try to help out in the community. We need to be asked more often to help. We would like to get involved in planning projects in El Cajon and be sure we are not forgotten. This is a good plan that looks at so many areas of transportation. I am happy they are going to be more equitable with projects and bring more projects to East County. I really like the El Cajon transit center.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W64	Celina Maria Parra	Bayside Community Center	<p>Hola, es un gran proyecto. Me gustaria que consideraran el costo por boleto ya que somos una familia con varios integrantes talves paquetes de boletos familiares, los colores de las lineas delos bagones del tren mas claras para poder distinguir mejor las rutas *** Hi. This is a great project. I would like you to consider the price of the tickets. We are a family of several members, and you might consider offering family ticket packs. The colors of each Line on the train cars need to be clearer so it is easier to differentiate the routes.</p>	<p>Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio permitirá que las partes interesadas publicas tengan la oportunidad de expresar su opinión sobre las opciones. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los</p>

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				jóvenes menores de 19 años. *** One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W65	Celine Khoury	UC San Diego	I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr. service on popular transit routes and present a clear implementation schedule.	SANDAG is currently undertaking a social equity pilot analysis that will evaluate which routes could operate 24 hour service and how to create a network of routes that would provide a complete trip.
W66	Celine Khoury		I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.	The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.
W67	Césaire Carroll-Domínguez	SDSCPA SD youth Antifa group	<p>Hey @everyone SANDAG is discussing their 2021 plan and this is an opportunity to pass an important measure that affects youth's access to public transportation. Below are all the details you will need to submit an e-comment. The deadline to comment is TODAY, Friday August 6th at 5PM. Please share this!</p> <ol style="list-style-type: none"> <li>1. Go to the e-comment website: <a href="https://regionalplancomment.sandag.org/">https://regionalplancomment.sandag.org/</a></li> <li>2. Enter your information</li> <li>3. Organization: The San Diego LGBT Community Center</li> <li>4. Chapter: General Comment</li> <li>5. Appendix Type: Appendix A Transportation Projects, Programs, and Phasing</li> <li>6. You can create your own comment or use the sample comment below</li> </ol> <p>I am a supporter of The San Diego LGBT Community Center and I am writing to urge the Board to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>I believe that every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our region's equitable economic recovery.</p> <p>When young people have access to no-cost transit passes, they are better able to access school, work, medical care, and resources otherwise not accessible.</p> <p>I urge the Board to take bold action to build a healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity Passes as a priority.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W68	Christina Abbott	Private citizen	No, no, and no. We are taxed beyond the max. Current taxes are grossly misspent. The rail system is a joke. Administration personnel are overpaid, and too many politicians are crooks.	Thank you for your comments.
W69	Christine Turrentine	N/A	<p>With your interest in North County Transportation:</p> <p>First, you have not honored your commitment to us in regard to taxes you have levied, collected and then sat on to fix, repair, or widen roads in the North County and now you want us all to use public transportation, or be taxed again for the miles we travel. My husband and I have been looking at buses as we go about our daily responsibilities and find that there are only one or two people riding a bus. A trip by Coaster from Escondido to Oceanside takes almost an hour. The</p>	A regional plan is a long-term blueprint for how the San Diego region will grow and how we will get around. It's a broad-based community effort that addresses many important issues, including using land more wisely, building a more efficient and accessible transportation system, protecting the environment, improving public health, promoting a strong regional economy, better managing our access to energy, incorporating equity into the planning process, addressing pressing needs on tribal lands, and supporting a vibrant international border.



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			<p>problem is that our cities are not like older cities that have a centralized area for banking, grocery shopping, and other commodities that are needed to live, we are all spread out. Our centers are spread out, our grocery stores may be three or four miles away, and if I were to travel by bus to do my grocery shopping, it would take me more than half a day to buy a loaf of bread.</p> <p>Construction the magnitude of your desires would cause a major disruption to the lives of many people in many cities, and you still wouldn't have done what you promised years ago and collected taxes for.</p> <p>Come up with a better proposal- or actually do what you have already promised!</p>	
W70	Christoph Weber		<p>I strongly urge you to not route the Coastal Rail Trail along Rose Canyon and instead follow Gilman Drive and then route through UCSD. This was originally intended, makes sense in a lot of levels (population density along the route, points of interest along the route, demographics. among others), and it is unclear to me why anyone would see Rose Canyon as the better option. As a longtime resident nearby and avid cyclist I have always wished for a better and safer way to cycle along the originally planned route, but never for the current option.</p>	<p>The City of San Diego's project S00951 follows the Gilman Drive alignment and is on the Adopted Regional Bike Network included in this Regional Transportation Plan, it is on the City's CIP list to begin construction in 2022, please see webpage here for more details <a href="https://cipapp.sandiego.gov/CIPDetail.aspx?ID=S00951">https://cipapp.sandiego.gov/CIPDetail.aspx?ID=S00951</a>.</p> <p>It is going to be a vital connector to SANDAG's recently upgraded Rose Canyon Bike Path and SANDAG's newly constructed Rose Creek Bikeways to the south. Extending north, however, there remains a desperate need for safe, direct, all ages and abilities active transportation alternatives extending into currently underserved residential (University) and employment centers (UTC, Sorrento Valley) to improve alternatives in this major transportation corridor. In order for SANDAG to stimulate the shift from personal motor vehicle use to people choosing to bike, a network of well-designed routes is essential. The City of San Diego's project on Gilman Drive is greater than 2 miles away from the Coastal Rail Trail Rose - UTC - and Roselle segments. Together these segments represent 6.2 miles of contiguous regional bikeways connecting to the existing Sorrento Valley Coaster Station, as well as future Transit Leap services.</p> <p>These projects and this alignment were first identified in the 2000 Coastal Rail Trail Project Study Report <a href="https://www.keepsandiegomoving.com/Libraries/Transnet-doc/Coastal_Rail_Trail_Project_Study_Report_reduced.sflb.ashx">https://www.keepsandiegomoving.com/Libraries/Transnet-doc/Coastal_Rail_Trail_Project_Study_Report_reduced.sflb.ashx</a> These projects were approved by the SANDAG Board of Directors In 2010 with the development of a comprehensive regional bike network - Riding to 2050: The San Diego Regional Bike Plan <a href="https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail</a> and again these Coastal Rail Trail segments were identified as a priority project in 2013 via the Bike Early Action Program (EAP) <a href="https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail</a></p>
W71	Christopher Guerrerri	U.S. Navy	<p>Please do no tax drivers per mile. I commute to Camp Pendleton from Eastlake Chula Vista, approx. 120 miles a day. I already survive off 1 military paycheck for a family of 3 and the gas alone is \$350 a month. Adding a tax on miles driven would absolutely bankrupt my family and I.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those commuting long distances, are paying more than their fair share, leveraging different mechanisms such as caps and rebates to ensure a fair system.</p>

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W72	Cindy C		Bad plan and expensive. Toss it out and start all over again. Tax payers will never approve it.	Thank you for your comment.
W73	Cindy Page	Crawford High School	<p>I am a teacher at Crawford High School and a supporter of Mid-City CAN. Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery.</p> <p>No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities.</p> <p>I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W74	Citlalli Mendoza	The San Diego LGBT Community Center	<p>I am a supporter of The San Diego LGBT Community Center, and I am writing to urge the Board to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>I believe that every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our region's equitable economic recovery.</p> <p>When young people have access to no-cost transit passes, they are better able to access school, work, medical care, and resources otherwise not accessible. From my experience, I know several youth who depend on public transportation to get to work and to their medical appointments. Especially during COVID, youth are depending on mostly themselves for mental health support and isolation, along with lack of parental support and little access to economic opportunities, makes that really difficult to stay connected and well.</p> <p>I urge the Board to take bold action to build a healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity Passes as a priority.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W75	Clara Zapata	Bayside community center	<p>He notado en las calles principales de mi comunidad que es Linda Vista necesitan senalamientos de limite de velocidad. Tambien he notado que los camiones publicos no respetan mucho los carros personales que manejan a su al rededor se meten sin fijarse que venga carro detras. ***</p> <p>I have noticed that the main roads of my community of Linda Vista need speed limits signs. I have also noticed that public buses have no respect for the personal vehicles driving around them, they merge without even looking if there is a car behind them.</p>	<p>Instalar letreros con los límites de velocidad y letreros de seguridad en las calles locales es responsabilidad de los departamentos de ingeniería de las agencias locales o de Caltrans en el caso de las autopistas. En Linda Vista, la agencia responsable es la Ciudad de San Diego o Caltrans en el caso de instalaciones del estado. Sus divisiones de transporte o de tráfico pueden ayudar. La seguridad es una prioridad para los operadores del transporte público de la región. Si se da cuenta de que existen condiciones de manejo inseguras, por favor contacte al operador del transporte público.</p> <p>Su comentario ha sido compartido con la ciudad de San Diego. ***</p> <p>Setting traffic speeds and traffic safety signs on local roads are done by local agency engineering departments or by Caltrans for freeways. In Linda Vista this will be the City of San Diego, or Caltrans for state facilities. Their transportation or traffic divisions can assist.</p> <p>Safety is a priority for the region's transit operators. If you witness unsafe driving please contact the transit operator.</p> <p>Your comment was forwarded to the City of San Diego.</p>
W76	Colin McDonnell	N/A	While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state

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			<p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
W77	Colleen dietzel		<p>Please make efficient, reliable and affordable public transportation, preferably electrified buses, your top priority. I support Environmental Health Coalition's and other respected groups demands which are: 1. Prioritize environmental justice communities who need public transit most 2. Improve the bus system now 3. Fund the Blue Line Express 4. Provide 24-hour service 5. Fund the Purple Line 6. Provide Youth Opportunity Passes for 24 and under 7. Electrify the bus fleet by 2030 8. Fund anti-displacement efforts 9. Provide bathrooms 10. Ensure an emergency ready transit system</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p>

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				<p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
W78	Colleen FitzSimons		<p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. I urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under and seniors will receive priority when Transit Fare Subsidies are allocated.</p> <ul style="list-style-type: none"> <li>- No-cost transit passes will connect youth and seniors to school, work, medical care, internships, and other early-career opportunities.</li> <li>- Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.</li> </ul> <p>I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority. Thank you.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p>
W79	craig a nelson	Nelson Financial Consulting Group	<p>Iky should be fired and sent back to LA. Waste of taxpayer \$\$. Nobody rides the train or the bus ....all EMPTY!! and you will never change it. Fill the potholes and widen the freeway. Y'all are dumber than a bag o rocks.</p>	<p>Thank you for your comments.</p>
W80	Craig Benedetto	NAIOP and BOMA San Diego	<p>NAIOP San Diego, the Commercial Real Estate Development Association and the San Diego Building Owners and Managers Association (AKA BOMA San Diego) appreciate the opportunity to review the draft regional plan. Both organizations will receive presentations in September, but wanted to offer some general comments in advance of those discussions. First, infrastructure improvements in our region are critical. Both organizations were supportive of the extension of the Transnet Sales Tax as a means to that end. As organizations providing jobs space to our region’s employers, we believe it is critical that goods, services and people are able to move freely to and from work spaces and encourage plans that achieve that end. Both organizations believe strongly in multi-mobility, but not necessarily to the detriment of transportation of cars and other vehicles. It is important, as our members have embraced electric vehicles, that these vehicles have the same ability to move around efficiently in our county as transit. A balanced mix of projects is critical to that end, particularly if any funding source requires public approval. Voters will demand projects that meet their needs, which was how the Transnet Extension was passed with over 2/3rds vote. Lastly, funding for these projects is certainly on the minds of our members. Impediments to economic growth in our region from overly punitive funding measures, particularly those that tax miles traveled could seriously hurt the movement of goods and services throughout the region, and ultimately lead to the increase in price for those very</p>	<p>The 2021 Regional Plan contains investments in many forms of mobility to enhance quality of life for all in our region. Our vision for an improved transportation network considers the needs of all travel modes in order to meet state and federal mandates on GHG emissions and air pollution, reduce congestion, and improve social equity. Please continue to follow along at <a href="http://SDForward.com">SDForward.com</a>.</p>



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			<p>goods and services. Additionally, these types of taxes could also impact workers, particularly those who can least afford it. Not everyone or every job can be accessed through transit. Autos provide critical flexibility to many, particularly when viewed against current transit availability and the long lead times to create a more functional system. We encourage careful consideration of funding that doesn't inordinately impact jobs creators, the employment spaces or the employees. The cost of living as well as operating a business in this region is already high, we should be careful not to make it significantly worse. We understand this is a delicate balancing act, and the need for investment in our roads and transit systems is strong. We look forward to further discussions about the plan and how to fund it when our organizations meet with SANDAG staff in the future.</p>	
W81	Craig Hanson		<p>I am a resident of Mission Hills in San Diego. I support the creation of a central Mobility Hub in either downtown San Diego or Old Town. We need to improve transportation to the airport, to San Diego neighborhoods and to the surrounding metropolitan area. The focus should be on forms of transportation that will minimize any negative impact on the environment, particularly climate change. The region also needs to expand its use of mass transit centers to provide for critical transportation needs of current and future San Diego residents and visitors.</p>	<p>The central Mobility Hub will provide direct connections to the airport and support all existing and planned transit modes.</p>
W82	Craig Hanson		<p>The San Diego region also has a serious need to substantially expand its supply of mixed income affordable housing, including both low and high density housing scattered throughout urban areas. Developers of multi-family housing should be required to set aside 20% to 30% of residential units for low-income households. The county also needs to avoid further development of residential and commercial buildings in high-risk wildfire areas.</p>	<p>SANDAG is currently developing a Regional Housing Incentive Program that will support the development and adoption of policies and process improvements to accelerate housing production for very low-income-, low-income-, and moderate-income housing while taking several factors into consideration to ensure the program meets the goals of the Regional Plan.</p> <p>California has experienced unprecedented wildfire damage in the last several years as climate change has increased temperatures and dried out land and vegetation. At the same time, the state is experiencing a massive housing shortage, which is driving up the cost of housing and forcing people to move farther away from job centers in search of more affordable housing. The connection between housing policy and climate change is clear. To mitigate wildfire risks, SANDAG will support the development of new homes through its Inter-Governmental Review (IGR) process to ensure that growth is consistent with the Regional Plan and is in safe in-fill locations such as existing urbanized areas and/or in Mobility Hubs that align with public resources to support the construction of affordable housing or in areas that are less impacted by wildfire risk and are not located in the Wildland Urban Interface (WUI)—the transition zone between uninhabited land and human development.</p>
W83	Craig Jones	Alliance for Regional Solutions	<p>We support approval of the draft RTP, and stress that a) Full and rapid implementation of flexible fleets access will be a key to achieving transportation equity for disadvantaged communities; please fund and advance flexible fleets projects in partnership with community agencies/CBOs to optimize equity and achieve social justice. b) Implementation of all components of the RTP should be geographically prioritized in disadvantaged communities to advance social equity. c) Climate change is real, and impacts disadvantaged communities first and worst. Aggressive measures to reduce GHGs are absolutely necessary, above and beyond the 20% measure expected via this regional plan. Land use sprawl must be ended and affordable housing promoted to also advance equity.</p>	<p>Improving social equity and reducing greenhouse gas emissions are primary goals for the Regional Plan. We also want to do more than achieving the greenhouse gas reduction mandates. Chapter 3 and Appendix B describe implementation actions. The first priority implementation action is to Apply the Social Equity Planning Framework to ensure that equity is considered throughout 2021 Regional Plan implementation. Other implementation actions focus on partnering with communities to implement Flexible Fleet services, climate action planning, affordable housing, and land use planning in support of these goals.</p>
W84	Craig Jones	Alliance for Regional Solutions	<p>My comments are specific to North County. In North County, for there to be a meaningful alternative to the private auto, there must be public transportation which is as fast or faster than using a car, and which is frequent enough. The draft RTP plans for North County will not accomplish this. There must be NextGen Rapid Bus which not only is fast north/south, but also east-west; the draft RTP Rapid Bus routes currently planned are circuitous, not connected from Oceanside to Escondido, and it will take about an hour to use bus service between these two cities, then add on (hopeful) flexible fleet time at both ends. It takes about 20 minutes to drive between Oceanside and Escondido points, door to door. I am informed that NCTD has asked that Rapid Bus not "compete" with the Sprinter, but even with improvements the Sprinter will take about an hour to connect between Oceanside and Escondido. There MUST be better Rapid Bus service which will compete in time with the private auto. Please amend the RTP plan to accomplish this.</p>	<p>The North County Comprehensive Multimodal Corridor Plan (CMCP) work is digging into the finer details of what is proposed in the Regional Plan, and may propose additional Rapid Routes.</p>

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W85	Dan Gallagher		I did not see anything in the Regional Plan on Public Health and the Built Environment. Given we are in an ongoing pandemic it is important to discuss how CDC protocol may affect mobility access.	Appendix T: Network Development and Performance includes modeled performance analysis. Public health measures in this analysis include particulate matter exposure and transportation related physical activity.  SANDAG relies on partner agencies for tracking public health benchmarks, including the San Diego County Air Pollution Control District, San Diego Food Systems Alliance, and Health and Human Services Agency.
W86	Dan Gallagher		In order for EV's to gain widespread adoption charging stations must be available in the parkways of all public sidewalks esp. in dense urban neighborhoods where most park on the street and don't have access to a garage. Charging stations integrated into street lights may work.	The Regional Plan supports investments in the electrification of cars, trucks and buses and their supporting infrastructure. Appendices A (Table A.17) and B address SANDAG's proposed EV commitments. For light duty vehicles, SANDAG plans to invest \$45 million by 2025 and a total of \$270 million by 2050 for EV charging station incentives. On-street charging is currently eligible for the EV charger rebate program, CALeVIP San Diego County Incentive Project. SANDAG will review future program phases to enable inclusion of on-street charging is an option, including chargers integrated with streetlights.
W87	Daria Flores	SanDiego350	I would like you to write into the plan specific, measurable language that would guarantee that fares will be affordable for low income residents. Student, senior, and young adult discounts are a good start, but this is not enough.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W88	dave nicolai		We sure have a lot of "Karens" around here whining about the inconvenience of sharing the road with other means of transportation (FB page) Those are the ones that need to get off their fat a**** and move a different way. I'm not a complete fan of your plan, especially with the class IV bikeways going in on 30th, 4th and 5th. As a seasoned commuter (i use my bike for a good amount of errands, & also own a car), I feel less safe using those lanes, and will choose to use other streets that have not been modified. If you look at Cardiff, and in Honolulu (King St.), there are plenty of pitfalls by putting up this type of layout.	Thank you for your comment.
W89	David Breidenthal		I generally like the regional plan and appreciate the emphasis on transit options. In an ideal world we could finally begin to approach even a hint of the San Diego electric railway of the 1920's and 30's. I think we should focus less on self driving cars as that doesn't really fix the parking and congestion issues we see on the roads. Average occupancy for a car is 1.6 people regardless of whether or not it drives itself. We need to avoid becoming a city of Parking lots and instead encourage people to take various other transit options as our network becomes better Integrated. I look forward to the Regional Plan coming to fruition, keep up the good work despite they naysayers who want nothing more than highway lanes and unlimited land to park on. A better, cleaner, more integrated and walkable city is possible	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W90	David Williams II	Personal	NCTD needs a lot of help, very unreliable. Must have one hell of a Union for what I've seen in the last 6 years. I would really like to speak to someone about it	Thank you for your comment.  Your comment was forwarded to North County Transit District (NCTD).
W91	dawn saad	self	It concerns me about how the \$0.02/mile will be assessed. The mileage specifically has to be within the country, the state and county. This means specific GPS tracking and record logging. This seems to be a direct violation of privacy. Will every car be equipped with the SW and connection necessary to obtain the exact mileage and the exact measurements of county/state/country lines? how will the mileage be obtained? There is concerns about the people who don't live in CA or SD county, how will they be assessed? Have you considered that there are many people who volunteer and required their vehicle to do so? I ask because there are many who drive people to/from appointments and grocery stores, because the folks don't have a car, cannot drive, and/or mobility issues. Many of these people cannot afford other means of transportation) There will be a reduction of desire to drive around and help others. This is yet another way to neuter the volunteer forces from being able to serve when more of the donated money will have to go to the government (the \$0.02 mile) just to keep the activities running. The government will also have to spend more \$ on getting these elderly and infirmed people to their appointments.	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.  The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure

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W92	Deborah McDaniel-Lindsey	La Mesa First United Methodist Church	Environmental justice must be embedded in our mobility in San Diego. Therefore, I ask that the 10 Big Moves to Transportation Justice be included in the 2021 Regional Transportation Plan. I listened to regular riders of the City Heights Community and they clearly explained how they felt their transportation needs have been slighted. I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion.	<p>that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p> <p>The Mid-City Trolley Line (Purple Line) is included as the first major new rail project in the Plan and will serve the north-south travel needs in Sorrento Mesa, National City, Kearny Mesa, and University Heights. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is completing a more detailed ridership analysis of this route. The analysis is studying an alignment that would include stations in City Heights and at San Diego State University (west campus). Also, transit subsidies are a component of the proposed Final Plan and implementation of those subsidies would include a consideration of low-income and youth populations.</p> <p>Additionally, Rapid services are planned that can use dedicated roadway space to increase speeds and avoid congestion. The vast majority of these Rapids also are planned in near-term phases of the Plan.</p>
W93	Delia Contreras	Voluntaria Independiente de la Comunidad De City Heights and Voluntaria de Hoover High School	<p>Autorizacion par pases no costo para jovenes y niños en edad escolar ( estudiantes ). *** Authorize free passes for school aged youth and children.</p>	<p>Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio permitirá que las partes interesadas públicas tengan la oportunidad de expresar su opinión sobre las alternativas. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los jóvenes menores de 19 años. ***</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W94	Denise Mc Andrews	Poway Unified School District	Please keep in mind that we need public transportation to connect adults to schools and community-based organizations that provide career education and language classes as well as supports. In San Diego County, there are several adult schools that are part of the overall education system. Poway Adult School, for example, is located on Twin Peaks Road. But, there is not currently a public transportation option to (or close to) the Adult School.	<p>We would like to refer you to our Data Viewer on the SDForward website (<a href="https://sandag.maps.arcgis.com/apps/Cascade/index.html?appid=897af882e8c14b1e996c33e48bc15347">https://sandag.maps.arcgis.com/apps/Cascade/index.html?appid=897af882e8c14b1e996c33e48bc15347</a>). There, you will find through the Regional Plan, Twin Peaks Road, which connects to the Poway Adult School, is part of our Complete Corridor Regional Arterials. Complete Corridors are designed to provide priority access for transit and Flexible Fleet shared ride services on our regional arterials and provide safe and comfortable transportation options to get people to their destinations safely and efficiently.</p> <p>For more details on Complete Corridors, please see Chapter 2: Sustainable Communities Strategy of the 2021 Regional Plan. Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>
W95	Deron Bear	Marian Bear Natural Park Advisory Group	<p>The Marian Bear Natural Park Community Advisory Group has the following comments regarding the Regional Transportation Plan (Draft, 2021): Project ID CC004 CC085 CC086 CC003 CC004 CC028 CC039</p> <p>All these projects involve additional freeway lanes or connectors between lanes bordering Marian Bear Memorial Park. In addition, portions of Project AT119 involve constructing a bike way along SR-52 adjacent to the</p>	<p>Many of the complete corridor projects in the draft plan utilize existing right-of-way, and in many cases existing roadway shoulders without encroaching into any additional land. This will greatly reduce environmental impacts, speed project delivery, and reduce costs. Where this is not an option additional project specific outreach and engagement will be conducted with affected residents and stakeholders. This process aims to develop projects with minimal impacts. For clarification a few of the projects listed aren't adjacent to Marian Bear Natural Park. CC004 and CC003 are along Interstate 5, CC039 is along SR 163, CC085 and CC086 are managed lane connectors between Interstate 805 and SR 52.</p>

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			<p>Park.</p> <p>1. We oppose any encroachment on Park property that violates the terms of the Multiple Species Conservation Act applicable to Marian Bear Natural Park. This includes widening of existing lanes and “spot” widening associated with lane connectors.</p> <p>2. Mitigation of environmental impacts of construction needs to consider off-site impacts on wildlife from noise, light, and habitat disruption in Marian Bear Memorial Park.</p> <p>3. Habitat adjacent to park boundaries affected by construction must be replaced using appropriate materials conforming to the Marian Bear Memorial Park Natural Resources Management Plan. This includes freeway embankments bordering the Park.</p>	
W96	Desdemona Aviña		<p>I am a supporter of The San Diego LGBT Community Center and I am writing to urge the Board to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>I believe that every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our region’s equitable economic recovery.</p> <p>When young people have access to no-cost transit passes, they are better able to access school, work, medical care, and resources otherwise not accessible. As a low income student, transportation is one of the largest obstacles that I face. A free youth pass would advantage me and my peers who would be able to serve our community due to the opportunity of transportation. As an environmentalist, public transportation is a service that I respect and love. I know that many youth are dissuaded to use this amazing service because of the cost. A free youth pass would encourage more use from public transportation.</p> <p>I urge the Board to take bold action to build a healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity Passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W97	Dheman Suldan	Nile sisters development initiative	<p>Amazing projects specially the affordable housing.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W98	Diego Olivera		<p>This is unfair to those with low income and can’t afford an expensive apartment or house in San Diego that’s close to work. They’re forced to live in lower income areas far from San Diego and have long commutes.</p>	<p>SANDAG recognizes the need for more affordable housing for people of middle- to low-income households that are near employment centers and a variety of transportation options. SANDAG is currently developing a Regional Housing Incentive Program that will consider climate change, climate resilience, and consistency with the transportation improvements and land use goals included in the 2021 Regional Plan.</p>
W99	Diego Soto Lopez	Gompers Preparatory Academy	<p>Barry mentioned during the zoom meeting that we need to spread the word and idea of sustainable transportation for students. I believe the best way to achieve this is through a school announcement during school hours for all of the people at Gompers to hear. This announcement can take place in the morning before students go to their classes and whilst all the students are lined up waiting to enter campus. We can also pass out flyers or cards with this info at the school entrance. Maybe we can even set up a presentation at our school assembly presenting all of this information.</p>	<p>Sustainable transportation is a key component of the 2021 Regional Plan and public engagement is critical to a successful plan. Appendix G of the 2021 Regional Plan includes the Public Involvement Plan and details the strategies used to consult with the public. Additional engagement will be conducted as elements of the plan move forward to its implementation phases.</p>
W100	Dionne Nguyen	The Urban Collaborative Project	<p>I am an intern working at The Urban Collaborative Project. Last Wednesday at the transportation meeting with SANDAG, community members voiced their concerns about transportation issues within their neighborhoods. Some of the topics that were brought up in our discussion include but are not limited to bus frequency, traffic and bus routes, the digital divide with smart infrastructure, broader sidewalks, traffic congestion, accessibility accommodations. Community members are seeing transportation changes in their neighborhoods and are offering their thoughts on what is changing. This is just a sliver of the concerns that they would like to be addressed going forward.</p>	<p>The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. Also, the Plan includes Complete Streets improvements to address sidewalks and accessibility accommodations.</p>
W101	Dionne Nguyen	The Urban Collaborative Project	<p>On behalf of the District 4, Southeast San Diego community that UCP represents, we ask for the following to be a part of your 2021 Regional Plan: better bus frequency, bus routes in more neighborhoods, broader and more accessible sidewalks, a roundabout on Euclid and Imperial St</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of</p>



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			(and other busy intersections), request for a Mobility Hub in our community located at our current Orange line trolley station, MTS youth passes for youth up to 24 years, fiber optics underground to ensure that our communities are ready for the state of the art transportation system that is currently being designed, coverings on our MTS bus stops (structures), consider 24-hour service on the lines that are taking residents to work, focus on transitioning to all-electric buses in the 2-3 years of implementation, improve the frequency and reliability of our bus routes, ensure all out our streets are designed with the “complete streets” design.	<p>approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p>
W102	Doaa Polus	El Cajon Collaborative/Barrio Logan College Institute Parent Arabic	I like the idea of car sharing, especially Smart cars or Zip cars. Since many refugees do not have more than one car, it would be wonderful to have a car to use to grocery shop, run errands and visit friends. I also like the idea of a shuttle. I approve. Thank you.	Flexible Fleet services like carshare, on-demand ridehailing, and micromobility provide greater options for different trips and needs. The Plan will expand the availability of these services in the Region, helping to reduce the reliance on owning a car to move around the region.
W103	Don Wood	San Diego Waterfront Coalition	The updated RTP needs to be far clearer on how SANDAG proposes to pay for implementing it, with explicit discussion of potential funding sources, funding strategies and plans to work with each of the funding sources to procure long term funding for all the new transportation elements of the new plan.	The Cost Estimation Methodology and Funding Strategies for the RTP were presented to the SANDAG Board of Directors on March 12, 2021, Item No. 8B. This report and presentation described the various funding assumptions developed for the draft 2021 Regional Plan. The entire Board meeting can be found at <a href="http://www.sandag.org">www.sandag.org</a> .
W104	Donna Stabe		Your transportation plan is flawed on every aspect of the proposal. San Diego is way to spread out to have a successful mass transit hub. We are not willing to spend hours and hours and transfers to get to our final destination. Expand our freeways. We do not have any carpool lanes in the east county. How dare this entity propose to charge us to drive our cars on roads and have several sales tax increases to dump additional millions of dollars into the ridiculous plan. How about this challenge. Starting in July 2021, ALL of you sell your cars and start using public transportation to get around. Let’s start with your transportation Czar and Nathan Fletcher, his wife and any Board of Supervisor who is supporting this plan. Then all City Council members do the same thing. Be the example. Also, use public transportation late at night. Let’s see how safe you feel. Be sure to bring your loved ones too. Get their feedback in using this ridiculous transportation mode.	Thank you for your comments.
W105	Eddie Meyerholz	Landscape Architecture Grad Student	From the map on page 23 there seems to be a lack of “Off-Street Bikeways”, especially in disadvantaged communities south of I-8, that connects to existing & planned Off-Street Bikeway infrastructure. It would also be great to see more Class 1 biking corridors that connect to existing and planned Commuter and Light-Rail transit systems.	<p>As an early action out of the Regional Plan, SANDAG will be developing a new Active Transportation Plan. The plan will take a fresh look at the network and the options to make it safe and comfortable to use active transportation. SANDAG prioritizes community engagement and will develop these connections in partnership with the community so that we can make sure the routes take people where they want to go.</p> <p>As each of these transportation projects moves forward there will be a great deal of planning, engineering, and design work ahead of the project’s construction. In the future there are opportunities for bike, pedestrian, and neighborhood safety projects like these you mentioned in conjunction with the RTP’s transportation projects. The</p>

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				Current Community Planning Projects are a good example and I strongly encourage you to be involved in the South Bay to Sorrento project see more info here: <a href="https://www.sandag.org/index.asp?subclassid=83&amp;fuseaction=home.subclasshome">https://www.sandag.org/index.asp?subclassid=83&amp;fuseaction=home.subclasshome</a> .
W106	Edna Diaz		You have lost your minds to propose a tax for each miles driven. You have done nothing to even take care of our local streets and now you want to add taxes to “add public transportation”. If this passes, you will have an exodus from San Diego. Ridiculous!!!!	The road usage charge included in the 2021 Regional Plan is consistent with the statewide transportation plan developed by Caltrans. The Regional Plan is a long-range planning document that requires regular updates. A minimum of two more Regional Plans will be completed with updated information prior to the planned implementation of the road usage charge in 2030. Currently funding based on fossil fuel use is not sustainable as the state transitions to new fuel technologies. Maintenance, repair, and operations needs for the safety and efficient movement of people and goods remain despite changes in fuel technologies.
W107	Elaine May		The idea of a road usage tax is ridiculous. And the way Todd Gloria “cloaked” the issue, saying Tesla and other cars will pay their fair share is stupid. Put this to the people of San Diego to vote on and just see how far this gets. Tax paying residents are tired of the dumb ideas, ESPECIALLY from money-wasting SANDAG.	Thank you for your comment.
W108	Elizabeth O’Shea-West	Vista Adult School	Support Flexible fleets and quicker routes for our students to get to school and to work.	The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. These services will help people better access school and work.
W109	Ellen McCann		I am urging SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated. I am 58 and have been riding buses my whole life and don’t own a car. Let’s step up our bus game.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.
W110	Elyse Dilloway		The proposal for taxing mileage driven by San Diegans each fiscal year seems unfair to those who have to travel for work because they live in more affordable areas, or people such as delivery drivers or rideshare drivers. Undoubtedly this proposal will meet public distaste, especially if the aforementioned affected groups of people don’t get a proper chance to make their voices heard.	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.  The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.
W111	Emerito Barrientos	n/a	Very satisfactory.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.
W112	Emilia Castillo	Platicando Con Mi Gente	Who will be held accountable to get the services we need in the South East San Diego transit lines?	The Regional Plan includes frequency increases on most of the 14 routes in the South East San Diego area. A new table has been added to Appendix A showing the increases for each route.
W113	Emiliano Benitez		Reliable and free transportation for all the youth of San Diego is crucial to the well-being and overall improvement of families across the city. Young people shouldn’t have to pay to get to school or work or anywhere in the city on public transportation.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway,

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				staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.
W114	Emily Barnes	N/A	Could some areas become hourly based for carpool lanes? Like they have on the 14 fwy in LA? During the hours of 10am-1pm nobody uses the carpool lane and the other lanes congest quickly.	The Managed Lanes concept envisioned in the Plan, provides the opportunity to dynamically manage the lanes based on real time conditions, time of day, and vehicle occupancy, to make all lanes more efficient and provide benefits to the system as a whole.
W115	Emmet Farrell	Creation Care Ministry, Catholic Diocese of S. D.	I call for an electrified bus fleet by 2030. Fund the implementation of California's Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources	The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a> .
W116	Emmet Farrell	Creation Care Ministry, Catholic Diocese of S. D.	I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.	The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.
W117	Emmet Farrell	Creation Care Ministry, Catholic Diocese of S. D.	I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.	SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
W118	Emy Bernardo		I strongly oppose this 163 billion dollar plan. We do not need to "reimagine transportation" and this should NOT be paid for by a user fee or mileage tax. You are going to make San Diego even less affordable and hurt the people you supposedly trying to help with this plan. Face the reality that everyday San Diegans that have jobs and families do not want to use public transit, nor is it practical. How is that we have the highest gas taxes in the country and the roads are horrible?	Thank you for your comment.
W119	Eric Berry		Appendix does not list making Laurel Street an airport priority roadway and building new ramps to I-5. Is this no longer part of the concept or is it included in something else?	Appendix A includes a grouped collection of priority airport roadways. These improvements include: Convert Laurel Street to Primary Airport Entrance/Exit Roadway, Modify Laurel Street between Pac Highway and I-5, and Install new I-5 Freeway Ramps at Laurel and Redwood St.
W120	Eric Berry		There really needs to be new interchange improvements on the 67 south to 8 east connector and 8 west to 67 north connector. On both of these connections, traffic regularly backs up for a mile due to merging from Mollison Ave on the 8 west side and due to merging from Magnolia Ave and Mollison Ave on the 67 south side. This merging, slowing, and backup frequently causes accidents.	No reconstruction of existing interchanges is currently planned at SR 67 and I-8. However, at the project development stage (which follows the Plan), alternatives and access will be reviewed for the Managed Lane improvements that are included in the Plan and connect to at and through these interchanges.  Your comment was forwarded to Caltrans.
W121	Erika Brooks	SoCal Pre Apprenticeship Program	Eager to learn about the progress of transportation for the future and open to understanding how I can play a role in project's progress.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W122	Esther Brasmer	La Mesa First UMC	I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr service on popular transit routes and present a clear implementation schedule.	The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.

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W123	Esther Brasmer	La Mesa First UMC	I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets.	The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.
W124	Etelvina Tinoco	Elac	<p>Es importante que ayuden a los jovenes y adultos mayores con el costo reducido del transporte , con un veneficio hasta los 25 años .</p> <p>***</p> <p>It is important to help young adults and seniors by reducing the cost of transportation and provide this benefit until they are 25 years old.</p>	<p>Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio asegurará que las partes interesadas públicas tengan la oportunidad de expresar su opinión sobre las alternativas. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los jóvenes menores de 19 años.</p> <p>***</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W125	Eve Simmons	TheGreenFlash.org	Please be proactive and mindful of our shared environment and the implications of all of your decisions. Please do all you can to foster the availability of clean, local, solar/wind/renewable energy. Please lessen plastic pollution, and other toxins in our air, earth, and water. Your actions matter.	The 2021 Regional Plan includes a Sustainable Communities Strategy (SCS), as required by California Senate Bill 375 (Steinberg, 2008) (SB 375), for the San Diego region. This SCS describes coordinated transportation and land use planning, and identifies Priorities for Adaptation Planning, which include serving as a resource for local agencies' Climate Action Planning efforts and the general public on the impacts of climate change. When combined with the transportation network, the SCS exceeds the state's target for reducing per capita GHG emissions set by the California Air Resources Board.
W126	Fabiola Torres	National Latino Research Center	<p>Mis ninos usan el train, quier mas suiguridad. Espero que este plan realmente suceda. Hemos tenido tantas reuniones con escuelas y otras organizaciones, para brindar comentarios y sugerencias para nuestras comunidades, pero nunca completaron su promesa. No hemos visto ningún cambio aquí.</p> <p>***</p> <p>My children use the train, we want more security. I really hope this plan succeeds. We have has so many meetings with the schools and other organizations, to present ideas and suggestions for our communities, but they never fulfilled their promise. We haven't seen even one change here.</p>	<p>SANDAG, MTS y NCTD creen que se puede hacer más para mejorar la seguridad en y cerca del transporte público y están trabajando para implementar estas mejoras ahora y en el futuro. Por ejemplo, MTS está reasignando parte de los fondos asignados a la seguridad que usualmente se usan para monitorear el pago de las tarifas a mejoras de seguridad. SANDAG trabajará arduamente con la ayuda de todos nuestros pasajeros y representantes para asegurar que este plan sea implementado.</p> <p>***</p> <p>SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements. SANDAG will be working hard with the help of all of our passengers and representatives to ensure that this plan gets implemented.</p>
W127	Fatima DaSilva	Nile Sisters development initiative	I think this would benefit my community tremendously especially with housing needs for people around the community.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W128	Fatin Amjad	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- The plan is so beautiful and El Cajon will be so much better if it is successful. I wish to see signs and information about the buses and trolley in Arabic. We would like a free train (shuttle) or car (Zip cars) for low-income families to use.	<p>SANDAG will be applying a social equity planning framework throughout the implementation of the Regional Plan. Through this process, SANDAG will be working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are available to all San Diegans. In addition language accessibility will be considered as a key factor when planning and designing the Next OS in order to improve access and travel options to all San Diegans.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services such as the trolley. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth. You can find more information on the Regional Fare Impact Study also in Appendix B. In addition, the 2021 Regional Plan envisions subsidized</p>



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				<p>microtransit services to ensure all residents can benefit for new services like these.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>
WI29	Fatin Amjad	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- We had a great time listening to the presentation of the Regional Plan that the society really needs. We wish you can put all instructions on buses and trains (trolley) in Arabic so we can use them more. We wish there was a free bus (shuttle) in El Cajon similar to what they have in San Diego.	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services such as the trolley and bus shuttles. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth. You can find more information on the Regional Fare Impact Study also in Appendix B.</p>
WI30	Fatin Amjad	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- In fact, this workshop was so good and useful for all El Cajon residents. By implementing this Plan we wish we could have information in Arabic and classes on how to use transportation. We also wish some free transportation for usage for Smart cars.	<p>SANDAG will be applying a social equity planning framework throughout the implementation of the Regional Plan. Through this process, SANDAG will be working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources for transportation services are available to all San Diegans. In addition language accessibility will be considered as a key factor when planning and designing the Next OS in order to improve access and travel options to all San Diegans.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services such as the trolley. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth. You can find more information on the Regional Fare Impact Study also in Appendix B. In addition, the 2021 Regional Plan envisions subsidized microtransit services that include shared vehicle services to ensure all residents can benefit for new services like these.</p>
WI31	Fatin Amjad	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- Hi all. The subject we talked about on buses and trains (trolley) is very beautiful plan that was suggested. It will help us go further places and know our city more. I wish there were some classes on how to use transit in Arabic so we can know how to use the transportation and purchase tickets.	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as purchasing tickets in Arabic) and translated educational resources on transit are available to all San Diegans as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p>
WI32	Fatin Amjad	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- Hi all. We want this beautiful train project (El Cajon) we talked about and the buses to be the easiest way to travel in the future. We wish there were some classes to help us use transportation is Arabic and then we can have more information on how to use them. Thank you very much for that what you are doing for us.	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p>

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W133	Fatin Amjad	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- New apartments are very important in El Cajon. We wish that times and places of buses and trains (trolley) in Arabic and then we can use them. We wish to keep roads safe for everybody and we wish we had free transportation for the elderly and poor.	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations and educational resources on transit as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan and Regional Fare Impact Study.</p> <p>The plan will also implement safe streets at the local level through Mobility Hubs, which will provide safer and comfortable spaces for people of all ages and abilities get to their destinations. Mobility Hubs will be centers of activity where transportation investments of the Regional Plan will come together along with strategic decisions about land use, including providing housing near transit with programs such as the Regional Housing Needs Assessment Plan (or RHNA Plan). To learn more about the plan’s Mobility Hubs and the RHNA Plan, please see Chapter 2 on Sustainable Communities Strategy.</p> <p>Lastly, the plan will implement a near-term Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, youth, and students.</p>
W134	Fatin Amjad	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- 1) The plan is beautiful. 2) We need more information and schedule for train (trolley) in Arabic. 3) I support idea of free bus transportation for low-income. 4) We need classes on how to use bus and train (trolley) and how to use roads (freeways). 5) I love the idea of putting buses (rapid) in special lanes in the freeway. 6) I hope you remove bumps (potholes) from the roads because it is an obstacle. 7) Lexington St. in El Cajon needs maintenance for potholes and bumps.	<p>SANDAG will be applying a social equity planning framework throughout the implementation of the Regional Plan. Through this framework, one of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations and educational resources on transit are available to all San Diegans as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan and Regional Fare Impact Study.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study to This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth.</p> <p>In Appendix U: Cost Estimation Methodology, Table U.2 captures the transit fare subsidies to riders throughout FY2026-FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U.</p> <p>Lastly, SANDAG will create a framework, called the Fix it First Strategy, which aims to repair our region’s existing roads and develop long-term maintenance of our transportation network. More detail can also be found in Appendix B.</p>
W135	Francine Maxwell	Naacp San Diego branch	Hi I need every bus stop to have shelter on it a full shelter or designed. We need bus passes for low income youth and seniors free to very discounted. Traffic calming in Southeastern San Diego.	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. Bus shelters are provided wherever there is sufficient right of way to locate them.</p>
W136	Francisco Guitron		I’m against the plan of charging drivers for using our roads. As somebody that struggles financially I can’t afford for more charges that doesn’t benefit everyone equally. I’m a student, hard worker, an independent person that does not have any type of financial support. The	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on</p>

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			<p>struggle paying for school, rent, food, health and basic needs is great. The stress that it creates trying to survive under the system that is clearly unequal for San Diegans is huge. And as me I know there are thousands of individuals and families with the same struggle as me. I totally oppose to this action to be taken. Our community should make use of democracy and vote for or against this action. NO! To this unfair plan.</p>	<p>calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources. The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W137	Frank Norton		<p>I oppose the proposed high-speed rail system as described in San Diego Forward: The 2021 Regional Plan for the following reasons:                      1) Too expensive--even assuming that the system can be completed at its current estimated cost. Plus, these types of projects are always more expensive that anticipated, e.g., California high-speed rail.                      2) Mandating high-density neighborhoods. That the envisioned high-speed rail requires imposing high-density zoning is proof that the plan has not been tailored to the needs of San Diego county. It is like requiring everyone to buy carts because you have horses to rent. I am not against high-density neighborhoods per say. Rather, SANDAG should not impose zoning and density rules on local communities. Local communities know what is best for them.                      3) Reduction in greenhouse gases (GHG) may be less than projected. Chapter 1 (page 7) states, "41% of GHG emissions come from passenger cars and trucks." However, electric vehicles are coming. By 2040, most passenger vehicles will likely be electric, drawing into question the Plan's estimate for high-speed rail's reduction in GHG. Just today President Biden signed an executive order to encourage the increase of electric-vehicle production to 50% by 2030.                      4) Fully-autonomous vehicles are coming. Instead of a high-speed rail system that requires high-density neighborhoods to ensure sufficient ridership, fully-autonomous vehicles could form the basis for a distributed transportation network that would go to where residents want to live, not where they need to live to make the high-speed rail viable.                      5) Obsolete before it is made. Widespread adoption of telecommuting and fully-autonomous vehicles plus other, currently unimagined, innovations may make the planned high-speed rail system obsolete before it is completed.                      In the end, the envisioned high-speed rail system is an update of the Shinkansen, Japan's bullet train that first went into service in the 1960's. SANDAG should look for 21st-century solutions, not attempt to update solutions from the last century.</p>	<p>The 2021 Regional Plan's Commuter Rail system is planned to be different than California's High Speed Rail, proposing speeds up to 110 MPH using vehicles that are zero-emission. Land use and zoning authority is reserved to local jurisdictions, however, SANDAG encourages cities to densify where transit is planned. State law does not allow regional plans to take credit for the GHG emission reductions resulting from the changeover of gas-powered vehicles to electric, therefore the 2021 Regional Plan outlines additional ways for the San Diego region to meet state mandated GHG reduction targets (increasing transit and other modes capacities to encourage mode shifts from solo driving to these alternative modes).</p>
W138	Fred Brown		<p>Those of us who were here in North County 40 years ago remember how wonderful it was before all the traffic congestion, the noise and pollution, the crime and high taxes. Population growth has been ruinous to North County. Growth is not progress; it's not progress when you make things worse, and things are worse. The developers have paid off the City Council members and the Board of Supervisors. It is called campaign contributions, in other words, legalized graft. The politicians benefited and the developers benefited and the residents suffered. We do not have enough water for the population we now have and the politicians are still thinking in terms of growth. We have enormous waste disposal problems, what do we do when the land fills are full ? The wild life has been destroyed, most of it is gone. Growth is not progress.</p>	<p>The County Water Authority is the agency responsible for projecting water needs in the region and their projections use the SANDAG Regional Growth Forecast as an input to their modeling effort.</p>
W139	Frederick Simson		<p>I see a greater need for more public education outlining responsibilities of individual motorists, bicyclists, and pedestrians in regards to their interactions with each other within the shared network. These 3 components do not "play well together" as each claims superiority over the others. ALL are breaking rules assumed to be followed by the planning hierarchy. New constructs such as North Park's round-about traffic circles are foreign to local users who cannot grasp the concept of "Yield". I would triple the size of the Yield signs and reduce the size of the circular arrows. Motorists are confused by the absence of stop signs.</p>	<p>SANDAG is actively working on developing an outreach program for all roadway users focused on the projects being constructed in the Regional Bike Early Action Program. We have received a competitive State Active Transportation grant to develop and implement and education and outreach program that is beginning soon.</p> <p>Your comment was forwarded to the City of San Diego.</p>



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W140	G King	Local Citizen Taxpayers	<p>SANDAG has not followed the law or provided representative government. You ignored &amp; failed your obligation made by promises from funded ballot measures to provide additional freeway lanes for commuters in single occupant vehicles &amp; work trucks.</p> <p>You intentionally depleted the funding by using it solely for mass transportation, HOV &amp; toll lanes, your outrageous salaries &amp; pensions, and self promotion.</p> <p>SANDAG ignores the new situation that was forced upon us by the Covid-19 Pandemic, which makes mass transit unusable due to respiratory-disease transmission.</p> <p>Mass transit has also become dangerous due to the skyrocketing crime rate. Trolley stations are hot spots for crimes like assault, robbery &amp; murder.</p> <p>People need &amp; want the freedom to own their own vehicle and move about freely. We can't spend 2 1/2 hours to get somewhere that only requires a half hour drive. We can't walk miles to &amp; from bus stops to work or carry enough bags of groceries on a train, trolley or bus.</p> <p>We refuse your oppressive gas taxes, tolls, and per mile charges! We already pay the highest gas taxes in the country, but it's never enough to satisfy you. Your social engineering repulses us. You spend &amp; waste billions of our tax dollars without being accountable or following the law.</p> <p>Seniors can't afford to live here if you get your way, but you would force grandma into danger &amp; poverty. You are truly heartless.</p>	<p>Transit Leap greatly increases transit speeds, frequency, and span of service providing a compelling alternative to driving. Flexible Fleets help address access to transit facilities and travelers' final destinations. Complete Corridors with continue to provide mobility and access to all modes throughout the region.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p> <p>Oversight of public agencies is important and SANDAG welcomes public review of its work and processes. Federal and state agencies regularly review SANDAG and there are two ongoing local oversight processes with the Office of the Independent Performance Auditor and the Transnet Independent Taxpayers Oversight Committee.</p> <p>SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.</p>
W141	Gary Clasen		<p>Safety concerns in East County: Traffic on 125 and 152 not to mention hwy 67.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Continue with the current plan. Do not pull already approved east county projects.</p> <p>Projects that should be a priority for SANDAG: Hwy. 52 and 125.</p>	<p>The 2021 Regional Plan includes a managed lanes network proposed for SR52 and SR125 and supporting managed lane connectors, included in Appendix A. The Plan includes three phase years, 2025, 2035 and 2050. SR52 between I-805 and Mast Blvd and SR125 between Jamacha Rd and Amaya Dr. are proposed for 2035. Additional managed lanes segments on both State Routes are proposed for 2050.</p>
W142	Gary Clasen		<p>Safety concerns in East County: HWY 67.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: IMPROVE HWY 52 &amp; 8 &amp; 67.</p> <p>Projects that should be a priority for SANDAG: 52 &amp; 8 &amp; 67.</p>	<p>State Route 67 is slated for roadways improvements: shoulder widening and straightening improvements from Maplevue to Dye Road in the 2021 Regional Plan's phase year 2035.</p> <p>For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a></p>
W143	Gary Clasen		<p>Safety concerns in East County: 67 and 52 freeway fix promises need to be met. Public transportation is not safe.</p>	<p>The 2021 Regional Plan includes managed lanes network for SR52 and supporting managed lane connectors, included in Appendix A: Transportation Projects, Programs and Phasing. The Plan includes three phase years, 2025, 2035 and 2050. SR52 between I-</p>

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			<p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Drone transportation. Explore replacing a substantial part of the transportation energy (electric and fossil fuel) by investing in nuclear energy transportation solutions.</p> <p>Projects that should be a priority for SANDAG: Overdue freeway fixes. Transportation that focuses on public safety.</p> <p>Additional questions and public comments: Fund safe and clean transportation before building new infrastructure for low ridership.</p>	<p>805 and Mast Blvd is proposed for 2035. SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements. SANDAG and Caltrans are currently preparing Comprehensive Multimodal Corridor Plans that includes both corridors which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor.</p> <p>The Plan also includes near-term and continuing actions to expand regional programs on low-carbon transportation options, roadway safety and maintenance, and nature-based climate solutions.</p>
W144	Gary Clasen		<p>Safety concerns in East County: Highway 67.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Focus on creating economic hubs in the East County Region to lessen traffic on the freeways. Focus on other goals than trolleys, buses and bike lanes. These goals do not meet the needs of East County. You goals should be to meet the needs of each region, not just along the hwy 5 corridor.</p> <p>Projects that should be a priority for SANDAG: Highway 67. Develop alternative solutions that will reflect our needs. Realize the needs in each region are different, but as equal to all project on the west side of hwy 5. Re-prioritize Hwy 67 to meet immediate needs, do not postpone until 2035, which will be too little, too late.</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor.</p> <p>The 2021 Regional Plan includes Mobility Hubs for East County which can facilitate creating additional economic opportunities within that hub. Mobility Hubs are communities with a high concentration of people, destinations, and travel choices. They offer on-demand travel options and supporting infrastructure to enhance connections to high-quality Transit Leap services while helping people make short trips around the community on Flexible Fleets. Mobility Hubs vary in their size, needs, and services being unique to each community.</p>
W145	Gary Clasen		<p>Safety concerns in East County: The 67/Mapleview intersection continues to be dangerous - likewise the proposed removal of lanes on Woodside Ave to convert them to bike lanes aren't needed and will only contest the area worse than it already is.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: According to SANDAG's own 2019 report, the use of marijuana amongst juveniles has increased - so SANDAG needs to have a backbone and deny the city forcing easy county to accept marijuana shops and grow areas because the city is supported by Lobbyists and not listening to the citizens of east county. As presented , the Lakeside Community planning group brought this issue to the community and the room was filled with lakeside citizens who didn't want this project. Why are you keeping silent?</p> <p>Projects that should be a priority for SANDAG: For East County- the 67 corridor upgrade- the expansion of 52.</p> <p>Additional questions and public comments: Sandbag criminal justice research division conducted a report in 2018 that showed a 66% increase of juveniles vaping THC. Forcing east county to take marijuana stores and grow areas are going to be inequitable to the lower socioeconomic citizens that outnumber the medium income earners. Forcing lakeside to accept weed stores when they've told you they don't want it should be criminal- your own reports show how this would disproportionately affect lakeside and increase theft, health and increase the use of other harder drugs. Keep the marijuana market out of Lakeside!</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor.</p> <p>Land use authority and decisions related to the types of commercial uses are reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively, understand the unique needs of their communities and geographies. SANDAG does make it a priority to share public safety information and data through publications and SANDAG's Public Safety Committee.</p>
W146	Gary Clasen		<p>Safety concerns in East County: Highway 67 and other routes that need updating and made much, much safer.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: The East County and other non-urban, non-downtown, non-coastal areas have different needs that need to be addressed. Bike routes, trolley stops, "fast" buses are not the answer. Better highways, shorter travel times (less time idling in traffic jams) are required and were promised when taxes were raise.</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements from Mapleview to Dye Road. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor. For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p>

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			<p>Projects that should be a priority for SANDAG: Routes 67 and 78 and other areas that need to be safer and often more lanes added.</p> <p>Additional questions and public comments: Don't just think about the urban areas. NOBODY is going to take a bus or ride a bike from Ramona or Campo, Lakeside or Jamul, Escondido or Vista to job centers in cities or along the coast. Many people in these areas work construction, so they need trucks, vans, and other private vehicles not only to get to jobs, but to work from as part of their routine. Don't forget about us. Did I miss the community meeting in Lakeside, BTW?</p>	<p>Additionally, the 2021 Regional Plan includes a system of managed lanes including on State Route 78. SR78 includes four managed lanes proposed for 2035 and supporting managed lane connectors.</p>
W147	Gary Clasen		<p>Safety concerns in East County: Homelessness increase. 52 Freeway needs more lanes, should be a priority. Trolley should connect Santee to North County.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: 52 freeway size increase within 5 years. Trolley to connect Santee to North County in 5 years or less.</p> <p>Projects that should be a priority for SANDAG: 52 freeway increase in lanes. Trolley to connect Santee to North County.</p>	<p>The 2021 Regional Plan re-envision the transportation network which includes a system of managed lanes supported by technology improvements. Managed lanes operate very similar to the I-15 Express Lanes which prioritize use of transit, carpools, vanpools, and rideshare. The Plan includes three managed lanes on SR52.</p> <p>SANDAG and Caltrans are developing a Comprehensive Multimodal Corridor Plan (CMCP) for the Coast, Canyons, and Trails corridor which includes SR52. The Coast, Canyons, and Trails CMCP aims to guide the development of an innovative transportation network, transforming the way people and goods move east and west through the central San Diego region. This CMCP evaluates all travel modes and transportation facilities in the Coast, Canyons, and Trails study area and tailors solutions for the travel needs of the corridor. Major transportation network improvements by 2050 include additional Managed Lanes and ramp improvements along portions SR 52. By 2050, active transportation projects include buildout of SR 52 Bikeway and several enhanced bike lanes through Santee, El Cajon, La Mesa, and unincorporated San Diego County.</p> <p>For more information regarding the Coast, Canyons, and Trails corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=610&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=610&amp;fuseaction=projects.detail</a>.</p>
W148	Gary Clasen		<p>Safety concerns in East County: Highway 67 improvements have been put off for over 20 year already. People continue to die in accidents on this highway. Now we're seeing another 15 years added to the timeline???? This is unacceptable. Bike lanes should not come before Highway improvements that can SAVE LIVES!!!</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Improve Highway 67 ASAP.</p> <p>Projects that should be a priority for SANDAG: San Vicente - Highway 67 Improvements.</p> <p>Additional questions and public comments: What is your reasoning when you put Bike Lanes as a priority over SAVING LIVES?</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements from Maplevue to Dye Road in the plan phase year 2035. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor. For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p>
W149	Gary Clasen		<p>Safety concerns in East County: Short on-off ramps. Highway 67...scary speeds, narrowing of lanes allows stupid people to still pass on the right.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Same/similar as past years...make highway 67 slower/better. Remedy those short on-off ramps to determine which ramps cause the most accidents. Clearly the one at 67 N just past the bridge and before Riverford! Horrible on-ramp.</p> <p>Projects that should be a priority for SANDAG: See above.</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements from Maplevue to Dye Road in the plan phase year 2035. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor. For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a></p> <p>Flexible Fleets will offer people a variety of on-demand shared vehicles. Flexible Fleet services may complement fixed-route services, even in more suburban communities such as Lakeside. They offer additional convenience, as the on-demand nature of Flexible Fleet services allows people to book a ride almost anywhere and anytime.</p>

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			Additional questions and public comments: Public transportation for our Lakeside, utilizing smaller vehicles to allow them to have better cost effective results.	For more information regarding Flexible Fleets please visit: <a href="https://www.sdforward.com/mobility-planning/flexible-fleets">https://www.sdforward.com/mobility-planning/flexible-fleets</a> .
W150	Gary Clasen		<p>Safety concerns in East County: Hwy 67 from Vigilante Rd. up north to Ramona.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Roads in east county and Hwy 67 now.</p> <p>Projects that should be a priority for SANDAG: Hwy 67.</p> <p>Additional questions and public comments: Please do not support any additional road tax not the mileage tax we seniors struggle now just to pay the registration fees.</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements from Mapleview to Dye Road in the plan phase year 2035. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor. For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
W151	Gary Clasen		<p>Safety concerns in East County: 67 needs to be widened for safer travel.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Projects that should be a priority for SANDAG: street repair.</p>	<p>State Route 67 is slated for roadways improvements: shoulder widening and straightening improvements from Mapleview to Dye Road in the 2021 Regional Plan's phase year 2035.</p> <p>For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p>
W152	Gary Clasen		<p>Safety concerns in East County: Highway 67 south and highway 8 connection is dangerous and to backed up plus highway 8 west getting onto 67 very backed up.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Projects that should be a priority for SANDAG: Highway 67.</p>	<p>State Route 67 is slated for roadways improvements: shoulder widening and straightening improvements from Mapleview to Dye Road in the 2021 Regional Plan's phase year 2035.</p> <p>For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p>
W153	Gary Clasen		<p>Safety concerns in East County: Aviation Pollution and aviation crashes.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Affordable housing, bike lanes.</p> <p>Projects that should be a priority for SANDAG: Move Gillespie Field Airport, waste of money and pollution.</p>	<p>Land use authority is reserved to local jurisdictions – the cities and the county. Gillespie Air Center is in the jurisdiction of the City of El Cajon and subject to the city's zoning and ordinances.</p> <p>In recognition of the lack of affordable housing, SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed 2021 Regional Plan. The proposed 2021 Regional Plan has a full network of transit stations throughout the San Diego region that are located where key mobility connections need to be made between residential, commercial, and employment centers, such as UTC and Old Town. SANDAG will work closely with local jurisdictions to determine design and services of Mobility Hubs based on the community's needs.</p>



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			Additional questions and public comments: Why are we building two transit hubs? One in UTC and one in Old Town Makes no sense, Lindberg is an embarrassment. We need a WORLD airport ai Miramar MCAS You are playing politics with our transportation tax monies.	
W154	Gary Clasen		<p>Safety concerns in East County: Evacuation in an emergency will be impossible because Rte. 52 will be clogged (not enough lanes) when trying to get to other freeways. Likewise, the junction of 125 South and 94 West will also be clogged.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Add lanes to Rte. 52 where it junctions with Rte. 67 and continuing all the way to the I-5. Morning traffic is at a standstill on the 52 in East County heading West. Afternoon traffic is stop and go going East. Also, add lanes to the junction of the 125 South and 94 West.</p> <p>Projects that should be a priority for SANDAG: Freeways from East County heading West need to have more lanes.</p> <p>Additional questions and public comments: Why is it that projects in East County are usually moved to the “back burner?” Why not give the same priority to all county residents?</p>	<p>MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p> <p>The 2021 Regional Plan includes managed lanes network for SR52 and supporting managed lane connectors, included in Appendix A: Transportation Projects, Programs and Phasing. The Plan includes three phase years, 2025, 2035 and 2050. SR52 between I-805 and Mast Blvd is proposed for 2035. SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements. SANDAG and Caltrans are currently preparing Comprehensive Multimodal Corridor Plans that includes both corridors which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor.</p>
W155	Gary Clasen		<p>Safety concerns in East County: Mapleview Ave and highway 67 stoplight.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Widening 67 at choke points in Ramona.</p> <p>Projects that should be a priority for SANDAG: Bradley Ave bridge over 67 highway.</p> <p>Additional questions and public comments: Spend money on roadways which our gas tax is supposed to be spent on. Don’t allow the head of SANDAG to spend majority of budget(taxpayers) money on public transit.</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements from Mapleview to Dye Road in the plan phase year 2035. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor. For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p> <p>Your comment was forwarded to Caltrans.</p>
W156	Gary Clasen		<p>Safety concerns in East County: As an East County resident, I feel extending the public transportation will benefit our County Economy, especially the downtown areas (restaurants, retail) but we have seen an increase homeless and an increase in crime. My only fear is my opening up more transportation option the crime issue will continue to rise.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: I think transportation improvements are key to making a better San Diego. As people continue to move further away from downtown due to costs, many residents still work in the City area. Accessible transportation could provide a better work life for those working in the City.</p> <p>Projects that should be a priority for SANDAG: Transportation Improvements and Land Use and Growth.</p>	<p>The 2021 Regional Plan puts forth a 30 year vision for the region that considers the needs of all parts of San Diego County, including trips from east county to other parts of the region. As SANDAG implements the plans, projects, and programs envisioned, the agency will work closely with community members to address project-specific concerns and develop solutions tailored to the community. The Regional Plan includes strategies focused on transportation improvements and planning for land use and regional growth.</p>
W157	Gary Clasen		<p>Safety concerns in East County: Highway 67 is always a concern, I can’t see if it is included in the plan, but if it isn’t, it should be.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements from Mapleview to Dye Road in the plan phase year 2035. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable,</p>

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			<p>Investments I would like to see from SANDAG: East County roads are pretty bad in general and need to be repaired. I would like to see more investment in fixing the roads and less in public transportation. I see so many empty busses and trolleys and spending major money on the transit system in San Diego doesn't seem practical.</p> <p>Projects that should be a priority for SANDAG: REPAIRING ROADS.</p>	<p>and equitable transportation solutions that are tailored to the needs of the corridor. For more information regarding the San Vicente Corridor please visit: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p>
W158	Gary Clasen		<p>Safety concerns in East County: Homeless population increasing.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Community development, more housing, no gas tax for miles traveled. NOW.</p> <p>Projects that should be a priority for SANDAG: Housing, Road repairs, Community enhancements. Bringing in more small, med and large businesses to our community.</p> <p>Additional questions and public comments: How could you push out some of the programs until 2035 to 2050. That is hard to fathom that this can be done when each project proposed has a need now and in the future. By the time those years come around, all the needs would have changed.</p>	<p>The 2021 Regional Plan considers the needs of the San Diego region, including communities in east county. The plan includes investments in an affordable housing program, road repairs, and community enhancements, particularly in Mobility Hub areas. These are areas where multiple travel options come together. The Regional Plan is a long-term blueprint for the region and is updated every four years to account for new data and information, changes in population forecasts, new technology, and policies.</p>
W159	Gary Clasen		<p>Safety concerns in East County: Otay Lakes being allowed to be a share the road for cyclist.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Make a bike loop from Chula Vista along Otay Lakes Rd to Campo Rd (HWY 94) to Proctor Valley Rd to Chula Vista. It would be a safer and a well used two way bike lane and will attract active bikers an encourage more health in the community.</p> <p>Projects that should be a priority for SANDAG: Widen Hwy 94 and Otay Lakes.</p> <p>Additional questions and public comments: How many people, mostly bicyclist have to die to make the simple change.</p>	<p>While this segment of roadway is not included in the 500+ miles of SANDAG's Regional Bikeway Network, the Otay Lakes Road bikeway is a Local Bike Project in the City of Chula Vista's adopted Active Transportation Plan, available at: <a href="https://www.chulavistaca.gov/home/showpublisheddocument/20838/637346375732130000">https://www.chulavistaca.gov/home/showpublisheddocument/20838/637346375732130000</a>.</p> <p>More details on that effort, including staff contact information, can be found at: <a href="https://www.chulavistaca.gov/departments/engineering/active-transportation-plan">https://www.chulavistaca.gov/departments/engineering/active-transportation-plan</a>.</p> <p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p> <p>Your comment was forwarded to agencies that oversee these facilities.</p>
W160	Gary Clasen		<p>Safety concerns in East County: East County is not represented fairly at SANDAG. New SANDAG plan will not work!</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Defund and dissolve current SANDAG, and create a new regional entity that is capable, honest, and balanced. Invest in better road planning and housing approvals that prevent super dense neighborhoods. See project recommendations.</p> <p>Projects that should be a priority for SANDAG: Defund and dissolve current SANDAG. For a new Regional entity - 1) water &amp; electricity availability for growing population, 2) population management / control based on utilities available (water, electricity), 3) better road planning to avoid gridlock and out of touch green energy ideas that are not realistic - planning should not based on SANDAG or County staff recommendations, but heavy on citizens input, which is ignored most of the time. 4) Help solve the border crisis - help complete building the border wall and contribute to creative solutions to stemming illegal</p>	<p>Thank you for your comments.</p>

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			<p>immigrant tide, child abuse at border, drug infusion into US at border, and COVID19 influx into U.S by immigrants who are spreading it.</p> <p>Additional questions and public comments:                      1) Start this organization over again from scratch. It is broken and dysfunctional. 2) Listen and act based mostly on citizen input (75%), and minimally on staff or insiders who are frequently out of touch (25%). 3) Include citizens at the table, with voting rights. 4) Create balanced representation and action of all opinions and viewpoints at the table. 5) Include fair representation of all areas - for example, East County and several other areas are not fairly represented at the current SANDAG table. 6) Do not follow the new green deal concept, which is extreme liberalism at its worst - it is not based on science and data, but is based on climate change existentialist threat assumptions and poor data modeling. San Diego is not Portland Oregon, or other cities - massive biking and mass transportation infrastructure will not work here! Do not try to force feed this to the people and waste our money and time. Create realistic plans and ideas that will work!</p>	
W161	Gary Clasen		<p>Safety concerns in East County:                      Crime coming in on trolley.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG:                      Influence, fund or advocate for:</p> <p>Help restore and save historic East County buildings.                      Stop spoiling communities by increasing historic density based an a failed theory it will increase MTS ridership.</p> <p>Allocate local funds back to state for sole purpose to widen SR 52.                      Eliminate/redesign crime-ridden drug infested transit centers.                      Improve streetscape and landscaping.                      Eliminate funding waste to trolley in East county which has little demand.                      Leave local funds in cities to better decide their use. Such as Santee’s sun-rotten decrepit illuminated street name signs that were never maintained. Similarly decrepit signage in places like the Walker Preserve.                      Turn county property at old Edgemoor hospital site with historic oak trees into large picnic park.                      Restore dilapidated, historic Edgemoor barn. The ONLY historic building in Santee that has been ignored.                      Demolish El Cajon ugly jail floors. Shorten eyesore building.                      Declare Mary’s historic donut sign historic and allow to be rebuilt as monument sign in front of commercial strip center.</p> <p>Projects that should be a priority for SANDAG:                      52 freeway traffic debacle</p> <p>Additional questions and public comments:                      See above, there is a lot there.</p>	<p>The 2021 Regional Plan re-envision the transportation network which includes a system of managed lanes supported by technology improvements. Managed lanes operate very similar to the I-15 Express Lanes which prioritize use of transit, carpools, vanpools, and rideshare. The Plan includes three managed lanes on SR52.</p> <p>SANDAG and Caltrans are developing a Comprehensive Multimodal Corridor Plan (CMCP) for the Coast, Canyons, and Trails corridor which includes SR52. The Coast, Canyons, and Trails CMCP aims to guide the development of an innovative transportation network, transforming the way people and goods move east and west through the central San Diego region. This CMCP evaluates all travel modes and transportation facilities in the Coast, Canyons, and Trails study area and tailors solutions for the travel needs of the corridor. Major transportation network improvements by 2050 include additional Managed Lanes and ramp improvements along portions SR 52. By 2050, active transportation projects include buildout of SR 52 Bikeway and several enhanced bike lanes through Santee, El Cajon, La Mesa, and unincorporated San Diego County.</p> <p>For more information regarding the Coast, Canyons, and Trails corridor please visit:  <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=610&amp;fuseaction=p.projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=610&amp;fuseaction=p.projects.detail</a></p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. Land use authority includes parks and recreation, and historic preservation.</p>
W162	Gary Clasen		<p>Safety concerns in East County:                      Fire, medical, water supply.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG:                      High speed internet throughout the county.</p> <p>Projects that should be a priority for SANDAG:                      Fire protection and internet.</p>	<p>The transportation system envisioned in the 2021 Regional Plan relies on a vast network of digital infrastructure to connect and manage the transportation system. For Complete Corridors, NextOS, Flexible Fleets, Transit Leap, and Mobility Hubs to succeed, a robust broadband and telecommunications network is essential. The Plan includes an investment in the backbone fiber infrastructure needed to support the transportation network however SANDAG is also developing a Regional Digital Equity Strategy &amp; Action Plan to support the expansion of broadband county-wide. The Strategy &amp; Action Plan will define strategies for expanding broadband and internet connectivity in the San Diego region to support quality of life, transportation, and equity.</p> <p>The San Vicente Comprehensive Multimodal Corridor Plan (CMCP) will study ways to</p>



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				<p>improve transportation safety, maintain rural community character, create greater trip reliability and efficiency, and provide emergency evacuation options in the event of fire or other natural disaster.</p> <p>For more information regarding the San Vicente, please visit:  <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p>
W163	Gary Clasen		<p>Safety concerns in East County:                      The plan is not a set of strategies, but rather a set of aspirational statements, goals and principles that have few specific actions. And there is no recognition that to achieve the image of the future state will require changes in voluntary behavior by citizens, as well as participation by multiple industries. Specifically not mentioned is the main tool of government to enact such designs, i.e., regulation. Also, local government must operate within state and federal frameworks as well. So the city and county of San Diego can't implement requirements, technologies and infrastructure unilaterally. The plan makes no mention of the coordination of these human and governmental elements.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG:                      I don't know what SANDAG's budget is, so I don't know what is possible. If the proposed \$163 billion was arrived at through analysis with more data than presented by the document, in terms of why the amount is what it is. The source of funds was not clear as to whether new taxes will be required; "new sources of funding" will be required. Without knowing the boundaries of the budget, I cannot offer opinions on what I'd like to see the money spent on.</p> <p>Projects that should be a priority for SANDAG:                      I didn't see anything in the report (maybe I missed it) that talked about autonomous vehicles, the impact of higher remote working ratios, the conversion to electric mobility, the impact of delivery services that will remain post-pandemic, etc. All of these factors will contribute to less need for mobility in terms of frequency of travel by humans. Have these trends been considered?</p> <p>Additional questions and public comments:                      Is this publicly available version of the plan simply a "Cliff's Notes" marketing version, meant to raise awareness and hopefully increase public support for taxes raised to pay for the projects?</p>	<p>The 2021 Regional Plan is a long-range planning document and is required by federal law to provide a reasonably feasible funding strategy for the projects, policies, and programs of the plan. As described in Chapter 3 and Appendix B, additional work, including advanced planning, public involvement, pilot testing, and legislation will be necessary to implement elements of this plan. SANDAG updates the Regional Plan every four years with the latest in planning ideas and concepts.</p> <p>The 2021 Regional Plan envisions a transportation system that will evolve as our mobility needs continue to change well into the future. Flexible Fleets, which include shared, electric, connected and eventually autonomous vehicles, work in concert with mass transit, providing on-demand solutions. SANDAG continues to monitor the development and deployment of autonomous vehicles as there is great uncertainty about when fleets of fully autonomous and connected vehicles capable of operating will be ubiquitous.</p>
W164	Gary Clasen		<p>Safety concerns in East County:                      Parking, Policing, Total Gov Reform.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Projects that should be a priority for SANDAG:                      Termination of Bloated city-county employees at the top.</p>	Thank you for your comment.
W165	Gary Clasen		<p>Safety concerns in East County:                      Maplevue Ave and highway 67 stoplight.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG:                      Widening 67 at choke points in Ramona.</p> <p>Projects that should be a priority for SANDAG:                      Bradley Ave bridge over 67 highway.</p> <p>Additional questions and public comments:</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements from Maplevue to Dye Road in the plan phase year 2035. SANDAG and Caltrans are currently preparing a Comprehensive Multimodal Corridor Plan which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor. For more information regarding the San Vicente Corridor please visit:  <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=607&amp;fuseaction=projects.detail</a>.</p>

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			Spend money on roadways which our gas tax is supposed to be spent on. Don't allow the head of SANDAG to spend the majority of budget(taxpayers) money on public transit.	
W166	Gary Clasen		<p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Additional carpool lanes asap.</p> <p>Projects that should be a priority for SANDAG: Carpool lanes, electric vehicle chargers, NOT trains to Ramona or other distant areas, and NOT more empty busses with no one riding other than the driver as currently seen all over north county.</p> <p>Additional questions and public comments: Address what the public actually wants and not some politicians' pipe dream. We DO NOT want to be like Los Angeles.</p>	<p>The Managed Lanes concept is envisioned in the 2021 Regional Plan. They provide a system of managed lanes allowing the opportunity to dynamically manage the lanes based on real time conditions, time of day, and vehicle occupancy, to make all lanes more efficient and provide benefits to the system as a whole.</p> <p>SANDAG will explore ways to integrate EV charger location and availability data into the Next OS platform.</p> <p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W167	Gary Clasen		<p>Projects that should be a priority for SANDAG: NOT road user fees.</p> <p>Additional questions and public comments: A BIG NO! to Road User Fees (page 47 of The 2021 Regional Plan). I'm fine with Managed Lanes, people can choose to pay extra to use the faster lane or not (we'll see if they actually end up being faster). But you will have a grassroots uprising if you try to start taxing us to drive on the roads! I am retired and have worked hard all my life. I am already over-taxed here in CA, but this is my home and I plan to continue living here. I don't want to be forced to take public transportation. I am usually going several different places when I drive somewhere - various errands and shopping and hiking. So I am bringing things with me and then also carrying bags of groceries. I DO NOT support Road User Fees!!!</p>	<p>Dramatic changes are necessary to address unprecedented challenges facing our region, and state. One component of these necessary changes are updates to how transportation systems are funded. The funding structure we grew up with, paying at the pump, will not carry us into the future as the state transitions to alternative fuel vehicles to address necessary climate change goals and alternate travel modes that still require funding support.</p>
W168	Gary Clasen		<p>Safety concerns in East County: Why is the forest service so dysfunctional?</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Invest more in hydrogen gas-powered vehicles.</p> <p>Projects that should be a priority for SANDAG: Invest more in the fuel of the future hydrogen.</p> <p>Additional questions and public comments: Why is the transition to hydrogen fuel going so slowly?</p>	<p>The Regional Plan supports investments in the electrification of cars, trucks and buses and their supporting infrastructure (e.g., EV charging stations and hydrogen fueling stations). These electric vehicle investments are one of the ways SANDAG is working to reduce regional GHG emissions and improve local air quality. Appendices A (Table A.17) and B show SANDAG's proposed EV commitments. Innovation and advanced technologies will be critical to meeting regional GHG reduction goals in 2035 and 2050.</p> <p>The proposed zero emission vehicle incentive program will provide rebates for both plug-in electric vehicles and fuel cell electric vehicles powered by hydrogen. SANDAG investments will also support the transition of transit and freight vehicles to zero emission including funding for hydrogen fuel cell electric buses and battery electric buses.</p>
W169	Gary Clasen		<p>Safety concerns in East County: Because of years of neglect and lack of forest/brush management, the landscape is littered with dead and dying trees, shrubs, grasses, etc. which are tinder dry and ready to create a difficult, if not impossible, to stop fire storm. Emergency evacuations from Ramona, San Diego Country Estates, Barona Mesa, and other areas are bottlenecked with only Highway 67 south (one lane in each direction for the most part) and Wildcat Canyon Road (one lane in each direction) available for egress. As was demonstrated during the last 2 huge fires, these routes do not allow for the evacuation of the area. Vehicles were lined up for hours stuck in line to get out. This deadly condition has been recognized for the last 25 years in official reports describing the situation, and the area's population has continued to increase while the outdated roads have stayed the same.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Highway 67 must be widened to a minimum 4 lanes (2 in each direction) beginning immediately.</p>	<p>SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements from Maplevue to Dye Road in the plan phase year 2035. These additional improvements could help address crashes and evacuation needs in the rural areas, evacuation in the event of wildfire or other disasters. Additionally, in conjunction with the Regional Plan, SANDAG and Caltrans are actively preparing the San Vicente Comprehensive Multimodal Corridor Plan, which is a more focused effort to identify projects and strategies that integrate transportation options, wildlife connectivity, and technology deployment to improve mobility and evacuations along the SR 67 corridor.</p> <p>Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p> <p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005</p>

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			<p>Projects that should be a priority for SANDAG: As above. Next priority--throw away the 'SANDAG 2021' Regional 'Plan' and research, with independent scientists, planners, engineers, etc. a realistic and beneficial plan that will actually help the region.</p> <p>Additional questions and public comments: A bus, trolley, or train carrying a few people does nothing to help the region, environment, or the earth. It has been blatant to anyone willing to do the research that electric vehicles when considering the environmental damage and costs their production, use, and scrapping causes, are more polluting and less practical than standard internal combustion-powered vehicles. Their range is limited, technology is still in its infancy, safety issues not resolved (for example, if the battery in an electric vehicle combusts, it is virtually impossible to extinguish short of dropping the vehicle into a swimming pool), not to mention the inane promise that by 2035 a state that can barely keep its lights on will allow only electric vehicles to be sold, relying on solar and wind power to produce the massive amounts of electricity necessary. There are so many problems with this so called 'regional plan' that it would make more sense to start over.</p>	<p>levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions from all sectors and achieving state goals related to carbon neutrality requires actions at all levels of government. Implementing the 2021 Regional Plan, while also facilitating the development and implementation of local Climate Action Plans (CAPs) across our region, will help everyone—the State, SANDAG, cities, and other public agencies—achieve their climate goals.</p>
W170	Gary Clasen		<p>Safety concerns in East County: Hwy 67 from Mapleview to Scripps Poway Parkway.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: East county needs improvements to SR 52, Hwy 67, and the 94.</p> <p>Projects that should be a priority for SANDAG: Widening SR 52, Hwy 67, and the 94.</p>	<p>The 2021 Regional Plan includes managed lanes network for SR52 and supporting managed lane connectors, included in Appendix A: Transportation Projects, Programs and Phasing. The Plan includes three phase years, 2025, 2035 and 2050. SR52 between I-805 and Mast Blvd is proposed for 2035. SR67 includes safety and operational improvements such as shoulder widening, curve realignments, and technology improvements. SANDAG and Caltrans are currently preparing Comprehensive Multimodal Corridor Plans that includes both corridors which aims to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor. Three managed lanes are also proposed for SR94. SANDAG and Caltrans will be complete a Comprehensive Multimodal Corridor Plan for SR94 to evaluate transportation solutions tailored to the community needs.</p>
W171	Gary Clasen		<p>Safety concerns in East County: Fire safety.</p> <p>I do feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Promote the development of more and better jobs where people already live (i.e., around employment centers).</p> <p>Projects that should be a priority for SANDAG: Growing existing employment centers throughout the County.</p>	<p>The 2021 Regional Plan considers the needs of east county and prioritizes investments in rural corridors and climate resilience programs to assist with fire safety concerns. The proposed land use pattern in the Regional Plan envisions future jobs and housing to be concentrated in Mobility Hubs throughout the region. Many Mobility Hubs are employment centers and SANDAG envisions both job and housing growth in these areas to facilitate more mixed use development.</p>
W172	Gary Clasen		<p>Safety concerns in East County: The intersections of freeway transitions, including to local roads; the need to assess job center creations/enhancements that support climate change policies that impact health.</p> <p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Reversal of some of the proposals that are pushed out to 2050 but are needed sooner.</p> <p>Projects that should be a priority for SANDAG: Some that the plan projects for 2050 should be earlier - 125/8/67/52 corridors.</p> <p>Additional questions and public comments: Can SANDAG consider Mobility Hub developments that consider senior citizen facilities (current and future) like Lantern Crest in Santee and La Vida Real in Rancho San Diego?</p>	<p>Thank you for your comment. Safety in and around regional Mobility Hubs including transit stops situated throughout these communities is of utmost importance. We are planning for complete corridor infrastructure that better protects people walking and biking from vehicular traffic.</p> <p>Mobility Hubs will be implemented in close coordination with local jurisdictions to align with the unique needs of each community. Many Mobility Hubs are employment centers or other popular destinations, and SANDAG would work with local jurisdictions to update plans and policies to allow for more housing in these locations where feasible. A map of all of the Mobility Hubs is included in Appendix A. Local jurisdictions maintain land use authority and are responsible for decisions regarding density, zoning, and housing policies. Regarding the highway improvements, State laws have changed from requiring congestion relief (usually solved in the short term by widening roadways) to reducing vehicle miles traveled and greenhouse gas emissions (usually solved by people living closer to destinations and using alternative modes of transportation such as walking, biking, carpooling and taking public transit). The Regional Plan reflects this shift.</p>

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W173	Gary Clasen		<p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: Roads repaired.</p> <p>Projects that should be a priority for SANDAG: Roads repaired and freeway updated.</p> <p>Additional questions and public comments: My big concern is the mileage tax it would mean with being charged .06\$ a mile I wouldn't be able to go anywhere. We already pay the highest gas tax in the USA. How many SANDAG people use mass transit to get to their meetings?</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
W174	Gary Clasen		<p>I do not feel the SANDAG 2021 Regional Plan meets the needs of my community.</p> <p>Investments I would like to see from SANDAG: The focus and area where cooperation with tribes seems to be most well developed is regional transportation planning. Appendix I page 7 does not include the Mesa Grande Band of Mission Indians; and page 19 does not include tribal corridor SR 78, the Band's primary access to tribal housing and access to a very large portion of its undeveloped reservation and semi-developed fee lands. I would like to see more emphasis on working with individual tribes (rather than collectively through SCTCA) on economic development as well; and how San Diego County and other governments in the region can help remove barriers to non-gaming tribal development of tribal economies on their own lands.</p> <p>Projects that should be a priority for SANDAG: Many east county rural economic development projects are thwarted by SDG&amp;E shutdowns during wind and heat events; what role can SANDAG play in responding to or working with SDG&amp;E to mitigate these circumstances?</p> <p>Additional questions and public comments: In tandem with the above question, what role can SANDAG play in non-gaming tribes' tribal energy development plans and concerns?</p>	<p>The San Diego Forward 2021 Regional Plan is a comprehensive regional planning document. The regional plan is required by both state and federal legislation. The plan is intended to be applied to the entire San Diego region and might not have details for subregional areas. For information that is more specific to SR 78, Mesa Grande, and emergency preparedness, please the San Vicente Comprehensive Multimodal Corridor Plan at: <a href="https://sandag.mysocialpinpoint.com/sanvicente">https://sandag.mysocialpinpoint.com/sanvicente</a>.</p> <p>The Mesa Grande Band of Diegueño Mission Indians are listed in the 11th row of Table I.1.</p> <p>As a Council of Governments (COG) SANDAG established a government-to-government framework with its counterpart - The Southern California Tribal Chairmen's Association (SCTCA). At a policy level the SCTCA advises SANDAG on the Board and Policy Advisory Committees and Mesa Grande in the past has represented the SCTCA on the Borders Committee. However, at a technical level, all tribes, representing their nation can be a member of the Interagency Technical Working Group on Tribal Transportation Issues which serves as a forum for all tribes to discuss transportation and other planning issues with the public agencies who impact tribal communities. We encourage Mesa Grande to become a member again. That said, we appreciate your suggestions to do more one on one communication with individual tribes. SANDAG as a regional planning agency has a role facilitating the regional energy strategy and one of our collaborative strategies with the SCTCA is to explore how the tribes can contribute to the energy planning in the region - especially to benefit non-gaming tribes. We look forward to more discussions.</p>
W175	Gary Clasen		<p>It is sad to see the needs of East County residents be put on the backburner. I believe that the Regional Plan should allocate equitable resources and programs to East County residents because they have paid their fair share through taxes and continually do not see the benefits within their communities.</p>	<p>A critical component of reviewing the impacts of the 2021 Regional Plan is evaluating the effects on historically underserved and systemically marginalized groups. This evaluation is known as a social equity analysis and focuses on communities of color, residents with low incomes, and seniors. While the 2021 Regional Plan delivers improvements to the entire region, this review ensures that the benefits are shared by everyone, including our</p>



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			<p>East County has some of the largest amounts of low-income, refugee, immigrant, and rural community members in San Diego. It is disappointing, but not surprising, to see the needs of these communities continually dismissed.</p> <p>One area that I believe must be addressed before anything else is fire safety within East County San Diego. Wildfires will continue to get worse over the next several years and a lack of investment in infrastructure will quite literally cost lives. I hope to see SANDAG invest in increased lanes for rural communities to be able to safely evacuate when needed. East County is particularly prone to wildfires because of the heat and bush; it is crucial that San Diego invests in reliable, sustainable, and fire safe programs to prepare for the next several years. The problems with fire safety have been shown through recent fire scares and it will continue to worsen and cost people their livelihood and lives if it is not addressed immediately.</p> <p>Thank you for your work, I am sure this is an extremely difficult project!</p>	<p>social equity focused populations, and that the burdens of the 2021 Regional Plan's changes are not disproportionately shouldered by any social equity focus population.</p> <p>The 2021 Regional Plan proposes a system of managed lanes including corridors that serve East County such as I-8, SR52, and SR94. Additionally, rural corridors such as 67 include investments such as shoulder widening, curve realignment, and technology improvements to address safety and operational improvements to facilitate ingress/egress during peak travel and emergency evacuation conditions. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
W176	Gayle Martin		<p>I feel we should use small electric buses, vans, vehicles, etc. that can easily handle handicapped, children and luggage that run frequently and everywhere to central areas that connect to larger buses/vans/vehicles that travel on dedicated lanes with only one or two stops on the way to large workplaces, airport, stadium, etc. This would use our current streets &amp; highways. We should also ensure that everyone is given a computer, a cell phone, and a very low cost provider, in order to have access to the reservation system, which would include free automatic software/hardware upgrades and technical support. There must be train/bus/vans/vehicles from Escondido with several stops on the way to San Diego. Need to start NOW as bulk of funds are much later in availability. Fares must be low cost with free transfers. Maps of the transit network should be everywhere.</p>	<p>The Transit network will provide frequent service along the County including fast and reliable NextGen Rapid services from Escondido to Central San Diego. To complement these transit services, Flexible Fleets will be available to provide quick and convenient connections to transit. Flexible Fleets can range from bikes and scooters to autonomous shuttles that provide on-demand service for all sorts of trips. These vehicles contain different features and amenities that cater to different mobility needs such as wheelchair accessibility, space for luggage/stroller, bike storage, and real-time arrival information. Flexible Fleet services will also provide options so that all people can benefit from the service like free or reduced fare options, call center, cash payment options, or travel kiosks around the County to help riders book a ride. SANDAG plans to start testing different Flexible Fleet applications and services models in 2022.</p>
W177	Gayle Martin		<p>How is the system tracking how many miles you've used?            What happens when the system makes an error and charges fees to the wrong person?            What happens when the system network crashes? Or, is hacked?</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG will rely on coordination with the other Metropolitan Planning Organizations (MPOs) in California along with the State department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers. There are various methods that are being explored to track how many miles are being driven, and your important concerns will be considered while coordinating with other agencies in the State to select the best possible system to administer the program.</p>
W178	Gener Abdon		<p>I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.</p> <p>I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.</p> <p>I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.</p> <p>I call for a 24-hour service by 2025 on popular transit routes to connect late night and early</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual</p>

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			<p>morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr service on popular transit routes and present a clear implementation schedule.</p> <p>I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion</p> <p>I call for no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Further, I ask that it be accelerated for a 2035 implementation rather than the current delayed plan to implement in 2027.</p> <p>I call for an electrified bus fleet by 2030. Fund the implementation of California's Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.</p> <p>I call for the funding of to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study.</p> <p>I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets.</p> <p>I call for the funding of the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.</p>	<p>Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
W179	George Ho	Sunrise Movement San Diego	<p>For the final plan, I urge this Board to (1) maximize emissions reductions, (2) prioritize investments in the communities on the frontlines of environmental injustice and the climate crisis, and</p> <ul style="list-style-type: none"> <li>+Improve the Bus System</li> <li>+Create a Blue Line Express</li> <li>+Provide 24 Hour Service by 2025</li> </ul>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p>

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			<ul style="list-style-type: none"> <li>+Have a Purple Line Serve Central City Heights</li> <li>+Create Youth Opportunity Passes (YOP): Provide No-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Connect youth to school, work, internships, and other early-career opportunities.</li> <li>+Electrify Bus Fleet by 2030</li> <li>+Identify Anti-Displacement strategies</li> <li>+Improve the transit Bathroom network</li> <li>+Create an Emergency Ready Transit System</li> </ul>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant</p>



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				<p>programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p> <p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p> <p>MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
W180	Glen Farrell	self and family	<p>Please stop with additional plans and "Use fees." This is in effect a regressive tax on middle and lower class working families, and instead of better using existing tax dollars like SB-1 funds, past experience proves it will be raided with little going to the actual infrastructure. SANDAG should not be voting on this, it should go to a vote before the people of the county and it should ideally require a supermajority to impose this tax. We are already looking at having to Leave CA because it is simply getting too expensive and rather than becoming more efficient, the solution is to impose new taxes (or fees) to make up for squandering the existing revenue. Please vote down any proposal that imposes new costs on taxpayers.</p> <p>Also any use fee should properly go to the counties where the driving occurred. It is not right that a family vacationing in the rest of the state or out of that pays San Diego County.</p>	<p>Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public's privacy.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources. The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation.</p>
W181	Glen Hopkins		<p>Having read through the regional plan (marketing pitch) I submit that there are number of "flawed assumptions" coupled with significant "conformational bias" that need to be brought forward and addressed. There are risks when people passionate about a given topic are entrusted to develop a truly objective analysis taking in all facts and realities. In this case people that clearly believe mass transit is the only acceptable approach, and thus, come at it from that vantage point finding ways to sell that belief and force its implementation upon others. Contrast that with an open and objective analysis by non-partisans on the topic of: "What are the best (most economical, most convenient, most likely, most affordable, highest ROI) ways to move people around San Diego in the future?".</p> <p>Recognizing that mass transportation is only economically feasible for mass population densities, the plan's low population growth projections is in itself NOT going to create any materially worse problems than San Diego currently has which are significantly less than larger metro areas on the west coast. By the plan's own admission, 60% of the population growth in 2050 will be from people 75 years and up. It is a known fact that people drive &amp; travel significantly less as they leave the workforce and age. Additionally, the plan discusses the large number new job in the areas of "innovation" or knowledge workers without acknowledging the dynamics in this space which is large movement to completely remote work or hybrid workforces resulting in positive impacts on automobile congestion in the future. Furthermore, it is also a known fact that people shopping remotely for everything will only continue to grow in the coming decades further reducing congestion associated with cars. Net-net, it is highly questionable to state that there will be materially more cars on the road in 2050 than there is right now in 2021 requiring huge new investments in rail and bus.</p>	<p>A key goal of the public involvement process is to hear from diverse stakeholders and residents to gain additional insights, better understand concerns, address them or adapt ideas. To reduce bias SANDAG uses an evaluation criteria process for evaluating project bundles (Appendix T) and an activity based model to assess the performance of the transportation system (Appendix S)</p> <p>The transit system envisioned in this Plan responds to updated growth projections and focuses on high-speed services that will connect jobs and offer service with similar travel times as autos. Previous plans focused on access but not necessarily speed of travel and equivalency with other options, thereby making these planned services much more desirable to the traveling public.</p> <p>Although population growth is forecasted to be slower between now and 2050 than it was forecasted to grow in previous decades, the population of the region is still forecasted to grow, adding population of all age groups to the region.</p>
W182	Glen Hopkins		<p>In addition to the demographic trends mentioned above, the report absolutely ignores the impact of convenience, or the lack thereof, that comes with mass transit. For all people, time is</p>	<p>The transportation system is designed to provide convenient travel choices for residents, employees, and visitors. Fast and frequent transit remains the most effective way to</p>

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			<p>precious! Based on San Diego’s predicted density there is little chance that mass transit will be more convenient for a very large majority of individuals living, working, or visiting San Diego. What the report also does NOT acknowledge is that the vast majority of people love cars, want cars and there is no factual information anywhere that says they are going to be willing to give them up. The plan also does not point out the aggressive plans in place to make cars more sustainable. There is though factual information that says when car and gas prices come down, higher numbers of lower economic echelons of society access them (cars) for all the obvious reasons. As such, if we really cared about equity, we would be talking about making cars (or ride sharing – Lyft &amp; Uber) more affordable and practical for everyone in San Diego.</p>	<p>move a lot of people and studies indicate that this will continue to be the case well into the future. Commuter rail operating along the region’s urban corridors, can serve longer-distance regional trips and providing a remedy for today’s congested corridors. Additionally, Flexible Fleets like e-bikes, shuttles, or autonomous ridesharing will be available to serve shorter trips or areas where traditional fixed transit may not work well. Analysis during development of the Plan found that over 90 percent of the county’s population is within a 10-minute Flexible Fleet ride to transit. Together, these multimodal services provide greater and more convenient choices than what is available today. SANDAG is planning to start testing and launching Flexible Fleet pilots in 2022. Pilots will be designed to provide affordable and convenient options based on community needs.</p>
W183	Glen Hopkins		<p>And finally, in the body of the report there is no acknowledgement that MTS is currently “struggling” at best other than what can be found in the last auditors report buried in the appendix. Huge investments have been made over the last two decades, fare prices are highly subsidized, yet ridership, like virtually every other city in the country, has been declining over the years. Contrast this with the airline and automobile ecosystems that have not, and do not, require massive government subsidies. Cars and planes are an instructive example of free market capitalism at work – people want to drive their own cars (or take Uber), people want to selectively fly, and thus industries are willing to invest, and people are willing to pay. In summary, I find the SANDAG Regional Plan flawed on multiple accounts. The focus should be on more convenient and more efficient automobile infrastructure investments selectively augmented with other transportation means, not the reverse.</p>	<p>While SANDAG is primarily concerned with ground transportation, both the airline and automobile transportation systems receive massive government subsidies annually. Transportation Network Company services like Uber and Lyft are being subsidized by venture capital.  SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system, how different modes are being subsidized, and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p>
W184	Gloria Van Grove		<p>We DO NOT need a high speed railway down the coast. There is already a sufficient travel method via rail (Coaster &amp; Trolley). We need a viable solution such as a trolley line along the I 15 corridor. This freeway is congested much of the day between Mira Mesa and Rancho Bernardo. Please reconsider removing parking from businesses and apartment complexes until the infrastructure is in place. Even if one lived within walking distance of transit, it is unlikely that the destination is also (and vice versa). It is inconsiderate to the disabled, lower, and middle class to force us to hire a ride. I cannot get anywhere I want to go without a car. Please reconsider and listen to the residents of the county. That is what the city counsel and board of supervisors were elected to do. Don’t assume that you know best for us. And stop the ADUs from destroying suburban communities. More housing would be available if you at least enforced the current laws and enacted stricter laws concerning vacation rentals.</p>	<p>The Coaster is the only commuter rail planned for the I-5 corridor. No additional rail lines are proposed. The I-15 Corridor is difficult to serve with rail because of the development patterns which resulted in widely spread out communities. This area is served by Rapid bus routes which will be expanded in the future with more services. All of our major capital projects go through additional planning that will assess the impacts to parking. In the event parking is removed a viable transportation option will be available. SANDAG does not have housing authority but makes recommendations that housing density be placed near major transit nodes.</p>
W185	Greg Lefevre		<p>Photo in your and says it all: your plan caters to a tiny minority, cyclists, young who bike for recreation. It ignores the majority, including seniors who rely on vehicles for transportation, shopping, commuting, medical and personal visitation. You pattern after the failed Encinitas model which has brought only injuries, congestion, hampered movement and dissatisfaction. Your solutions are based on &lt;mile planning while the populations you pretend to serve are &gt;mile communities.</p>	<p>The 2021 Regional Plan aims to provide a system that improves access for all including seniors and those who bike, walk, drive or take transit. The Plan improves access for those who drive but also improves access to a quality public transportation system for all San Diego residents, especially for seniors and other disadvantaged populations.</p>
W186	Guadalupe Lopez	El Cajon Collaborative/Barrio Logan College Institute Parent Spanish	<p>Thank you for all the work you put into the plan (SANDAG). We are happy you are including the community in your planning. I like the transit center in El Cajon and look forward to it being built. The train will be very beneficial to residents in El Cajon. I also like the downtown transit center and happy there will be a train to the airport.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W187	Guadalupe Rosas	NLRC	<p>I’m from Los Angeles but I attend Cal State San Marcos. I’m going into my 5th year there and something I have noticed about the city of San Marcos and its that skate boards are prohibited. With that I’m assuming so are scooters and rental bikes. I would like for that to change because I know SD has many of those scooters that anyone can use, would be very helpful for the students that attend CSUSM. I lived in the dorms and it was very challenging to be able to get groceries especially since I didn’t have a car. If I wanted to take an Uber it would be like \$5 just to go to Ralphs which is down the street. If the scooters were available it would be so much helpful and affordable for the students that live around that general area.</p>	<p>While the various cities in our region (e.g. San Marcos) can apply and enforce regulations on their roadways, the Regional Plan encourages access to transit and to future Mobility Hubs via a number of mobility options, including scooters and skateboards. SANDAG is committed to working with the local jurisdictions to ensure safe access to all transportation options and will be developing a Flexible Fleet Implementation Strategic Plan upon adoption of the Regional Plan.  Your comment was forwarded to the City of San Marcos.</p>

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W188	Guy Johnson	Voter	<p>SANDAG's plans for the county will continue to isolate the communities they believe they are helping. Commute times from the east, north and south parts of the county will not improve. These times are not reasonable even where public transportation is available (trolley and bus services). SANDAG's support of the states proposed road home program will further isolate these outlying communities. These additional taxes based on distances driven discriminates against those who can't afford to live in the coastal communities. Creating additional governmental bureaucracies will only cost taxpayers more. Do your job improve the existing roads. At some point you need to realize somethings (bike lanes, bus and trolley lines) are not cost effective. At what cost to the taxpayers do you put the environment and you personal agendas? Represent the people and give us our independence, freedom and choices without Government interference. SANDAG has its own agenda not the citizens who pay your salaries.</p>	<p>The 2021 Regional Plan includes a variety of transportation options serving communities across the region. In particular, the services envisioned as Flexible Fleets will offer convenient, on-demand transportation options that may be preferred to driving a personal vehicle for certain trips. The plan includes improvements to existing transit services and an expanded transit network to serve more communities. Maintenance of existing roads continues to be a priority of the plan's Fix-It First policy area. In particular, many improvements are identified in the rural corridors of the region as described in Appendix A.</p>
W189	Hannah Doermann	UCSD	<p>Environmental justice must be embedded in our mobility in San Diego. Therefore, I ask that the 10 Big Moves to Transportation Justice be included in the 2021 Regional Transportation Plan. I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.</p> <p>I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.</p> <p>I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.</p> <p>I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr. service on popular transit routes and present a clear implementation schedule.</p> <p>I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion I call for no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Further, I ask that it be accelerated for a 2023 implementation rather than the current delayed plan to implement in 2027.</p> <p>I call for an electrified bus fleet by 2030. Fund the implementation of California's Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot</p>

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				<p>that may provide free fares for youth under age 19.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p>
W190	Haoyu Jia	UC San Diego	<p>Two questions regarding the transit leap projects:</p> <p>For the 2025 transit leap projects, I see a lot of comments about light versions of the Rapid. What does that entail exactly? Does it include 10 minute headways, bus lanes, or signal priority? Or would it be more like the Superloop (just larger bus shelters without much changes)?</p> <p>For the high speed commuter rail that’s being proposed, does SANDAG have any detailed plans for implementation? Namely, approximately how much tunneling or viaducts will be needed for commuter rail lines, what kind of rolling stock would be required, and would overhead electrification (i.e. Caltrain) be involved? I might have the math wrong, but it seems like y’all are budgeting for 250 million USD per km, which is much lower than what underground/elevated rail normally costs in the US, while the current study for Coaster improvements already estimates total cost of 4.2 billion USD.</p>	<p>Light versions of Next Generation Rapids are only planned for the earliest years of the plan to get these routes in operation sooner. The routes will be fully upgraded by 2035. The light version of Rapids include the higher frequencies and span of service but will not include all of the same infrastructure as the full implementation Rapids.</p> <p>With regard to commuter rail, SANDAG uses Federal Transit Administration costing sheets which include the estimation for below ground, viaducts, culverts, and at-grade. It also includes the rolling stock.</p>
W191	Hayden Schill		<p>I am a volunteer with San Diego 350. I believe every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. I urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p>
W192	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	<p>Submitted in Arabic- I wish the Arabic translation would be available for the schedule so Arab immigrants can use transportation more, and also classes for us to know how to use the transportation because most of us are not capable of using them. We are afraid that we are going to make the right time and place. A free local train (shuttle) would be nice.</p>	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (CBOs) to ensure that language translations (such as schedules in Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services such as the trolley and shuttles. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. You can find more information on the Regional Fare Impact Study also in Appendix B.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>
W193	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	<p>The lecture was very useful and valuable with good information. Our children need this support to go to school (university) and do other things in faraway places from home. We wish the information was available in Arabic for the community of El Cajon.</p>	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action</p>



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				<p>Plan.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services such as the trolley and busses. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth.</p> <p>In Appendix U: Cost Estimation Methodology, Table U.2 captures the transit fare subsidies to riders throughout FY2026-FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U.</p>
W194	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- It was a beautiful lecture and very useful for me. Now I have hope of changing many things in my life. We will be able to move easier and visit places with our family. I wish for everybody working on this project success and achievement. Now we need a class on how to move around.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W195	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- We wish from new plan to help us use the train (trolley). We need to get there faster. Arabic language is very important. We are afraid if we lose our way and don't know how to get home. I hope all information will be in Arabic. Free or low prices are also very important. Classes will help us break the fear factor.	<p>SANDAG will be applying a social equity planning framework throughout the implementation of the Regional Plan. Through this framework, one of the Regional Plan's near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as in Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>
W196	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- All the plans were very good and it is good to know. If we put good information about buses and trains (trolley) in Arabic we will use it and enjoy. I wish for a free bus or train (shuttle) in El Cajon for low-income people.	<p>One of the Regional Plan's near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services such as the trolley and buses. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth.</p>
W197	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	Submitted in Arabic- Hi. How are you? This was very good, useful and amazing but I wish from you some things I hope become true. First, I want information about train (trolley) and public transportation in Arabic. Second, I wish a train (shuttle) or bus available. Third, a class on how to use transportation. Fourth, The problem of traffic lights in the morning because I have 2 children (one in elementary school and one in middle school). (She likes the idea of smart signals.)	One of the Regional Plan's near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.

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				<p>Additionally, our planning framework also includes implementing smart intersections in our complete corridors. Through technology and infrastructure improvements, one of the features of our complete corridors are smart intersections. These smart intersections will facilitate communication among users, improve traffic flow, situational awareness, signal operations, and intersection safety. For more information on complete corridors and smart intersection systems, please see Appendix A: Transportation Projects, Programs, and Phasing.</p>
W198	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	<p>The idea of the plan is very good. I am happy there is such a project in El Cajon city. But we need some ideas in El Cajon the most important thing is first road map in Arabic (bus routes) and schedule of buses and trains (trolley). Second, we need a free bus (shuttle) that goes around El Cajon streets. Third, we need to make tickets for transportation free for Arabi students.</p>	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services such as the trolley and busses. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth.</p> <p>In Appendix U: Cost Estimation Methodology, Table U.2 captures the transit fare subsidies to riders throughout FY2026-FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>
W199	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	<p>There is some lane striping that is fading. Please renew stripes in roads or make them darker before accidents happen. Please work on new projects (in Regional Plan) and make information available in Arabic. Also information on buses in Arabic, too. Also, the free bus (shuttle in El Cajon).</p>	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services, such as our buses. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth.</p> <p>Lastly, SANDAG will create a framework, called the Fix it First Strategy, which aims to repair our region’s existing roads (such as lane striping) and develop long-term maintenance of our transportation network.</p> <p>For more information on these three initiatives, see Appendix B: Implementation Actions.</p> <p>Your comment was forwarded to the City of El Cajon.</p>

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W200	Heba Hadaya	El Cajon Collaborative/ Barrio Logan College Institute Parent Arabic	<p>The plan was great. We need more information in Arabic like bus lines, time, and more. Information also help to get training on how to use the train (trolley) and bus. Free or very low cost shuttle in El Cajon is really needed for senior and low-income.</p>	<p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems. For more information, I would like to refer you to Appendix B: Implementation Actions, for more information on the Digital Equity Strategy and Action Plan.</p> <p>In addition to language accessibility, SANDAG will also conduct a near-term Regional Fare Impact Study for our transit services such as the trolley and busses. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth.</p> <p>In Appendix U: Cost Estimation Methodology, Table U.2 captures the transit fare subsidies to riders throughout FY2026-FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U.</p>
W201	Ioana Tcholakova	Interfaith Coalition for Earth Justice	<p>I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.</p> <p>I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.</p> <p>I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.</p> <p>I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr service on popular transit routes and present a clear implementation schedule.</p> <p>I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion</p> <p>I call for no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Further, I ask that it be accelerated for a 2035 implementation rather than the current delayed plan to implement in 2027.</p> <p>I call for an electrified bus fleet by 2030. Fund the implementation of California’s Innovative Clean Transit rule to accelerate the electrification of the</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for</p>



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			<p>bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.</p> <p>I call for the funding of to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study.</p> <p>I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets.</p> <p>I call for the funding of the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.</p>	<p>people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
W202	Irwin von Winckelmann	Global Ohana	<p>I would like to see an improvement to the bike lanes that are not protected by parked cars or a barrier. Any and all bicycle lanes should be marked with reflective paint and also have that bicycle separation line marked using a rumble strip. When cyclists are not in the bicycle lane, automobiles regularly cross over into the bicycle lane. Providing the rumble strip will help separate the traffic lane from the bicycle lane. The rumble strip also works as an important reminder to drivers, that the bicycle lane is there and to stay to the left and in their own traffic lane. Let's make it a habit for people to stay away from the bicycle lane by adding the rumble strip to all bicycle lanes that share traffic lanes with the automobile.</p>	<p>SANDAG follows national and international best practices in bikeway design to create safe facilities for users of all ages and abilities. Multiple studies show that most people feel safer in protected bikeways, and when well designed, they are safer than any other type of bike facility. The focus of our efforts is on people who may be "interested but concerned" in riding a bike alone or with family. For those who do not feel comfortable riding in protected bikeways, the California Vehicle Code allows people to bike in the roadway with traffic. While protected bikeways are a great solution in many cases, we know they are not always the best solution. Every project goes through a detailed and context sensitive design process which results in decisions regarding the best facility, which may include protected bikeways, buffered bikeways, shared use paths, or shared streets with significant traffic calming elements. The Regional Plan also includes funding for upgrading existing bikeways that may not meet current best practices in maintenance or bikeway design.</p>
W203	Jacquelyn Clark	NAACP San Diego, Chair Environmental & Climate Justice Committee	<p>Overcoming the fear of being hit by a vehicle is a top concern for many pedestrians and those who already take public transportation. Even with clearly marked bike lanes, drivers still cross over those lines all the time. In areas where there are no sidewalks, walking in the bike lane would seem like a safe bet, but is actually very scary and dangerous. There is no barrier between a bicyclist and a vehicle. There needs to be some kind of barrier. Consideration should be given to also places where riding a bicycle excludes motor vehicles. To have the full benefit of clean, fresh air from the reduction of pollutants being released in the air, having a safe place to ride bicycles is also a way to have improved outcomes of better health.</p>	<p>SANDAG follows national and international best practices in bikeway design to create safe facilities for users of all ages and abilities. Multiple studies show that most people feel safer in protected bikeways, and when well designed, they are safer than any other type of bike facility. Every project goes through a detailed and context sensitive design process which results in decisions regarding the best facility, which may include protected bikeways, buffered bikeways, shared use paths, or shared streets with significant traffic calming elements which includes improvements for people walking or using transit. The Regional Vision also includes funding for upgrading existing bikeways that may not meet current best practices in maintenance or bikeway design. Additionally, as an early action out of the Regional Plan, SANDAG will be developing a</p>

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				new Regional Active Transportation Network in which projects will be reassessed and reprioritized based on data and community engagement.
W204	Jacquelyn Clark	NAACP San Diego, Chair Environmental & Climate Justice Committee	For the emergency preparedness bringing awareness to communities about what bus lines and trolley lines are in the community would benefit the households by knowing in advance what is available close to where they reside. Maintaining the signals at trolley stops Lemon Grove in particular is important if traffic will be diverted to flow in a certain direction. It is terribly frightening at the Lemon Grove crossing because the lights never work. That is so unacceptable. Several trolley stations on The Orange Line need to be re-evaluated for safety and emergency preparedness. The current infrastructure does not seem like it would hold up if a widescale evacuation of the areas were necessary.	<p>MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q: Transportation Security and Safety also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>
W205	Jacquelyn Clark	NAACP San Diego, Chair Environmental & Climate Justice Committee	All I can say is that it took nearly 2 hours to get from Lemon Grove to Old Town Trolley, to get a bus to Ocean Beach. That's like traveling by vehicle to Los Angeles on a good day.	The Regional Plan includes a variety of new commuter rail services that will provide higher speed transit with reduced travel times. Additionally, existing transit is envisioned to be upgraded with grade separations that allow for faster travel times and more frequency throughout the day.
W206	Jacquelyn Clark	The San Diego Urban Collaborative Project	Gain meaningful input from a broad range of individuals, organizations, agencies, and (The MTS has the opportunity to reach the broadest and pertinent individuals. Those who actually use public transportation have the most at stake. When the Public Safety Officers board the trolley to check for fares they announce themselves and give instructions to have fare and passes ready for instruction. Also, with the rollout of the new Pronto system public outreach is happening at different stations at different times. Perhaps there is an opportunity to utilize the same method to engage public involvement by going more consistently to those who are already on a transit system and who use it frequently. Occasional public transportation users experiences are different from regular, frequent user's experiences. There is a difference between choosing public transportation as an option and it being your only option. Each experience matters, but the one who rides more often has more to gain or lose. Seeking input from both groups adds value however I am more partial to those who rely on public transportation to get to work, appointments, grocery shopping, school, etc... Offering something free, daily, weekly or monthly passes for participating is a sure way to get their attention and participation. I would definitely perk up and listen if I was offered a free pass. I do not purchase a monthly pass because I primarily telework. However I still like to get out and around San Diego. So each time I pay for a daily pass. I'd love to be given a daily pass to use for future travel. Those are the things frequent public transportation users appreciate. Something- Anything free and useful.)	Meaningful input and public participation is key to the success of the Regional Plan. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W207	Jaime Gonzales		We do not need transit at the NAVWAR facility, which would bring untenable scarifies to the life, cultural, and historical experience of San Diego citizens and visitors today and in the future (350 ft buildings, density that matches Coronado, 70K added car trips a day). The tradeoffs do not justify the returns nor has the Navy provided even close to adequate mitigations to address the risks introduced by the proposals. Put transit downtown at the Santa Fe Station where it can be connected to other regional lines and serve as a hub for our vibrant downtown community.	Development of the NAVWAR facility project is being led by the Navy. Please visit: <a href="https://navwar-revitalization.com/">https://navwar-revitalization.com/</a> for more information regarding the NAVWAR facility project.
W208	james brannen		I do not envision going anywhere on a bicycle. I am deeply offended that your "plan" is being crammed down my throat. I am seriously considering moving to another state	Thank you for your comment.
W209	Janae Kenner	N/A	<p>I would like to share my feedback on the proposal for a transportation tax for San Diego residence.</p> <p>No, no, no! Don't do this to me. This tax will affect those of us who already can't afford to live near our jobs and have to commute into more affluent areas for work. We commute because there aren't many jobs where we live and we have to commute long distances because we aren't paid enough to live in the area where jobs are located. People say that they need workers and that jobs aren't being filled, I believe this tax will make it harder for people to get to work.</p> <p>I am a parent and in order provide my child with access to activities and opportunity, I drive him</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents,</p>

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			<p>to more affluent areas and it helps us. The education and instruction is better. If you have this new tax it will crush us. We can barely afford to have in these activities with our limited one income budget.</p> <p>If you pass this transportation tax it will affect his entire life prospects. We may not be able to continue taking him to these places in San Diego because we can't afford to. He is the only representative of his ethnicity there.</p> <p>This tax will increase the gap between the haves and the have-nots. It will negatively impact the elderly and anyone who is on a fixed income. It will gravely affect the poor and middle-class families. It will create isolated islands based on where you live and severely reduce diversity and socialization between social classes. STOP this tax!!!</p>	<p>visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p>
W210	Jane Illades		<p>I call for an Environmental Justice RTP, including 24 hour service, Purple Lline alignment, More investment in the Blue Line Express, Electrified Bus Service by 2030, And Anti-Displacement that doesn't gentrify communities</p>	<p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
W211	Janet Lettang	self	<p>REMEMBER THE DISABLED WHEN YOU ARE CREATING THIS PLAN!</p>	<p>The 2021 Regional Plan makes significant investments in paratransit programs as well as including 'universal design' in projects to ensure that transportation means access for all.</p>

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			<p>As it is now it is difficult for the disabled to get from place to place. Some of us have no other option than to drive our own cars (for us with a wheel chair lift to get to our appointments and essential outings.</p> <p>Please keep in mind the challenges of the disabled when you finalize your plan.</p>	<p>SANDAG also has an advisory group, Social Services Transportation Advisory Council (SSTAC), who represent social service agencies, individuals, transportation providers, and the Consolidated Transportation Services Agency. The mission of SSTAC is to review, recommend, and promote the development and use of accessible transportation services within the San Diego region.</p>
W212	Janette Olivera		<p>Even though this plan has good intentions, it is unfair to those of us that are lower income and simply cannot afford to travel less. It is extremely unfair to those that live further from jobs in the city of San Diego and have long commutes due to housing closer to work simply being unaffordable to an average American with an average income. Californians already pay outrageously high taxes and the government is not transparent or specific enough about how our collected taxes are invested in infrastructure or other programs. I oppose this plan!!</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W213	Janice Valdivia		<p>OCEANSIDE (KUSI) – SANDAG’s \$160-billion plan to expand rail, bus and other transportation services relies heavily on getting more money from drivers by way of a road charge.</p> <p>The fee would charge drivers a set price for every mile traveled within the state.</p> <p>SANDAG has still not yet decided how to collect the road charges, which it anticipates collecting more than \$34 billion through to 2050.</p> <p>I find this to be rather counter-productive to SANDAG’s goal of ensuring equity in the transportation sector by charging those who drive THROUGHOUT the state of California to use the roads our high taxes (gas and local) are already paying for. This isn’t about any type of improvement in life, it’s about making those who can pay, pay more. Just WHO will be able to afford to drive anywhere? Take a road trip, don’t think so. Drive to see elderly family members--- let me check my bank account. This will cause more harm than good if you look at the whole picture. Just how much will it cost me to go to work every day? Who is going to drive to shop, dine out when charged to do so? Please re-think your plan. It’s harmful and unjust.</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
W214	Jeanne Rawlings	San Diego Commons	<p>Does SANDAG’s projected 2050 13% population increase account for the projected significant regional water supply decrease and potential water insufficiency to support that level of growth?</p>	<p>The future population projections used in the Regional Growth Forecast are based on the vintage 2019 Department of Finance population projections release on January 10, 2020</p>



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				and are not based on water availability in the region. The County Water Authority (CWA) uses SANDAG's Regional Growth Forecast in their water planning efforts.
W215	Jeannette Temple	Atlantis Group Land Use Planning	Love it!! We need to move beyond cars. Demand must happen before transit expands...	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W216	Jeff Bonine	Mid-City CAN	I am a volunteer with Mid-City CAN and an educator in City Heights for over 15 years. Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under as well as our seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated. Not only do programs like this create life long transit riders, no-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities. Something that is critical to our youth's success. Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles. I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.	SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.  Transit subsidies also are a component of the Plan and implementation of those subsidies would include consideration of low-income and youth populations.
W217	Jeff Huston		Your plan sucks. Period. Stop taxing me	Thank you for your comment.
W218	Jeffrey Joseph		Toll roads are offensive because motorists are already paying for roads. Plus it's regressive and discriminates against motorists who are forced to live longer distances due to housing costs. Finally, what is SANDAG's authority to impose user fees on the public?	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.  The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.
W219	Jeffrey Mihalik		I am a strong supporter of the plan. I am particularly happy that the plan increases bus frequencies to every 10 minutes on key routes - great idea!  But I can't find anything on trolley frequencies. We should aim for every 5 mins on the Blue line and every 10 mins on Green and Orange lines, minimum.	The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final 2021 Regional Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021.
W220	Jeffrey Mihalik		I support the plan's vision for a network of high-speed regional rail lines linking our county together. Please make sure these lines are fully electric, with overhead catenary, following the best practices for regional rail lines in countries like Germany and Switzerland. I would also encourage SANDAG to build the north-south (Oceanside-San Ysidro) line first, as this seems the highest potential ridership. Also make sure a one-seat ride from Oceanside to San Ysidro is possible. Having to change trains downtown would waste time.	Vehicle type, detailed ridership, and more detailed station-by-station routing would be explored through advanced planning of regional rail lines. This regional scale approach presents the vision for a more connected and high speed network that better addresses future population, housing and employment growth. The commuter rail line between National City and Sorrento Mesa would be phased first with other connecting segments to follow based on funding availability. However, other alternatives would be studied during the specific analysis of that corridor which would follow the adoption of the Regional Plan.

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W221	Jeffrey Mihalik		Please make sure this plan will increase blue line trolley frequency to every 5 minutes and orange and green line frequency to every 10 minutes. Also please make sure all bus routes come at least every 15 minutes. Increasing service is the easiest and cheapest way to make transit more useful.	The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A of the proposed Final 2021 Regional Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021.
W222	Jeffrey Mihalik		I support SANDAG’s plan for a regional rail system. Please make sure it is fast and runs frequently, with man good connections. I would also make sure there is a one seat ride all the way from Oceanside to San Ysidro.	SANDAG is working on a commuter rail plan that would get the vehicles up to 110 mph and trains coming every 10 minutes. The current plan does not include a route from Oceanside to San Ysidro, however, there will be opportunities for a seamless connection at several stations that would allow a passenger to make this trip.
W223	Jennifer Avina		I am happy with the focus on transportation alternatives to cars. Please continue to work for easier public transit options to our beaches and airport. I also support increasing dedicated bike lanes at the expense of car access and parking. Thank you.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W224	Jennifer Dunaway		SANDAG already has enough taxpayer money. You do not need more of taxpayer hard earned money to spend as you see fit. Spend what you have and do what said you were going to do earlier. Two HOV lanes on I-5, one on 78; follow through with your plans.	<p>The <i>TransNet</i> measure approved by San Diego county voters in 2004 focused on congestion relief and included a set of transportation improvements, many of which have been completed. The remaining projects in the <i>TransNet</i> measure may not be constructed due to changes in regional needs, changes in state law, and technology advancements that would suggest a different transportation solution.</p> <p>The SANDAG Board of Directors may review the <i>TransNet</i> ordinance and discuss possible updates. This process is outside of the development the 2021 Regional Plan.</p>
W225	Jennifer Dunaway	private citizen	If you truly want comments, you need to put choices on a ballot for citizens to choose from. NO MILE TAX! Use our outrageous income taxes, increased gas taxes, and property and sales taxes to fund roadway improvements. We just increased gas taxes. California’s income tax is extremely high; use some of that for roadway and trolley improvements. Stop coming after taxpayers for yet more money. Stay out of our lives and our cars.	Modern funding solutions, such as a road usage charge, provide an opportunity to achieve multiple goals, such as: generating revenue to maintain and improve our transportation system; reducing greenhouse gas emissions; optimizing performance of the transportation system; relieving congestion; improving mobility; improving equity by exploring opportunities to reduce the burden on lower income individuals; and promoting fairness.
W226	Jennifer Saliwan		<p>I have lived in San Diego County for almost 50 years. My family and I live in the southeastern part of the county. We live here because it’s more affordable. I am strongly opposed to the idea of a per mile tax. If you add a per mile tax to San Diego County residents, you will be unfairly burdening the less affluent people who live farther away from business centers. Look at a map and find the communities that are furthest away from downtown, Mission Valley, Mira Mesa, etc. Those are the communities that will pay the most and they can least afford it! Public transportation is not a viable option. It would take me two hours to get to work and it would involve more than 40 bus stops and 6 trolley stops. Not to mention that no one in my family feels safe on public transportation.</p> <p>Use the money you already have, stop wasting it on trolleys that no one uses, and widen our freeways in the south and east county. Give us a carpool lane on 8. Don’t keep ignoring us because we are poor and brown!</p> <p>Do you want the real solution to our traffic problems? Give businesses who utilize work-from-home employees a tax incentive. We all saw the empty freeways and breathed the clean air in March 2020. Incentivize THAT!</p>	<p>The 2021 Regional Plan re-envision the transportation network which includes a system of managed lanes supported by technology improvements. Managed lanes operate very similar to the I-15 Express Lanes which prioritize use of transit, carpools, vanpools, and rideshare. The plan proposes 4 managed lanes on I-8 from I-5 to Greenfield Dr. Near-term and continuing actions in the plan include an updated and expanded Regional Telework Assistance Program and transportation demand management grant and incentive programs to expand the region’s low-carbon transportation options.</p> <p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are</p>

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				multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.
W227	Jerry Holden		Let's focus on common sense the easiest thing for our community is to expand the 805 and the 5 freeways so people that don't have to sit in traffic. Fix the potholes on the streets to make biking safer I never bike at night because there's so many potholes. Sadly we wasted 2 billion dollars on a trolley going to UTC that will get limited no use. We've shut down Friars Road now for over a month and I can't get to PB in a timely manner. If your organization has all the time and money the wastes in such a plan I will not be voting for any tax increases for SANDAG in the future.	The Regional Plan is a federally required document with updates every four years. The draft Regional Plan seeks to provide transportation options through highway improvements, enhancements to transit, complete corridors for all modes and much more. Regarding pavement, the draft Regional Plan includes a Fix-it-First infrastructure program to support pavement preservation and maintenance across the region in addition to Local Streets and Roads dollars which are allocated to the cities and County within the region.
W228	Jim Curl	Oceanside Bicycle and Pedestrian Committee.	Please consider this a letter in support of the letter sent to SANDAG on 7/15/21 by Tom Lichterman, Chairman of the Oceanside Bicycle and Pedestrian Committee about the completion of the Inland Rail Trail section that serves the Oceanside Community. My opinions are contained in that letter, but it might be helpful to consider that our committee (I am co-chair) has worked for nearly 15 years on this issue and to wait for completion of this section until 2035 - 40 years after it was approved! Thank you for your consideration.	We have reviewed and responded to the Oceanside Bicycle and Pedestrian Committee via Tom Lichterman. I'd encourage your organization to be involved with the efforts of the North County CMCP if you are not already. <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail</a> .
W229	Joanna Gonzalez	El Cajon Collaborative/Barrio Logan College Institute Parent Spanish	Please keep us posted as new projects come to El Cajon. We would like to be included in more conversations. This has been very helpful, and we always enjoy Carol Lewis' information on the plan and how it was put together. Thank you for including us. Please be sure that there is money for street improvements. We need more crosswalks and bike lanes.	The plan includes funding for local streets and road and active transportation projects that would include features like crosswalks and bike lanes in El Cajon. We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W230	John Berry		Notes regarding the proposed Draft. 1) Too much money goes to mass transit, bikes, scooters	Thank you for your comment.
W231	John Berry		2) Not enough emphasis on expanding and/or building new roadways.	Thank you for your comment.
W232	John Berry		3) This plan will penalize drivers.	Thank you for your comment.
W233	John Berry		4) Where is the equity for self employed service contractors? You can't take a ladder on a bus or a scooter!	The 2021 Regional Plan aims to provide a system that provides transportation choices and improves access for all including those who bike, walk, drive or take transit.
W234	John Berry		5) The proposed "Grand Central Station" has been done it's called 1 America Plaza	The Central Mobility Hub will serve as a central gateway to the region with direct and convenient connections between every transit mode, the airport, the regional highway system while serving as a catalyst for transit oriented development.
W235	John Berry		6) Let technology deal with GHG through efficiency and Electric Vehicles.	The Regional Plan supports investments in the electrification of cars, trucks and buses and their supporting infrastructure (e.g., EV charging stations and hydrogen fueling stations). These electric vehicle investments are one of the ways SANDAG is working to reduce regional GHG emissions and improve local air quality. Appendices A (Table A.17) and B show SANDAG's proposed EV commitments. Innovation and advanced technologies will be critical to meeting regional GHG reduction goals in 2035 and 2050.
W236	John Dismukes	Capstone Studios	We live by Santa Fe Depot The trollies are very noisy can they reduce the beeping ? The Coaster train is terrible blowing horn and binging.	Quiet zones have been installed at all downtown at-grade crossings. These quiet zones reduce train horn noise, but operators have the obligation to sound horns if there are people or cars on the tracks. There are federal safety requirements for horns and bells at stations.
W237	John Eldon		The stack-and-pack infill Mobility Hub concept will destroy established residential neighborhoods in Encinitas, Solana Beach, and other coastal communities that are already bumping up against very real limits to population growth.	Mobility Hubs will be implemented in close coordination with local jurisdictions to align with the unique needs of each community. Local jurisdictions maintain land use authority and are responsible for decisions regarding density, zoning, and housing policies.
W238	John Eldon		For transit to work we do indeed need density at commercial, office, cultural, shopping, education, and employment destinations, because the Last Mile Problem is challenging. We do NOT need density at the source/origin end, because the First Mile Problem is trivial to solve with park&ride, bike&ride, kiss&ride (drop-off), etc. Don't destroy established residential neighborhoods with dense infill.	The 2021 Regional Plan envisions forecasted growth to be concentrated in Mobility Hubs throughout the region, which will be implemented in close coordination with local jurisdictions to align with the unique needs of each community. Many Mobility Hubs are employment centers or other popular destinations, and SANDAG would work with local jurisdictions to update plans and policies to allow for more housing in these locations where feasible. Local jurisdictions maintain land use authority and are responsible for decisions regarding density, zoning, and housing policies.



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W239	John Escher		The vast majority (95%?) of San Diego County residents want to continue to use cars for transportation. Even if we spend billions of dollars on mass transit only a small percentage of the population will use it. What we need is cleaner air. Mass transit will only have a tiny impact on improving air quality over the next 40 years. If we can get people to want and buy electric cars and trucks we could see a very substantial improvement in air quality in the next 10 years. SANDAG and the State of California should either be building out a very extensive very high speed “charging station” system on state and federal road ways or by providing private enterprise substantial subsidies to build out a very complete charging station system.	The 2021 Regional Plan supports investments in the electrification of cars, trucks and buses and their supporting infrastructure (e.g., EV charging stations and hydrogen fueling stations). These electric vehicle investments are one of the ways SANDAG is working to reduce regional GHG emissions and improve local air quality. Appendices A (Table A.17) and B show SANDAG’s proposed EV commitments. Innovation and advanced technologies will be critical to meeting regional GHG reduction goals in 2035.
W240	John Wotzka	Public speaker	Information on up coming floating offshore wind projects in California at the Morro Bay 399 Area with 3-GW of power and a project in the Humboldt Call Area. A lease sail could be done by mid-2022. Marine Log June 2021 pp. 26-27 Please allow me to send you comments by putting me on your list to do so. I attended public meeting for over 5-years before the pandemic closed us off at 401 B Street and I have not been able to send you comments.	The Port of San Diego would be the local lead agency for any Offshore Wind project. SANDAG will work with the Port of San Diego to discuss their efforts related to Offshore Wind projects and future transportation needs.  Your comment was forwarded to the Port of San Diego.
W241	John Wotzka	Public speaker, self, Regional Transportation Committee and research of energy issues.	Offshore Wind development is picking up off California with floating off shore turbine units concepts and lease areas. Funding is there from the Biden Administration and ports will be need to receive components and provide facilities for maintenance. Planning and development will be need in the Bold New Vision for the 2021 Regional Plan. These offshore units will provide power for the High Speed Rail system in the future too. This will reduce GHGs and provide a cleaner atmosphere in the future for the California coastal areas.	The Port of San Diego would be the local lead agency for the Offshore Wind project. SANDAG will work with the Port of San Diego to discuss the Offshore Wind project and other future transportation needs.  Your comment was forwarded to the Port of San Diego.
W242	John Wotzka	Public speaker, self, Regional Transportation Committee and research of energy issues.	There is a good update on the Navy’s shipbuilding for the future in the Congressional Research Service reports. They envision a Navy force-level goal for a 2045 fleet of 382 to 446 manned ships and 143 to 242 large unmanned vessels. Ref: Marine Log July 2021 pp. 15-18.	SANDAG works very closely with our military partners. Growth in their fleets and populations are included in our growth forecasts. We also work with our military partners on innovative transportation solutions for their commutes.
W243	John Wotzka	Public speaker, self, Regional Transportation Committee and research of energy issues.	With the changing of transportation systems to depend on energy supply’s moving away from fossil fuels to solar, on-land wind turbines, floating offshore wind turbines on the West Coast, and low carbon renewable fuels, such as hydrogen and biofuels, elsewhere, we will have less health issues and a longer and heather life span. As for power plants for energy for the transportation system, we will depend more on renewables and energy storage systems and will also have renewable and sustainable resources such as renewable fuels and more efficient ships in the future that are being developed for the Import/Export fleets. IMO’s mandates for a greener shipping fleet are in place and coming to mandated levels. Ports will need upgrades to use renewables and move away from fossil fuels in their infrastructure, to become less carbon intensive. Offshore wind will play a roll here too, as the ports are on the coasts. High Speed Rail will reduce carbon emissions by using less air travel and reducing vehicles on the roads with renewable energy sources from offshore wind systems along the California Coast. Smart energy management grid systems and home systems will help home owners to use energy more wisely such as using EVs as a backup to reduce power companies needs to build more power plants and be the home owners will able to save money on their electric bills by selling energy to the power companies, equating to less carbon issues in the atmosphere by utility power plants.	The Port of San Diego would be the local lead agency for the Offshore Wind project. SANDAG will work with the Port of San Diego to discuss the Offshore Wind project and other future transportation needs.  Your comment was forwarded to the Port of San Diego.
W244	Jonathan George		It seems like a devious move to charge people more to drive on freeways due to a loss in gas tax; especially when one considers how much local political and government leaders pushed all electric vehicles as a means to protect the environment. Poor planning and future forecasting should not result in more taxes and a punishment to the public. You created this problem local civic leaders when you failed to plan correctly, you need to fix it without continually taxing the traveling public. We’ve been overtaxed in this state already!!!!	The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.
W245	Jose Dennis Alabaso	California Abilities Network	I would like to know is there a brand new way to use Proposed Metrolink Services between Fullerton (North Orange County) and Escondido (North San Diego County)? For Example: The Metrolink route begins at Fullerton Transportation Center, and then continues in West Corona, North Main Street Corona, Dos Lagos Corona, Lake Elsinore, Murrieta/Temecula, and then ends at the Escondido Transit Center. Okay?	SPRINTER service from Escondido to Oceanside will provide timed connections to COASTER service to San Diego, Metrolink service to Orange and Los Angeles County, and Amtrak Pacific Surfliner Service. Furthermore, the California high-speed rail system is slated to connect Los Angeles to San Diego via the Inland Empire with stations planed in Murrieta/Temecula and Escondido.

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W246	Joseph Coppola	N/A	I will keep this short. We are SICK of constant tax increases. I can understand taxing electric vehicle owners but for persons using gasoline, we are already paying more gas taxes than any other state! Please use what other sources you have, state, federal, etc. BUT NO MORE GAS TAX!	Thank you for your comment.
W247	Joseph Nevins		The plan is lacking the necessary focus on converting drain vehicles to active travel for schools. There should be pedestrian and cycling pathways throughout neighborhoods surrounding schools connecting playgrounds to schools and subdivisions. There should be free transit for children and supervisors on the transit vehicles. There should be paid supervisors for walking and cycling 'trains' to and from schools. Vehicles should be required to have systems to capture tire micro particles. Transit agencies need to be consolidated into larger regional divisions within CALTRANS to ensure full cohesion of system design and implementation.	Active travel to school is an important component of a transportation strategy. The plan includes funding for "Complete Streets in Mobility Hubs," which will include active transportation improvements on local streets within the Hubs that will facilitate these kinds of connections. The intention is to make trips less than 3 miles more attractive for walking and biking. Local jurisdictions also have access to Safe Routes to Schools programs and funding which can assist with infrastructure, outreach, and other elements.
W248	Josephine Thompson		I was just in Aspen, CO. There was free bus transit between Aspen and Snowmass. I was with my daughter who is the transit committee in Tucson where they will offer free bus transit in Tucson. There should be free bus transit in San Diego county. FREE TRANSIT.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W249	Josephine Thompson		The buss transit in Aspen area run EVERY 15 MINUTES AND ARE RUNNING 7 DAYS A WEEK, EVERY DAY!!! BUS TRANSIT IN SAN DIEGO COUNTY EVERY ROUTE SHOULD RUN 7 DAYS A WEEK EVERY 15 MINUTES!	The Regional Plan includes substantial frequency improvements on local bus and planned Rapid routes. Routes are planned to operate at 10 minute frequency across the system, allowing passengers to easily connect.
W250	Josephine Thompson		THERE SHOULD ALWAYS BE A SECURITY OFFICER FOR EVERY BUS TO ENSURE CLEANLINESS, SAFETY, NO VULGAR LANGUAGE, NO THREATS TO ANYONE, AND EVERY RIDER IS SOBER.	Buses currently receive daily maintenance. As part of COVID-19 safety protocols, buses are wiped and cleaned at the end of each run throughout the day. Additionally, all riders are required by federal mandate to wear a face covering or mask while on public transit.  SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements. SANDAG will be working hard with the help of all of our passengers and representatives to ensure that this plan gets implemented.
W251	Joshua Olmstead		1. I see social equity as equal in importance to climate change impacts as part of the transportation strategy. I'm happy to see the significant considerations being made there for social equity. In some regions, public transit is seen as superior to personal transit—I feel we must aspire to reach this to remove not only remove a negative stigma from public transit, but also the impact it creates for all who cannot afford or use private transit options.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
W252	Joshua Olmstead		2. I would like to understand what considerations are being made regarding mobility and transit hubs to make them safe and comfortable for all users who may not have a workplace or home in that spot. How are comfort and productivity being considered for folks utilizing these liminal spaces being considered for both commuters and other transit users in equitable ways? I see a higher need to social services at these locations to support those that don't have resources at home/work/school or wherever their origin or destination.	Safety in and around regional Mobility Hubs including transit stops situated throughout these communities is of utmost importance. We are planning for complete corridor infrastructure that better protects people walking and biking from vehicular traffic. Additionally, transit or Flexible Fleet waiting areas throughout the region could be equipped with a variety of Mobility Hub amenities like complimentary Wi-Fi and mobile device charging ports to help keep people connected while they wait for their ride. Well-lit stations that also offer amenities like clean public restrooms or secure parking for personal bikes and other micromobility devices contribute to comfort and convenience as well.
W253	Joshua Olmstead		3. What considerations are being made for business districts to incorporate pedestrian malls and plazas to reduce vehicular traffic and promote active transportation in a way the prioritizes transit over private vehicles? For example applying the Bird Rock area roundabout concept with additional pedestrian space and bike lanes to an area like Park Blvd in University Heights.	As each of these transportation projects moves forward there will be a great deal of planning, engineering, and design work ahead of the project's construction. In the future there are opportunities for bike, pedestrian, and neighborhood safety projects like these you mentioned in conjunction with the 2021 Regional Plan's transportation projects. The Current Community Planning Projects are a good example of next steps, and so too will be the inevitable future Station Access and Specific Plans for placemaking projects. More information can be found at: <a href="https://www.sandag.org/index.asp?subclassid=83&amp;fuseaction=home.subclasshome">https://www.sandag.org/index.asp?subclassid=83&amp;fuseaction=home.subclasshome</a> .

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W254	Joshua Olmstead		4. I see commuter rail as an essential element. Understanding the high cost and frequently slipping timelines of similar projects (ex. purple line in London and Los Angeles), what is being done to ensure this becomes reality affordably and well within the plan's timeframe?	Lessons learned on other commuter rail projects will be an important consideration during final design. All efforts will be made to maintain schedule and budget once the project enters into construction.
W255	Joshua Olmstead		5. What considerations are being made with regard to generational transit preferences and adapting to future transit preferences? What about the rapid and constant evolution of technology and how it will impact our present plans?	The 2021 Regional Plan accounts for advancements in technology that may impact the transportation system. Flexible Fleets leverage technology and adapt as user preferences or demands change.
W256	Joshua Olmstead		6. I'd like to see more rapid progress on a rapid transit solution for folks living on the I-15 corridor in Riverside, especially rail service. Considering housing prices and the already significant number of commuters, it feels like this route could be important to reducing emissions as that commuting population booms.	While there currently are no routes in the 2021 Regional Plan for the I-15 north of Escondido, the North County CMCP is looking into finer details to see if such a route would be feasible. Carpool and Vanpool options are still out there, please visit <a href="#">icommuter's website</a> to learn more.
W257	Joshua Olmstead		7. Given our unique terrain, often things close "as the crow flies" are not convenient for a pedestrian. How is this considered in planning routes now and in the future? For example the Green Line in Mission Valley is hardly accessible to people 1/4 mile away up in North Park or Linda Vista. Any plans for aerial tramways to connect steep hillsides to transit? I'm also concerned about urban barriers that separate/break communities, like transit within freeway corridors rather than through the core of the community where it is accessible.	The 2021 Regional Plan includes a new mobility option - Flexible Fleets, that are designed specifically to allow people to obtain first and last mile access to transit when walking is not convenient. Micro-transit options such as shuttles, e-bikes, e-scooters are identified as part of Flexible Fleets and will be closely linked to transit.
W258	Joyce McClenney		What I notice is that nothing is planned for upgrading either transportation or communication for my rural community; I can't even read the maps because I do not have a strong enough internet connection (no cable here in nowhereland). We are moving out of the area for this reason.	<p>The Regional Plan primarily includes safety improvements to address crashes and evacuation needs in the rural areas, the event of wildfire or other disasters. However, in conjunction with the Regional Plan, SANDAG and Caltrans are actively preparing the San Vicente Comprehensive Multimodal Corridor Plan, which is a more focused effort to identify projects and strategies that integrate transportation options, wildlife connectivity, and technology deployment to improve mobility and evacuations along the SR 67 corridor.</p> <p>For these transportation technologies to work, broadband connectivity is essential. SANDAG is developing a Regional Digital Equity Strategy to develop a roadmap that will lead to an expansion of broadband services in the San Diego region. SANDAG recently initiated a project in partnership with Caltrans and the County of San Diego to expand fiber connectivity for high speed internet access along the SR 67 corridor. More information on our digital equity efforts can be found at <a href="http://www.sandag.org/digitalequity">www.sandag.org/digitalequity</a>.</p>
W259	Julia Capper	SDEA	Please prioritize free transportation passes for youth. It is a hardship for students who use the bus to get to school every day.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W260	Jusitn Grant	security guard	Need to run the bus and trolley at least until 2am.	The 2021 Regional Plan includes increased service spans (longer hours of service) for the trolley and buses up to twenty hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24 hour service.
W261	Karen Moyers		A "road user charge" that charges citizens per mile driven is an invasion of privacy and is probably unconstitutional. Government should not be allowed to track a citizen's mileage or where they drive. If legislated, any type of technology added to a vehicle or a cellphone to track distance can only be voluntary, not mandatory. I for one will never allow government to put a tracking device on my vehicle.	We understand there are concerns around the privacy and implementation of a road usage charge. There are several ways to implement the road usage charge that does not involve transformers or tracking devices in private vehicles. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public's privacy.
W262	kate yavenditti	law office	I support the call by Mid-City CAN and their Youth Council for free fares for riders under the age of 24. Most youth in this category that ride transit are students or low income workers and people of color and use mass transit for these purposes. It is our responsibility as a community to support this population and we can afford it.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway,

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				staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under
W263	Kathleen Amaya		There seems to be a mistake with the Coastal Rail Trail being marked through Rose Canyon rather than down Gilman and the UCSD campus. It is essential this is corrected with expediency as we must protect the pockets of wildlife that are still preserved.	<p>The City of San Diego's project S00951 follows the Gilman Drive alignment and is on the Adopted Regional Bike Network included in this Regional Plan. It is included in the City's CIP list to begin construction in 2022, please see webpage here for more details: <a href="https://cipapp.sandiego.gov/CIPDetail.aspx?ID=S00951">https://cipapp.sandiego.gov/CIPDetail.aspx?ID=S00951</a>.</p> <p>It will be a vital connector to SANDAG's recently upgraded Rose Canyon Bike Path and SANDAG's newly constructed Rose Creek Bikeways to the south. Extending north, however, there remains a desperate need for safe, direct, all ages and abilities active transportation alternatives extending into currently underserved residential (University) and employment centers (UTC, Sorrento Valley) to improve alternatives in this major transportation corridor. The City of San Diego's project on Gilman Drive is greater than 2 miles away from the Coastal Rail Trail Rose - UTC - and Roselle segments. Together these segments represent 6.2 miles of contiguous regional bikeways connecting to the existing Sorrento Valley Coaster Station, as well as future Transit Leap services.</p>
W264	Kathy Vandenneuvel	Greater Golden Hill Planning Committee	Please prioritize the Pershing Bike Project. Our community has been waiting for this project for years and we recently lost another life in a bike accident along Pershing in July. Please implement this project today before more lives are lost. Thank you!	Pershing Bikeway project has been advertised for construction and the bidding process has begun, a contract should be awarded this year and construction is expected to start in early 2022.
W265	Katie Spencer	Community member	I live in City Heights near the 94 & 805 freeways. My community is very close to the bay front but we do not have access to any bike paths or safe routes to ride or connect with existing paths in the South Bay or along the bay front. We need improved access and connections for City Heights. Currently we are cut off by the limitations of freeway-only accessibility.	The Chollas Creek Bikeways: North Fork - Bayshore Bikeway to University Bikeway and South Fork - Petway Park to Market Creek Plaza has been incorporated into the Regional Plan and will help facilitate the connections you've described. This project can be found in the updated data viewer and Appendix A's tables and maps for quick reference in the forthcoming proposed final 2021 Regional Plan.
W266	Keara Pina	Center on Policy Initiatives	<p>As a member of the San Diego Transportation Equity Working Group, we fully support the 10 Transit lifelines and request their inclusion in the 2021 Regional Plan (RP). They represent the priorities that residents at the frontlines of the climate crisis in Barrio Logan, City Heights, and National City have identified through a community-driven process. Though identified by residents in these three areas, the 10 lifelines reflect a vision to advance affordable and frequent transit solutions that will benefit all San Diegans.</p> <p>The RTP should include environmental justice-specific solutions to be completed by the year 2025 with an additional focus on connecting low-income workers to jobs. This comment will highlight five of the ten Transit Lifelines that will benefit workers the most and transform people's access to jobs in the region.</p> <p>Youth Opportunity Passes (YOP): Provide no-cost transit passes for all youth ages 24 and younger. YOP will build generations of lifelong transit riders and connect youth to school, work, internships, and early career opportunities. While reference to transit subsidies is included in the plan, more explicit inclusion of no-cost transit for youth 24 and younger is needed.</p> <p>Bus Service every Ten Minutes: Make bus service reliable and affordable now - we can't afford to wait. Buses are one of the most cost-effective ways to get workers where they need to go while cutting climate pollution. The RTP should include MTS as a collaborating agency in the RTP to ensure these immediate improvements are prioritized for 2025 implementation.</p> <p>Blue Line Express: Build a third track for a 24-hour Express Blue Line. The Blue Line already has the highest ridership and is the best-performing transit line in the region. This priority is not currently in the RTP, but is one of the most important improvements needed to better connect low-income communities in the South Bay to jobs throughout the region.</p> <p>24 Hour Service: Connect late-night and early-morning workers by 2025. Many workers are unable to use transit or are left stranded at the end of very late night or very early morning shift changes. By providing 24-hour service on popular transit routes, workers will be better and more efficiently connected to their destinations. The RTP should include explicit reference 24-hour</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions).</p> <p>The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>Land use authority is reserved to local jurisdictions –the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their</p>



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			<p>service.</p> <p>Anti-displacement Strategies: Protect low-income communities of color living near transit corridors from gentrification with proactive strategies that include building affordable housing and maintaining access to existing low-cost housing while ensuring high health and safety standards. In addition, provide increased community ownership opportunities and tenant protections. A Region Wide Displacement Study is included in the RTP for near-term implementation. This study should be completed within the next 6 months with clear implementation goals for the recommendations in order to truly prevent displacement due the RTP implementation.</p> <p>We urge the SANDAG Board to support these and all of the 10 Transit Lifelines and ensure their inclusion in the 2021 RTP.</p>	<p>communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
W267	Kerry Forrest	Descanso Community Planning Group, County of San Diego	<p>When I look at the discussions and graphics it would appear that the county ends at Alpine. There has been no contact with communities in the East County region AKA Back County. All the focus is on the City areas of the County. We in the backcountry live here because housing is less expensive and we are willing to make the long commute to provide for our families, This proposal does not address the impacts to the residents and to our communities. VMT impacts would be extreme for us financially, there are no other options for our commute. Transit improvements are not projected for improvements in the 2035 projections which stop at El Cajon. We cannot Bike, Walk, Ride a horse to work. The internet is inadequate to work from home. The VMT Fees would be highly burdensome to those of us who commute to work. I would like to bring up the potential for a rural resident exclusion from the planned mileage tax. This tax will kill our backcountry way of life, we could no longer afford to live here and there is not a viable option being offered for transportations to commuters in rural areas of the county.</p>	<p>Updates have been made in the proposed final 2021 Regional Plan to better represent to east county areas of the San Diego region.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W268	Kevin DelMastro	UCSD	<p>It's great you're going BOLD! San Diego has such potential and needs forward thinkers going outside the box, like you. Thanks for prioritizing public transit, bike lanes, complete streets and communities, and mixed use spaces. I love our vibrant neighborhood feel all over our city!</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W269	Kevin Krause	SKRE	<p>Our family has been fortunate to call coastal North SD County our home since the 90's. We feel we need to focus on making non-auto transportation options safer and more efficient. Please keep adding separated bike and walk options close to the dense coastal areas west of the 5 freeway.</p>	<p>The Regional Plan includes investments in active transportation projects, complete street makeovers, Vision Zero programs, and transportation demand management programs to create safer environments for non-auto transportation and to encourage people to bike and walk for short trips.</p>
W270	Kevin Krause	Segovia Krause Coastal RE	<p>We need a better system to get from A to B. Coaster &amp; Sprinter are good. Buses do not work as well. We need more help for the last mile after getting off at the station. Also make the pavement on the freeways the low noise ones as in AZ etc.</p>	<p>The 2021 Regional Plan includes the development of a high speed transit system which includes first and last mile solutions via Flexible Fleets investments.</p>
W271	Kimberly Caldwell	San Diego Unified	<p>Please allow funding for free youth bus passes for age 24 and under to attend work and/or school/college. Our youth's education is very important.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W272	Kimberly Cooke		<p>I read that today was the last day to put input into road fee tax. As it is there is ample methods for taxation, vehicle registration , - a portion of what is paid yearly goes towards Transportation improvement fee. Since this is not enough a tax is placed on each gallon of gas. This was</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on</p>

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			<p>supposed to be a temporary tax now since you are going to remove the extra gas tax there is a plan to tax per mile usage? This isn't acceptable for a person like myself, I only make 50K per year, my vehicle gets 23 miles to the gallon and due to the state charging over 1 dollar and twenty cents MORE per gallon than the national average. And now you want to charge me to use the road as well, I'm taxed per year to use the vehicle I'm taxed per gallon to fuel the vehicle now you wish to tax per mile to drive the vehicle. Please don't do this.</p>	<p>calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share. There are multiple mechanisms that will be explored to ensure a fair system. For example, drivers of fuel-powered vehicles in the state of Oregon receive a credit for fuel tax and remote emissions testing through their road usage charge program called OReGO.</p>
W273	Kip Lund	Sunrise	<p>Please create a youth opportunity pass so that transportation can be free for all youth under 24 years old. Not only will this help youth access education and jobs, but it also encourages youth to learn how to get around using public transit. I would like to also advocate for a better restroom system, so riders and the unhoused can have a place to use the restroom. Thank you.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Transit Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W274	Kurt Haider	San Diego County Bicycle Coalition; Oceanside Bike Walk Committee	<p>Oceanside should not have to wait 40 years to receive North County's last portion of Inland Rail Trail. The other option for east west travel is Oceanside Blvd., which has a narrow bike lane accompanied by a large volume of truck traffic.</p>	<p>The projects from the active transportation network were laid out and prioritized based on the analysis performed in Riding to 2050, SANDAG's Adopted Regional Bike Plan. While the deadline year for build out is 2050, this just means it would be proposed to be completed by that time. Many projects will likely be completed earlier. This is especially true as new funding sources come available. Additionally, as an early action out of the Regional Plan, SANDAG will be developing a new Regional Active Transportation Network in which projects will be reassessed and reprioritized based on data and community engagement.</p>
W275	Kyle Paoletta		<p>I've been considering moving to San Diego from Boston, but have been somewhat reluctant to out of fear that I'd have to rely on a car there because there's no comprehensive public transit network. Imagine my delight to see the ambitious proposals laid out in this plan! I really hope the county makes the necessary investments to complete everything from the new commuter rail lines to the much improved bicycle infrastructure— being able to enjoy the climate and culture of Southern California without having to sacrifice too much of the density and walkability of a city like Boston would be a total dream.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W276	Kyle Weinberg	San Diego Education Association	<p>I am the Vice President of the San Diego Education Association, proudly representing over 6000 certificated educators in the San Diego Unified School District.</p> <p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially the students in San Diego Unified School District, other young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego. No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities. And programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>

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			I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.	
W277	Lanni Smith		<p>By “making electric vehicle drivers pay their fair share” not only are you forcing gas vehicle drivers to pay twice as much to use the road (thanks corruptly passed gas tax) you’re also punishing consumers for having to abide by regulations legislated to delay climate change. You are punishing consumers who already live hand to mouth to use roads they can barely afford to have a vehicle to use, to “rent the roadway” which we’ve seen be a MASSIVE failure in the inland empire (91 express lanes Anaheim to Corona) reach fees of over \$30 for less than 5 miles of road that STILL become gridlock traffic because you STILL have the same amount of commuters. This is a flawed plan and best and a poorly funded cash grab/way to keep poverty levels rising at best. Public transport is not as efficient as personal, and people do not like to choose to add hours onto their commute. They have to. Utilizing public transport is also a mark against a possible employee/employer relationship thus increasing unemployment rates since managers don’t view it as reliable way to be at work on time.</p> <p>This plan may be good for the county’s funding accounts, but it’s so at the expense of quality of life and affordability to live here which is already running more and more people out of the state instead of bringing them in. You’re not finding the “type of desired resident”. You’re running out the loyal families that have spent generations here.</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
W278	Laura Constantinides		We already pay an extra tax for fuel cost, housing, property taxes, and everything else. Now you want to gauge us for money because we may have 1 electric car? You will be forcing our hands to make us move out of California. It is way too costly to live here, and now your creating another fee? Tax the millionaires!!! The middle class backs are broken for paying the bulk of taxes; for everything!!! First to pay, and last to receive help from the government.	The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.
W279	Lauren Edwards		How will you address the inequity of road use fees will impact those at lower income levels that have to live further away from jobs to afford housing will be paying more to get to work. Example, I cannot afford housing closer to Sorrento Valley, but will be paying more to drive due to miles driven taxes than someone who can afford to live closer. I also have no public transit routes that come close to the time it takes to drive. My car commute is ~1.5 hrs. round trip. A transit trip to work would be 4.5 hours round trip.	The 2021 Regional Plan is a long-range planning document and is required by federal law to provide a reasonably feasible funding plan. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. There will be two additional regional plans developed prior to the 2030 planned timing of the roadway usage fee.
W280	Leanne Best	Nile Sisters Development Initiative	Thank you for the great videos! This sounds wonderful. Please let me know how I can be of assistance.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
W281	Leslie Stepanek	resident	I call for an electrified bus fleet by 2030. Fund the implementation of California’s Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot wait 20 years to reduce GHGs.	The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a> .
W282	Leslie Stepanek	resident	I call for funding to protect vulnerable communities living near transit corridors by anti-displacement efforts: developing an anti-displacement strategy that includes affordable/low-	SANDAG is currently developing a Regional Housing Incentive Program and will take several factors into consideration to ensure the program meets the goals of the 2021



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			income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections.	Regional Plan. The program will consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with other SANDAG grant programs. Additionally, SANDAG will coordinate with the Social Equity Working Group and other interested stakeholders to ensure the housing program promotes equity and addresses issues like gentrification and displacement.
W283	Lilia Escalante	EHC	<p>I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.</p> <p>I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.</p> <p>I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.</p> <p>I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr service on popular transit routes and present a clear implementation schedule.</p> <p>I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion.</p> <p>I call for no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Further, I ask that it be accelerated for a 2035 implementation rather than the current delayed plan to implement in 2027.</p> <p>I call for an electrified bus fleet by 2030. Fund the implementation of California's Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.</p> <p>I call for the funding of to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study.</p> <p>I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets.</p> <p>I call for the funding of the planning and implementation of a transit emergency response</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive</p>

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			strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.	Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.
W284	Lillian Cross	N/A	I also read an article in the local paper about the road user fee. Gas is going up again another \$.50 a gallon and now SANDAG wants to charge a road, per mile, user fee to recoup the loss of the gasoline tax because Californians are moving to more fuel efficient vehicles like hybrids and all electric. How much more can we take? Businesses are going to suffer another recession because people are not going to drive to a store or restaurant. I drive less than 50 miles a month, and if a user fee is imposed, I'll drive 50 miles in two months. No wonder people are complaining about California and the high cost of living here. This is nuts.	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>While SANDAG does not influence State budget decisions, SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a regional road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group are paying more than their fair share.</p>
W285	Lilly K		<p>As a tax paying citizen, I definitely DO NOT support any version of road charges for non-commercial drivers.</p> <p>1. In a county where the AVERAGE price of a home is now \$800k, you’re not giving us much choice on how close we live to our jobs or hospitals or other destinations. You’re essentially taxing poorer people who need to travel for work, caretaking, or other necessities MORE because you created an environment where they’re forced to live further away from their destinations. UNACCEPTABLE. You’re complicit here.</p>	SANDAG recognizes the need for more affordable housing for people of middle to low incomes households that are near employment centers and a variety of transportation options. SANDAG is currently developing a Regional Housing Incentive Program that will consider climate change, climate resilience, and consistency with the transportation improvements and land use goals included in the 2021 Regional Plan.
W286	Lilly K		<p>2. We already pay more than enough in taxes. This city and state has one of the highest tax rates in the nation. Where is your accountability for living within your budget? Where is your accountability to your constituents for not continuously taking more money? You fail at even providing annual reports for how much was collected, where it was spent, and what progress was made. Furthermore, you don’t even provide great services. Our roads are bad (even though you’ve been taking that gas tax), our water infrastructure is frighteningly bad, our power grid is highly susceptible, our schools are bad (D/F averages despite continuously increasing their funding), you’re talking about “defunding the police” (despite taking zero community votes about whether constituents actually support that), and I don’t have a high degree of confidence in our medical/ emergency response infrastructure either. No more money. You need to figure it out with what you have. There’s plenty available, including just enforcing basic quality standards for CALTRANS. FRAUD, WASTE, AND ABUSE.</p> <p>3. The state has said numerous times it has a multi million dollar surplus. To quote Don Draper, “That’s what the money’s for!!!”. Why are you planning to take more money when you’re not even spending the money you have?! Rude, and sheer mismanagement.</p>	<p>SANDAG has never made any statement regarding defunding the police and is not covered in the 2021 Regional Plan.</p> <p>The federal gas tax was the largest source of maintenance and operation funding for many decades. However, the federal gas tax per gallon has not changed since 1993, that is when the minimum wage in California was \$4.25 and the federal gas tax does not grow with inflation. Additionally, the revenue collected per vehicle, by the federal gas tax diminished as vehicle miles per gallon (MPG) improve, but the cost of road maintenance increased. Also, road degradation is a function tied to the weight of the vehicles and multiplied by the amount of vehicle traffic. The average weight of passenger vehicles has largely increased since the 1980s, while gas tax revenues have decreased. Resulting in less revenue, but greater road degradation.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing</p>

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				<p>revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The 2021 Regional Plan is a federally required long-range planning document with horizon years of 2035 and 2050. It is a federal requirement to provide a reasonable and feasible funding plan. The road usage charge may be phased in as gasoline sales continue to be phased out through emerging technologies.</p>
W287	Lilly K		<p>4. I have significant privacy issues with this and will take those to court if needed. The way this is envisioned, it's far beyond your scope and you're collecting too much personal information. Not to mention, you're going to outsource part of the collection to private industry? No. I would prefer just another flat tax if it came down to it.</p> <p>5. What's the enforcement mechanism? Seems like that will be a significant cost driver for the estimate.</p> <p>100% do not agree with this. I pay hundreds of dollars every year for registration, additional hundreds in extra California gas taxes, AND smog. Not to mention property taxes and the nearly 9% sales tax you tack on to almost everything. You get enough. Go revisit your recent poor spending choices instead of exploiting your citizens.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>SANDAG will rely on coordination with other agencies in California and the State Department of Transportation to integrate the selection of technology, collection methods, and account management. California has strict data privacy laws to protect consumer privacy. In line with this, SANDAG remains committed to protecting personal privacy and it will be a strong consideration for SANDAG and other agencies around California when selecting technology and methods to administer the program.</p>
W288	Linda Alley		<p>Where is there the promised Quiet Zones along the railway routing at the intersections? This affects the quality of life for thousands of people!</p>	<p>That is one of the reasons why we want to build future rail that does not intersect with cars or pedestrians and is fully grade separated. For existing rail, SANDAG has worked with the transit agency and local cities to add Quiet Zones where most needed.</p>
W289	Lisa Sparaco		<p>This comment is to urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated. This will ensure that the RTP is equitable and inclusive of all communities and their needs.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W290	Lois Knowlton	La Mesa First United Methodist Church	<p>I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice communities by listing projects that will directly benefit those communities by 2025 and making all public communication easy to understand by the public. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.</p> <p>I call for an improvement in the bus system now that is fast, frequent, reliable and accessible through increasing frequency on popular lines, especially overcrowded ones.</p> <p>The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.</p> <p>I call for a 240hour service by 2025 on popular transit routes to connect late night and early morning workers to their jobs.</p> <p>I call for the funding of the planning, environmental review, engineering and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley.</p> <p>I call for no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders...and be an accelerated part of the plan for a 2035 implementation rather than the current delayed plan to implement in 2027.</p> <p>I call for an electrified bus fleet by 2030.</p> <p>I call for the funding to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation</p>

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			<p>ownership, and tenant protections.                      I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets.                      I call for the funding of the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.</p>	<p>Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p> <p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p> <p>MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>



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W291	Lourdes García Chepe	Platicando Con Mi Gente	SANDAG and MTS all together with the other organizations has to move on quickly, and no wait too many years in order to put more buses for all the communities that are minorities	SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
W292	Lucas Karasch		Please connect the Coaster Commuter train system with the Mid-Coast Trolley system to allow for north county coastal residents to commute to their offices in UTC. I would use it daily.	The Regional Plan includes a rail tunnel under UTC that bypasses the Miramar Hill and connects with the Mid-Coast trolley with an underground station to serve regional connections to key job centers.
W293	Luis Montero-Adams	The San Diego LGBT Community Center	<p>On behalf of The San Diego LGBT Community Center, I am writing to urge the Board to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our region's equitable economic recovery.</p> <p>When The Center was choosing the location of both its Hillcrest Youth Center and South Bay Youth Center, accessibility via public transportation was critical, as we know that so many of our youth cannot count on dependable transportation from their households. When young people have access to no cost transit passes, they are better able to access school, work, medical care and resources otherwise not accessible. (I want to add an additional line about the need for public transit within the LGBTQ youth community but don't know this talking point well enough. Should I reach out to Yey?)</p> <p>I urge the Board to take bold action to build a healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity Passes as a priority.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W294	Luke Yarnall		I strongly support the overall goals and vision of the 2021 Draft Regional Plan. However, I am concerned that the proposed timeline for Active Transportation projects is too slow. These projects are much less expensive than other aspects of the plan and have disproportionate benefits for safety, congestion relief, and livability. Therefore, they should be prioritized as soon as possible. In particular, EAP projects scheduled for 2035 completion should be brought forward to 2030 or earlier, and projects with a 2050 scheduled completion should also be implemented much earlier. Since these projects are both important and affordable, they should be prioritized. Thank you for your consideration.	The EAP projects are slated for 2025 implementation (\$200 million) and there are a host of other routes that will follow based on the corridor lists provided in Appendix A. Additionally, Complete Streets improvements (another Plan investment areas) will complement this anticipated Bike infrastructure.
W295	Luke Yarnall		In Figure L.8: Modal Families, “roller blade” is misspelled “rollar blade”.	Thank you for bringing this to our attention, the figure text has been updated.
W296	Luna Prieto	NLRC	I like the regional plans' ideas for improvement for future transportation. I like that focus will be given to trolley and sprinters. I feel like it is important to place waiting stations closer to the community and also to extend the travel routes. I live in lakeside and commute to San Marcos for school. Currently the bus, trolley, and sprinter routes and times are terrible for riders. It's slow and there are many connecting stops because there isn't a direct route. I also think we need basic needs met, like shelter on these waiting stops or simple improvements in the machines for ticket processing. I appreciate an effort to improve and protect the environment and pollution. I also see that equity is important for the plan but what are the plans to implement or target these efforts?	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights.</p> <p>SANDAG will also be conducting pilot programs for the implementation of Flexible Fleets and other micro-mobility options to help connect people in less dense regions into the greater transit network. Information regarding Flexible Fleets can be found in Appendices A and N.</p>
W297	lynn aliment	private citizen	As a native and life-long San Diegan, I absolutely do not support this plan. It's a beautiful, comprehensive plan suitable for cities like Tokyo, New York, Paris, and London – which have the infrastructure base in place. You're trying to shove a big square peg into a small round hole and	SANDAG's vision for a transformed regional transportation system is centered on the fundamental idea that increased personal mobility can help drive future economic prosperity regionwide, create opportunities for advancement for more people across our

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			that never works. I have more reasons than space allowed and am happy to talk with anyone at SANDAG if willing to call me at XXX-XXX-XXXX. My reasons include: 1) plan will cost at least double the \$160B – just look at the bullet-train to nowhere for comparison. Remember, government doesn't create income – government re-distributes everyone else's revenue. Every dollar in taxes and fees is one less dollar for education, food, health care, and housing.	region, and improve the overall quality of life for everyone. Appendix V contains a detailed list of revenue sources that are expected to fund the 2021 Regional Plan.
W298	lynn aliment	private citizen	2) Already pay highest gas taxes and fees in the country.	Nationwide states and regions are confronting the shortfalls of gas tax revenues to fund maintenance, operations, and construction of their transportation systems. The federal gas tax was the largest source of transportation funding for many decades. However, the federal gas tax per gallon has not changed since 1993, that is when the minimum wage in California was \$4.25. The federal gas tax does not grow with inflation and the purchasing power of that source has diminished over time. States and regions have implemented their own sales and gas tax measures to try and meet the needs of their transportation systems. However, the best tax measures tied to fossil fuel consumption will continue to erode in time as vehicle technologies change.
W299	lynn aliment	private citizen	3) There's plenty of money – just stop syphoning it off for other “pet” projects like bike lanes. Time for bicyclists to start paying their share of the costs through annual licensing fees.	The road usage charge is intended to replace the revenue losses from gas taxes in recent years due to more fuel efficient vehicle technology and electric vehicles. Gas taxes are implemented to fund the maintenance and operations of our current transportation system resulting from wear and tear from regular vehicle use, as well as unrealized costs of carbon emissions on the environment. Roadway wear and tear by bicycles is negligible and zero carbon emissions. Currently, gas taxes do not apply to cyclists and the proposed road usage charge would be expected to continue that practice.
W300	lynn aliment	private citizen	4) Promises made and not kept. Extended 0.5 cent sales tax and agreed to higher registration fees to pay for specific roadway projects and they are not being done. Finalizing Hwy 52 from 125 to 163 (RTIP #21-03 / Map ID CAL 536) was “promised” by 2022. You now show 2035.	CAL536, shown in the 2021 RTIP, is a project for Operational Improvements to SR 52 which include a truck climbing lane, bike lane, and an auxiliary lane. This project is currently expected to open to traffic in September of 2024. The project shown in the Regional Plan in 2035 includes the addition of 3 managed lanes to SR 52. When <i>TransNet</i> was adopted the anticipated future land use pattern included significant development in East County. Those developments are no longer expected due to expanded land preservation, slower regional growth rates, and state regulations focusing development near existing infrastructure. Many of the <i>TransNet</i> projects that have not yet been built were designed to support the East County growth that has not happened and is no longer anticipated.
W301	lynn aliment	private citizen	5) You say this is needed for transportation greenhouse gases and future population growth. Greenhouse gas problem is already being solved with EVs. you show 480K EV's by 2030. DMV shows 3M registered vehicles. Your EV projection equals 16% of vehicles – and by extrapolation and approximate 16% reduction in greenhouse gasses, with greater decreases each subsequent year. Population growth estimates range from 4M to 4.5M compared to current 3.3M. Growth is already off and will top out at 3.5M. Two reasons – first – we have too little water for all these people. Second –we have too many NIMBY's that sufficient housing will never be built (and I want more housing). I've lived in Santee since '84. Fanita Ranch on the map in '84. 38 years later it is still tumbleweeds and rattlesnakes – and it always will be.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT, not through the use of zero emission vehicles. Population growth is forecasted to slow in coming decades as compared to previous forecasts, however the population will continue to grow in the future due to natural increase (more births than deaths) and not due to in-migration in the region. More information about the components of population change in the Regional Growth Forecast can be found in Appendix F.
W302	lynn aliment	private citizen	6) Mileage tax and FastTrack fees – government is a horrible steward of the taxpayer's money. why would you think we will give you another dollar when the money we give is wasted or handed out for non-roadway projects. One example-expensive masonry sound walls built by over-priced union labor, when states like Texas and North Carolina use modular systems. Walls completed in a fraction of the time at a fraction of the cost – and are cheaper to repair when damaged. And their sound walls are more attractive than ours. 7) highspeed inner city rail – are you kidding! Neighborhoods will never allow it.	In order for a sound wall to be recommended for construction, it must meet criteria established by the Federal Highway Administration, which determine the level that future noise projection must approach or exceed to qualify for noise abatement measures. Noise abatement measures must also reduce the future noise levels by a minimum of 5 decibels to be preliminarily recommended for construction in the project's NADR. Learn more about the sound walls, visit the Build NCC “Sound Walls” tab at <a href="http://www.keepsandiegomoving.com">www.keepsandiegomoving.com</a> .
W303	lynn aliment	private citizen	8) Light-rail – if you believe that the proposed improvements will be so well accepted, then they should be easily paid for by revenue bonds backed by ticket revenue.	The funding strategy for the 2021 Regional Plan includes funding from a variety of sources, many of which may only be used to fund certain projects, programs, and operations. Additional revenue sources assumed for the plan are described in detail in Appendix V.
W304	lynn aliment	private citizen	8) I do not see where you project cost estimates factor in the millions in yearly subsidies that taxpayers will have to pay to support these mass-transit lines for perpetuity.	The Cost Estimation Methodology and Funding Strategies for the RTP were presented to the SANDAG Board of Directors on March 21, 2021, Item No. 8B. This report and presentation described the various funding assumptions developed for the draft 2021

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				Regional Plan. The entire Board meeting can be found at <a href="http://www.sandag.org">www.sandag.org</a> . The methodology for estimating the costs for operating and maintaining transit services is included in Appendix U.
W305	lynn aliment	private citizen	9) concern is falling gas tax revenue from EVs – simple solution is a \$250/yr. fee on EV (only EV) vehicle registration to replace lost gas tax (12,000mi divided by 25mpg times \$0.50/gal tax). In closing, SANDAG has lost credibility from the 80% of the population that does not approve of this plan (other 20% being unions and environmentalists). A century and trillions of dollars spent on existing transportation infrastructure – infrastructure that will remain the core mode of transportation for the remainder of this century (or until cars can fly..). By taking actions today to build out the highway, road, and bridge network in San Diego will provide immediate reductions in greenhouse gasses and transportation – verses the 10+ years it will take to get any of the proposed initiatives up and running (remember that this is CA and nothing is done quickly).. Please call me, I would like to have a meaningful conversation on this subject.	California leads the nation when it comes to driving more fuel-efficient and zero-emission cars. That’s a good thing! However, because these cars consume less or no gas at all, pressure is growing to find a replacement for the gas and diesel excise taxes that fund so many of the state and local transportation programs which support new infrastructure, as well as maintenance and operations of the current transportation system. Multiple officials and agencies within the State of California have expressed a desire to consider different road charging options, and many studies continue regarding implementation strategies, the timing of the road charge phase-in and rate setting. SANDAG’s 2021 RP assumes the road usage charge will replace the gas tax revenue lost by the move to fuel efficient and zero emission vehicles.  These and other revenues are planned for investments in a variety of transportation infrastructure types. Our 20th-century car culture, where driving alone dominates over public transit, carpooling, and other forms of shared rides, will not help us achieve our 21st-century goals: reducing congestion and improving safety, meeting state and federal mandates for reducing GHG and air pollutants, making a more socially equitable region, and improving the overall quality of life for everyone
W306	Lynn Sharpe Underwood	Black Girls Do Bike	SANDAG can do more to establish more of a cycling culture in our community and encourage cycling as a viable means of transportation: *Community Talks should cover bike lanes and safety *Community Talks should underscore not only road bikes, gravel bikes but ebikes (they are not just for old folks-different types should have different “rules”- I have a Strommer!) *Community talks should encourage day trips and over night camping trips *Community outreach should have a bike map and index in it. *SANDAG should call together Cycling groups...on a regular basis.  Please tell Cindy Burke I said Hello!!! Thanks!	SANDAG is actively working on developing an outreach program for all roadway users focused on the projects being constructed in the Regional Bike Early Action Program. We have received a \$1.9 million competitive State Active Transportation grant to develop and implement and education and outreach program that is beginning soon. We’ll discuss your ideas as a team and reach out to continue a conversation as appropriate. Will also tell Cindy hello, it has been great to work with her on the biking and walking InfoBits!
W307	Lynne Shaprio	N/A	This is a waste of bus transit riders time. We went to SANDAG to stop the MTS map blind destination insensitive engineer planners from imposing their spread sheet metric speed of vehicle trip 2018 Transit Optimization plan that harmed access to mid-city destinations including social service centers (Kroc Center, Social Security Administration offices, City Hall offices), and other key destinations for older adults, disabled people, women with children. You said you could do nothing. So you can have plans galore but if the MTS has unequitable access policies for route and schedule planning it is all for nothing.	SANDAG is committed to implementing projects and programs that ensure equity and increase mobility options for all residents. Coordination between agency partners, including MTS, is and will continue to be a consistent part of our planning process. Planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W308	Magdalena Ruiz	Bayside community center	Me gustaria que el transporte sea mas economico para las familias de bajos recursos me parese una idea increible para la ciudadania y mi comunidad pero es muy importante arreglar las banquetas y calles porque es dificil para el acceso en patineta estan en muy mal estado. Tambien hay mucha contaminacion y basura en las calles y neseditamos mas alumbrados en callejones y calles de nuestra comunidad de Linda Vista. *** I would like transportation to be more economical for low-income families. I think this is a great idea for the residents and the community, but it is very important to fix sidewalks and streets because they are difficult to access on a skateboard and they are in very bad shape. There is also a lot of pollution and trash on the streets, and we need better lighting in the alleys and streets of our Linda Vista community.	La red del Plan Regional 2021 incluye mejoras operativas y tecnológicas en las arterias regionales, incluyendo infraestructura inteligente e intersecciones inteligentes. La Red Regional para Bicicletas adoptada apoya a la red de arterias regionales e incluye tanto mejoras en las calles como fuera de las calles para crear un espacio seguro y cómodo para las personas que viajan a pie, en bicicleta o usan alternativas de micromovilidad.  Su comentario ha sido compartido con la ciudad de San Diego. *** The 2021 Regional Plan network includes operational and technological improvements for regional arterials, including smart infrastructure and smart intersections. The adopted Regional Bike Network supports the regional arterial network and includes both on- and off-street improvements to create a safe and comfortable space for people to walk, bike, and ride micromobility options.  Your comment was forwarded to the City of San Diego.
W309	Manuel Gonzalez	Keiller leadership Academy	No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The



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			No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities.	study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W310	Maria C	National Latino Research Center	<p>Me gusta que los trabajadores son muy amable ahora, ayudan a la jente y no son muy estrictos. Nos dejan a llevar el carrito del madado y se no compran el ticket, entienden. Espero que el plan tengamos personas que nos repectan y que se puedan comunicar con nosotros.</p> <p>***</p> <p>I like that the workers are now really friendly. They help the people, and they are not very strict. They let us carry our carts, and if we can't buy a ticket, they understand. I hope that plan has people that respect us and who can communicate with us.</p>	<p>Gracias por su comentario.</p> <p>***</p> <p>Thank you for your comment.</p>
W311	Maria Gonzalez	Southern Caregiver Resource Center	I urge that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W312	Maria Libia Cabrera	El Cajon Collaborative/Barrio Logan College Institute Parent Spanish	Thank you for coming to talk to us about transportation. And thank you to all the people who have been working on this plan for such a long time. We need more people to look out for the low-income families and to be sure that the plan includes everyone. I really like the plan. It should be affordable and accessible. Please be sure to include languages in the Plan. Also, we would like a free shuttle in El Cajon we could use to go shopping and to the trolley.	Thank you for your comment. SANDAG is studying different opportunities for Flexible Fleets in the region and intends to begin launching on-demand Flexible Fleet services starting in 2022. Flexible Fleets will vary based on the community they serve and will be designed to provide affordable and convenient mobility choices so that everyone in the community can benefit.
W313	Maria Navarro	El Cajon Collaborative/Barrio Logan College Institute Parent Spanish	It is so wonderful that SANDAG is asking us what we think. Too often we are not asked our opinion and we are the ones who use transit. Thank you for including us. Transit should be for everyone including low-income families and those who need to go to their jobs. It will be nice to have more rapid buses that could take us to job centers up north. We also need more frequent buses that are on time. Thank you again for this Plan.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W314	Mariana Duenas	Interfaith Community Services	TRANSPORTATION ACCESS IS A NECESSITY, AND A RIGHT.	Thank you for your comment.
W315	Maribel Arias	Comité organizador latino de city heights	<p>Necesitamos que apoyen a los jovenes estudiantes de hasta 24 años con pase gratis para que puedan ir a la escuela y trabajo.</p> <p>***</p> <p>We need to support young students up to 24 years of age with free passes so they can go to school and work.</p>	<p>Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio asegurará que las partes interesadas públicas tengan la oportunidad de expresar su opinión sobre las alternativas. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los jóvenes menores de 19 años.</p> <p>***</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W316	Marina Ahn		<p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.

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			<p>No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities. Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.</p> <p>I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority. Thank you.</p>	
W317	Mark Grant	N/A	<p>I just read through much of your document and it is indeed very bold, thorough, and ambitious. I do not agree with your big emphasis on transportation hubs and public transportation. Though this plan will attempt to change people's behavior to make them give up their cars and get on public transportation, I know that Californians will always have the opposite desire. People only use public transportation until they have the means to purchase a car. It is noble to focus on underserved communities, but the vast majority of your funds should go towards expanding roads and freeways, with lesser funds towards the various other forms of transportation. Middle class families do not want to ride a city bus or train. They do not want to raise their kids in hubs of high-density housing. This plan, as I read it, is mainly for the "underserved," the poor working class. It is, indeed, addressing a need that is out there. But it is my humble opinion that the middle class worker who drives a car is the backbone of San Diego.</p>	<p>State laws have changed from requiring congestion relief (usually solved in the short term by widening roadways) to reducing vehicle miles traveled and greenhouse gas emissions (usually solved by people living closer to destinations and using alternative modes of transportation such as walking, biking, carpooling and taking public transit). The bold changes are necessary to address unprecedented challenges facing our region, and state.</p>
W318	Mark Larson	Citizens for logical transportation.	<p>The trolley is a folly. It's irrational to build big new railroad networks, that is 150 year old technology.</p> <p>Mass transit trolleys are very expensive, require lots of security guards, and are primarily a haven for the homeless and criminals. Private citizens do not like mass transit, and most people who can afford a private vehicle will always choose a private vehicle over sitting on a train with homeless people. The future is likely private individual automated electric cars, like a Chevrolet Volt car for everyone that is automated. Please wake up, drop that silly, expensive, irrational massive train idea and focus on building more roads for private electric vehicles.</p>	<p>Fast and frequent mass transit is the most efficient and sustainable way to move large amounts of people – particularly in our urban corridors that are carrying the largest number of trips the longest distances. These corridors experience the greatest congestion which is why they have been slated for commuter rail that is much faster and more frequent than the rail service provided in the region today. Industry projections suggest that high capacity and higher speed rail will continue to be relevant into the future moving more people than any form of ground transit. In fact, a 2020 report by McKinsey &amp; Company found that by 2050, rail would carry about 13 times as many people as vehicles that are shared.</p> <p>Flexible fleets, which include shared, electric, connected and eventually autonomous vehicles, work in concert with mass transit, providing demand responsive solutions best suited for short to medium distance trips that traditional fixed route transit does not serve well. However, there is great uncertainty about when fleets of fully autonomous and connected vehicles capable of operating as you've proposed will be ubiquitous. Widespread deployment is unlikely until 2035 or beyond, but more and more cities will have automated rideshare available in selected geofenced areas over time.</p>
W319	Martin Pagel		<p>Multiple aerial gondola Skyway projects have been considered in the last few years (Balboa, airport, Coaster...), I was surprised that the regional plan does not mention Skyway. How would it fit in? Transit Leap?</p>	<p>The Regional Plan does not include Skyway projects because several new projects (Commuter Rail, Next Generation Rapid routes, and Flexible Fleets) have been identified in the plan to serve those travel markets and destinations.</p>
W320	Marvin Hernandez-Villareal	El Cajon Collaborative/Barrio Logan College Institute Parent Spanish	<p>I really like the Plan. We really need better, affordable housing for low-income families with some discounted rates for public transportation. I like the trolley, but it is too expensive to use. I also do not know how to use it. Our apartments are very old, and it is not safe to walk after dark in El Cajon. I would like more education for people in the plan and more housing around transit centers. Thank you for the Plan. I approve.</p>	<p>SANDAG is actively working on developing an outreach program for all roadway users focused on the projects being constructed in the Regional Bike Early Action Program. We have received a \$1.9 million competitive State Active Transportation grant to develop and implement an education and outreach program that is beginning soon.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's</p>

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				<p>housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p> <p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W321	Mary Oren		<p>Faster, Fairer, Cleaner? I'm on board!!! Thank you for your responsible effort to gather data, important feedback and put the right people in place to make this happen, we are grateful to SANDAG and the dedicated team effort!!! Now make it happen, all of it, another minute lost will only cost more financially, environmentally, impact safety and quality of life etc. Do not let anything stop you now please !! We've had moments of awakenings with covid, we can adjust to new behaviors and end bad habits. Bigger roads and electric cars will not guarantee safety or dependable arrivals - transit all over will! More tracks, more electric trains, more bike safety, urban housing, vertical housing near transit, all of it is important. All anyone from San Diego has to do is get out of town and see how other communities had evolved starting over 100 years ago in Europe, our East Coast (NY, DC etc.) it's easy to imagine in San Diego!! In addition we must commit to improving transmission, storage and charging stations for electric vehicles and housing. THIS is huge component, STORAGE is vital!! Community energy too!! Thank you again, let's go!!</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W322	MaryKatherine Reeber	Retired US State Dept	<p>You rightly note that the proportion of senior citizens in the area is going to increase. I am one of them who feels that with the understandable desire to reduce emissions and traffic congestions car owners are given second class citizenship in today's planning. Please include adequate reasonably priced parking by your mass transit stations as well as in business districts. I can assure you that if you do not many increased emissions will be due to frustrated seniors frantically circling the blocks trying to find a place to park.</p>	<p>The draft 2021 Regional Plan's network of Mobility Hubs includes strategies such as priced parking in commercial areas in combination with the deployment of on-demand Flexible Fleets, including services for seniors. Parking pricing is one of many travel demand management strategies communities can implement while ensuring there is adequate curb space for both parking and loading/unloading of passengers and goods.</p>
W323	Matt Cantor		<p>Population growth is flat in the country. That means that everyone wants to come to California. At what point does California say that there are enough people living here, live elsewhere? When the water dries up? When you can't go anywhere or do anything because the population density is too great for any movement? The state is not in a housing crisis, it is in a population explosion crisis and the government needs to recognize that fact.</p>	<p>Population growth for the region and state is still projected to grow, however at a slower rate than in past decades. In San Diego County the increase to the population is the result of more births than deaths (called natural increase) and not to in-migration to the region. Please see Appendix F for more information on the Regional Growth Forecast.</p>
W324	Matt Moody	San Diego Education Association	<p>Please include a grant for free transit ridership for 24 and under. All three of my kids will be taking bus and trolley from Oak Park to University City over the next 8 years. Lots of my former students also took transit to UC from as far away as Chula Vista. Many students have parents who work two jobs and now that transportation funding is low in school districts, it's been harder for students to make it to schools of choice.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W325	Matthew Lee		<p>NO MILEAGE TAX. Mileage taxes are punitive to essential workers. San Diego's housing is unaffordable and these people have no choice. Office workers who can telecommute are being told to commute by their employers. TAX the employers who are forcing employees to commute instead!!!</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of</p>

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				roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.
W326	Maureen Phillips		<p>Once again the rural unincorporated areas of the county are unrepresented in a transportation plan, except most notably in the recommendation/suggestion to inequitably implement user fees (VMT) to citizens, including Native Americans, seniors and others you recognize in the plan as historically marginalized, and have or have been afforded few, if any, options for transportation except the use of private vehicles.</p> <p>VMT, according to 2 land use commissioners recently ruling on a large scale energy development, “will limit building in small communities in east county” and with it the hope of economic improvement or creating more sustainable communities that serve as more than revenue or energy sources in the County’s overall Climate Action Plan.</p> <p>Rural Interstate 8 is not even recognized as a corridor, complete or otherwise, or the subject of improvements or actions. This despite the fact that it provides the most access to urban San Diego for private vehicles and commerce to and from Imperial county, Arizona tourists, and more, no mention on how VMT might be imposed on those travelers contributing to greenhouse emissions. For local citizens, Interstate 8 areas could become the source of Mobility Hub and transit leap innovative transportation resources (improving on the existing sources), such as microbuses, ridesharing, and more.</p> <p>Absence of broadband access in rural unincorporated areas is highlighted within the plan, and no more obvious than in Appendix C, the Public Involvement Program. Most of the communication and participation strategies involve the need to access information through broadband, which is essentially absent (and expensive) in rural areas, limiting people’s ability to learn and comment on plans and actions like this; those that directly affect our lives and quality of life. Its absence prevents working from home and educational opportunities. Aside from that, you cannot actually implement most of these recommendations without the availability of broadband or technology.</p> <p>I call upon you to find more equitable ways to communicate with, engage and invest in the rural unincorporated areas of the county.</p>	<p>Social equity disparity analysis is required by both state and federal law via Title VI of the Civil Rights Act of 1964 and Executive Order 12898. During the process of evaluating the 2021 Regional Plan, calculations were made to determine improvements in mobility by percent point difference, between a No-Build projection and the Build projection. SANDAG found marginal percentage point differences between each population, with slight advantages leaning in favor of low income, aging populations, and other disadvantaged populations. For more information regarding social equity, methodology, and state requirements see Appendix H. Interstate 8 is identified in the 2021 Regional Plan as a rural corridor and Appendix A describes the specific improvements anticipated for Interstate 8.</p> <p>SANDAG works closely with the County of San Diego and tribal nations to ensure transportation needs are met. SANDAG is currently preparing a Digital Equity Strategy to support advancement of access to broadband in areas with insufficient access.</p>
W327	Md jahangir hossen	N/A	We need bus transportation.	The Regional Plan includes increases in service span (hours of service) and frequency throughout the region. Many routes will operate all day long at 10 minute intervals.
W328	Meaghan Baril	University of California, San Diego	I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.	The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.
W329	Meaghan Harrigan		I urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.
W330	Melodee Takasugi		This proposed gas tax would hurt the most vulnerable people of this county -- low income, seniors, and middle class. The tax will cause what little money we have to go into wasteful ideas. You are causing more of us to flee the state with your incessant tax raises. I fact, you should be closed off as you are doing nothing to improve life in San Diego county.	Thank you for your comment.



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W331	Michael Hampson	Private citizen	For all protected bicycle lanes. I highly recommend you stop adding rocks and/or cement inside the protected bicycle lane curbs, as a filler. If someone falls off a bicycle onto these rocks, this will harm the bicyclist. For the protected bicycle lanes, where you need add a filler in between the curbs of the new protected bicycle lane curbs, please use the rubber that is now found in many playgrounds. If you don't understand what I mean, please have someone call me. I live in Hillcrest.	SANDAG works in coordination with local jurisdictions in the design and construction of these bikeways. Ultimately, the material choices up to the local jurisdictions who accept and maintain the bikeways once construction is finished. We will bring up the potential for use of different material types with them, but it will ultimately be their decision what materials get installed.
W332	Michael Ohnysty		Regarding the mileage user tax on page 38 and 42. This is unfair. There does need to be an offset to the all-electric plug-in car not paying the gas tax and the way to do that is to have just the all-electric plug-in cars pay the new mileage tax. Having gas car drivers pay the new tax would be a double tax. If just the all-electric plug-in cars pay it and it is done right it will balance the funds and will be fair because the all-electric plug-in cars need to pay too as they also use the roads.	<p>The federal gas tax was the largest source of transportation funding for many decades. However, the federal gas tax per gallon has not changed since 1993, that is when the minimum wage in California was \$4.25 and the federal gas tax does not grow with inflation. Additionally, the revenue collected per vehicle, by the federal gas tax diminished as vehicle miles per gallon (MPG) improve, but the cost of road maintenance increased. Also, road degradation is a function tied to the weight of the vehicles and multiplied by the amount of vehicle traffic. The average weight of passenger vehicles has largely increased since the 1980s, while gas tax revenues have decreased. Resulting in less revenue, but greater road degradation.</p> <p>The 2021 Regional Plan is a federally required long-range planning document with horizon years of 2035 and 2050. It is a federal requirement to provide a reasonable and feasible funding plan. The road usage charge may be phased in as gasoline sales continue to be phased out through emerging technologies.</p>
W333	Michael Parker		I feel that the plan to charge a use fee for miles traveled would be very unfair to people who live outside the major community centers, rural areas do not allow for the movement like mentioned in the Plan, also if the COVID crisis showed the more people are packed together the faster something like COVID is transmitted. This plan is also racist in the aspect that a lot of minorities cannot afford to live in the major city areas, and are therefore forced to live and commute. The gas taxes increase but are not being used as was voted for . Someone needs to step up to the plate and hold the politicians accountable!	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as rural residents, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W334	Michael Simons		Overall too board and too vague. Against any funding where based on mileage driven. Break plan up into bite size chunks with their own budget, where public can judge and approve continuation based on keeping to budget and timelines.	Thank you for your comments.
W335	Michael Verdu	Encinitas Resident	<p>I live in Encinitas and am very active in local and regional politics. I also work in technology. I'm writing with feedback about the 2021 SANDAG Regional Plan.</p> <p>While I believe the new SANDAG vision was created with the best of intentions, the proposed multi-modal hub-and-spoke system is impractical, prohibitively expensive, and is fighting powerful headwinds like the decline in train/subway/bus ridership (pre-pandemic), the explosion of ride-sharing services, slowing regional population growth, and a likely permanent shift to working from home for a growing segment of the population.</p> <p>Even with improved train frequency and shorter trip times, a multi-modal system based on commuter rail will be at a severe disadvantage relative to the point-to-point service that will be provided by networked autonomous cars and buses. We run the risk of having empty trains running on our hugely expensive new rail system while neglecting the roads that will serve the centrally dispatched autonomous vehicles that are coming whether we like it or not.</p>	<p>The 2021 Regional Plan provides a range of transportation options for different types of trips. This includes deployment of Flexible Fleet services that complement investments in transit and Mobility Hubs. Flexible Fleets range from bikes and scooters to autonomous shuttles and on demand rideshare, increasing the number of mobility choices for residents and visitors to use.</p> <p>Fast and frequent mass transit is the most efficient and sustainable way to move large amounts of people – particularly in our urban corridors that are carrying the largest number of trips the longest distances. These corridors experience the greatest congestion which is why they have been slated for commuter rail that is much faster and more frequent than the rail service provided in the region today. Industry projections suggest that high capacity and higher speed rail will continue to be relevant into the future moving more people than any form of ground transit. In fact, a 2020 report by McKinsey &amp; Company found that by 2050, rail would carry about 13 times as many people</p>

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			<p>I'd also like to address the quote by Hasan Ikhata comparing local resistance to this multi-modal plan to the opposition to BART in the Bay Area. BART was built in a different time (before ride-sharing and a revolution in tele-commuting) to serve a city with vastly different geography (with jobs concentrated in a highly constrained urban area). Our solutions need to be forward-looking, not backward-looking.</p> <p>The alternative to spending tens of billions of dollars on a multi-modal system based on "Mobility Hubs" is to lean into the autonomous vehicle revolution. Let's leverage the already gigantic investments in autonomous vehicle technology including sensors, software, networks, and batteries. Charging stations would be a good place to start, but there may be other ways we can accelerate the deployment of networked autonomous vehicles at scale.</p> <p>The faster we can roll out true autonomous vehicle technology, the more efficient our road systems will become. The logical end point for private ride sharing services like Uber and Lyft is the disappearance of private car ownership. Let's accelerate that process rather than making a wrong turn into the past.</p> <p>Local leaders have called out the inefficient and broken public funding mechanisms for road infrastructure - and they're right. But I think it would be cheaper and better to fix that problem rather than work around it with expensive and non-optimal multi-modal solutions.</p> <p>Finally, I want to address the idealistic vision for higher density housing springing up around the new train stations on the 200 miles of proposed commuter rail in the multi-modal transit plan. That's not likely to happen. Encinitas and Solana Beach are targeted for the initial leg of the new system, but these cities have a history of fierce resistance to high density development, and that's unlikely to change. Higher density will run into a buzz-saw of opposition in other North County cities and San Diego neighborhoods as well.</p> <p>Commuter rail is not the answer to our affordable housing crisis in the same way that it isn't the answer to our transportation problems. We need other answers.</p> <p>I believe that you're going to see sharp and sustained opposition to this plan and to the 1-cent tax and per-mile fees required to pay for it. I'm inclined to fight the plan as proposed.</p> <p>We can do better.</p>	<p>as vehicles that are shared.</p> <p>Flexible Fleets, which include shared, electric, connected and eventually autonomous vehicles, work in concert with mass transit, providing demand responsive solutions best suited for short to medium distance trips that traditional fixed route transit does not serve well. However, there is great uncertainty about when fleets of fully autonomous and connected vehicles capable of operating as you've proposed will be ubiquitous. Widespread deployment is unlikely until 2035 or beyond, but more and more cities will have automated rideshare available in selected geofenced areas over time.</p>
W336	Michele Shoemaker		<p>In the section called Transit Leap, there is no "Local Bus" connectors to the "Next Gen Rapid Bus Service" along Highway 56. There is zero bus service in Carmel Valley. This forces residents to drive everywhere. Families have 5 cars!!!! Help us not drive, please.</p>	<p>Flexible Fleets will offer people a variety of on-demand shared vehicles. Flexible Fleet services may complement fixed-route services, even in more suburban communities. They offer additional convenience, as the on-demand nature of Flexible Fleet services allows people to book a ride almost anywhere and anytime. Proposed Clean Transportation policies will also ensure that Flexible Fleet vehicles transition to zero-emission vehicles to further meet air quality mandates. In addition, the Regional Plan proposes investments in active transportation and Vision Zero policies to create a safer environment for biking. These strategies combined will make it easier to drive around without driving a car.</p>
W337	Michele Shoemaker		<p>"Regional Bike Network" in Carmel Valley needs improving. The Hwy 56 Bike Path does not connect to Carmel Valley Road and then Del Mar Heights Road. There are 3 high schools, 2 libraries, multiple parks, a middle school, and multiple shopping centers not connected to the bike path. I tried so hard to get this to happen before the land was developed but I was told it was too late. How did the planning department miss this obvious connection. We need planners that are thinking ahead!!!!!!</p>	<p>The bike network shown in the plan is the Adopted Regional Bike Network, which was adopted in 2010. As an early action out of the 2021 Regional Plan, SANDAG will develop a new Active Transportation Plan which will look at adding in a number of new connections like these. SANDAG prioritizes community engagement and will develop these connections in partnership with the community so that we can make sure the routes take people where they want to go.</p>
W338	Michele Shoemaker		<p>"Climate Strategies" indicates 41% GHG emissions are from transportation. Why do we allow parents to drive their kids to school? We do not have school buses in Carmel Valley. Idling cars queue up at least twice daily. These emissions are not counted. Let's get electric school buses!</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT, not through the use of zero emission vehicles.</p>

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			Also, parents waiting for their kids at places like sport practice and tutoring less as be their cars running. We are missing these emissions too.	The Local jurisdictions and special districts such as School Districts, can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.
W339	Michele Shoemaker		I support free transit passes for youth and students (all ages).	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W340	Michele Shoemaker		To encourage public transit, make it free for riders.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under
W341	Michelle Kearney		Please amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W342	Michelle Rodriguez	san diego mesa college	I am a many year bicycle commuter who lives in Clairemont. I teach full-time at San Diego Mesa College and serve as the chair of the Transportation subcommittee of their Environmental Sustainability Committee at the college. I support any improvements that can make cycling safer for commuters and students. Clairemont is a difficult place to ride because the main corridors, like Balboa and Genesee, include steep hills. This makes riding difficult (which is why I use an electric bicycle), but it also makes it scarier because cars speed down the hills at frightening speeds. I hope to be able to ride my bicycle to one of the 2 new trolley stops in Clairemont, but, so far, bicycling to them is still too unsafe. I hope more can be included in the plan to slow down these cars.	The bike network shown in the plan is the Adopted Regional Bike Network, which was adopted in 2010. As an early action out of the Regional Plan, SANDAG will develop a new Active Transportation Plan. Although the original plan considered topography, we will take a fresh look in the new one. With the ever increasing popularity of e-bikes, we do feel it is important to build bike network in both flat and steep areas so provide as many network connections as possible. Additionally, the prioritization will include more recently completed and near-term transit projects to facilitate connections like those you mention.
W343	Mike Bullock	Retired	Regarding Active Transportation, I support the following sections of the letter from the Oceanside Bike=Ped Committee:  1.) The improved car-parking system for the Civic Center Car Parking Garage for both the City Employees and the general public that registers their car in the new system. 2.) The Coast Highway Road Diet and Incentive Zone 3.) The Inland Rail Trail	Thank you, and noted, we have reviewed and responded to the Oceanside Bicycle and Pedestrian Committee via Tom Lichterman and appreciate your specific recommendations for projects here, too.
W344	Mike Bullock	Retired	From the Oceanside Bike-Ped Committee letter, I strongly support the Bike Bridge over I-5 Between Vista Way and Kelly Street. The shopping is a high-trip-count destination and the Active Transportation community deserves access. Also, coastal access should be improved for that community that lives east of I-5.	We have reviewed and responded to the Oceanside Bicycle and Pedestrian Committee via Tom Lichterman and appreciate your specific recommendations for projects here, too.
W345	Mike Harp		I am against this plan as a tax payer. There is no universe where this kind of taxing and spending is acceptable.  \$168 Billion is oddly (get out the calculator) exactly \$50,000 per person, adult and children. Really? I see projects enumerated, but to come up with \$50k per person is telling of the methodology you used to see how much money you could extract from taxpayers.  This is shameful. California already has the highest gas tax, San Diego has the highest electricity rates. Where are you going to get this money from?	Dramatic changes are necessary to address unprecedented challenges facing our region, and state. One component of these necessary changes are updates to how transportation systems are funded. The funding structure we grew up with, paying at the pump, will not carry us into the future as the state transitions to alternative fuel vehicles to address necessary climate change goals and alternate travel modes that still require funding support.
W346	Mike Harp		The Next Operating System costs are wildly underestimated. I help provide IT services to government. \$32M to build? \$63M to operate (over how long?) \$19M for smart intersections? Do you know the Chesterfield intersection in Cardiff cost almost \$7M to build with smart technology,	The estimated costs for Next OS planning, development, system integration, and operations are included in Appendix A. In addition to planning, operations and



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W347	Mike Harp		<p>and you can barely turn left there. Of course you did, you planned it. How many of these are you going to build?</p> <p>I am against fee-based (per-mile) pricing. Unless these are self-reporting (they won't be), they are an invasion in privacy via government tracking (Privacy Act, 4th Amendment).</p> <p>We have a gas tax that has worked for transportation for since 1932 (federally). SANDAG has a sales tax. California has a SBI tax, and the highest gas tax costs in the country.</p> <p>Gas taxes are paid at the source. I understand you cannot collect gas taxes for electric cars. However, you should charge electric cars taxes at the source (the electric meter), since there are separate electric meters for residential/commercial and car charging.</p> <p>Per-mile taxes turn all roads into toll roads. Of course, this is your goal to raise \$168B.</p> <p>I traveled last week, on a Saturday morning, on an empty toll road in Orange County for 4 (four) miles. Do you know what my toll was? \$8.82. I am sure your models are using this data to project your revenue. No one told me what the rate was. I just got billed for it. I think 10 years ago, it was \$1.25.</p> <p>Per-mile pricing is money grab that will result in ever-increasing tolls (which is undefined, and there is an intent to make "congestion" pricing very expensive), on top of the highest gas taxes.</p> <p>This is shameful.</p>	<p>maintenance costs, Appendix U includes technology and digital infrastructure investment costs.</p> <p>Nationwide, states and regions are confronting the shortfalls of gas tax revenues to fund maintenance, operations, and construction of their transportation systems. The federal gas tax was the largest source of transportation funding for many decades. However, the federal gas tax per gallon has not changed since 1993, that is when the minimum wage in California was \$4.25. The federal gas tax does not grow with inflation and the purchasing power of that source has diminished over time. States and regions have implemented their own sales and gas tax measures to try and meet the needs of their transportation systems. However, the best tax measures tied to gas and diesel fuel consumption will continue to erode in time as vehicle technologies change.</p> <p>We understand there are concerns around the privacy and implementation of a road usage charge. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public's privacy.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p>
W348	Mike Harp		<p>I am against SANDAG takeover and taxation of "managed lanes", roadway that has already been paid for.</p> <p>Converting roads into "managed lanes" for the sake of charging "variable tools" on top of the highest gas tax in the nation, and soon-to-be mileage taxes is too much. Rates would adjust based on congestion levels? Are you kidding me? Last week, I was on the 73 toll road, which was empty on a Saturday morning, for about four (4) miles. My bill? \$8.82. What would it be when it was "congested"? But of course, you know this since this data is probably already in your models.</p> <p>This is a scheme to extract a maximum amount of money from working families and taxpayers, and a regressive tax for poor people.</p>	<p>The 2021 Regional Plan maximizes our existing roads using technology to manage how lanes are used which reduces traffic congestion and delay. The proposed network of managed lanes also encourages carpooling, vanpooling and taking transit which creates more roadway capacity without adding additional lanes. This model is very similar to how the I-15 Express Lanes operate today.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p>
W349	Mike Harp		<p>The shortfall in the number of building permits, as asserted on page 18, is largely because of CEQA and state and local regulations that make housing more expensive.</p> <p>You acknowledge as much in Appendix B as it states you would support strategies "Minimum zoning near transit", "Permit process streamlining", "Fee-waiver program".</p> <p>Are you advocating the waiver of CEQA and other regulations in the "transit hubs"?</p> <p>And if so, will you also advocate elsewhere for 14th amendment equal protection for all? "No state shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any state deprive any person of life, liberty, or property, without due process of law; nor deny to any person within its jurisdiction the equal protection of the laws."</p>	<p>CEQA has been modified many times over the years by the state legislature to expedite judicial review and create exemptions for projects such as selected housing projects or housing near transit. The Mobility Hubs are areas near transit that align with these efforts from the state. SANDAG intends to coordinate with local jurisdictions to identify permitting and process improvements that increase density and streamline the production of housing in Mobility Hubs and transit priority areas.</p>

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W350	Mike Harp		<p>The graph on Appendix B, page 31 shows a steep rise in the number / % of electric vehicles on the road. (40k-450k in 9 years).</p> <p>How, specifically, does SANDAG believe that the electrical grid and generation can handle this increase in the time frame? How can SANDAG create other than conceptual models without understanding this basic problem of scaling renewable energy?</p> <p>There are two logical outcomes. Either there is not enough electricity to go around, and people can't charge their cars, OR electric base load relies further on "dirty" generation. Ironic that "electric cars" are really "coal" cars. People are already being told not to charge their cars overnight because there is not enough power (!?! when else would they do this to go to work).</p> <p>You are trying to sell a region-wide electric car/bus/truck vision. You need to say how we, as a region, will be able to cope with the increased generation demands. To just sell electric cars and charging stations without addressing supply is negligent.</p>	<p>The graph on Appendix B, page 31 of the draft 2021 Regional Plan was derived from Governor Brown's Executive Order B-48-18 that calls for 5 million zero-emission vehicles (ZEVs) on California roads by 2030. Based on population data, the region's theoretical share of that would be about 450,000 ZEVs in 2030. The final Regional Plan will include an updated figure based on Governor Newsom's Executive Order N-79-20 and the California Energy Commission's Assembly Bill (AB) 2127 Electric Vehicle Charging Infrastructure Assessment, available at <a href="https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127">https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127</a>, which will require planning for even greater numbers of ZEVs and infrastructure.</p> <p>The 2021 Regional Plan commits SANDAG to making investments to support the region's transition to electric cars, trucks, and buses. As SANDAG develops vehicle and infrastructure programs, it will continue to coordinate with SDG&amp;E as well as community choice energy (CCE) providers in the region on their programs to provide clean power and manage load. San Diego Community Power is committed to providing entirely clean and renewable electricity by 2035 or sooner and the state requires utilities including SDG&amp;E to provide a minimum of 50% renewable power by 2030 leading up to the state's carbon neutrality goal for 2045.</p> <p>In addition to regional scale load management that is led by the utility, CCEs, and larger power users, SANDAG's EV programs will encourage the use of load management tools and integrated renewable energy at the project level. SANDAG's current EV charger rebate program is CALeVIP San Diego County Incentive Project, with information available at <a href="https://calevip.org/incentive-project/san-diego-county">https://calevip.org/incentive-project/san-diego-county</a>. This and future charger programs will provide rebates for workplace chargers to enable a greater number of drivers to charge during the day when renewable energy is most available.</p>
W351	Mike Harp		<p>Several of the main documents and attachments advocate "transit fare subsidies" as a way to increase failing ridership.</p> <p>How much "subsidies" can SANDAG do? As a random sample, your published report (<a href="https://www.sandag.org/uploads/publicationid/publicationid_4602_25956.pdf">https://www.sandag.org/uploads/publicationid/publicationid_4602_25956.pdf</a>) says SPRINTER realized only "13.9% in FY2018" "farebox recovery" of operating costs, and system-wide was 17.6% in FY2018.</p> <p>At service that are only 13% paid for, how much more subsidies are you selling the public on? How about making it free?</p> <p>The whole model is broken. Using your math, I could ride the Coaster and take other regional public transportation for a round trip to downtown for \$13.00. at \$13% recovery, that trip cost taxpayers \$100! We could fly to Vegas and back for that.</p> <p>Yet this is the model you want to go forward with. I am strongly against your \$168B plan since you have no cost management and recovery capabilities and are only relying on the taxpayer for funding.</p>	<p>Thanks for your comments</p>
W352	Mike Harp		<p>Page 7 states your model is generating 10X the revenue from gas taxes via Managed Lanes tolls? Really? What sort of model are you looking at?</p> <p>What is your plan for managed lanes? 10X gas tax? More?</p> <p>Also absurd (NCTD v-7), "From 2023 forward, the passenger farebox recovery rate is maintained at 35%" when in 2018 it was 13%," with the promise of "subsidies". This accounts for \$22.7B in revenue that will never come in. You operate at a 87% loss. What kind of business or government entity would do that? Unless you are going the fact your own models don't pencil out this on taxpayers.</p>	<p>The \$2.3 billion of revenue listed in the "City/County Gas Tax" category is just a small subset of all the programs that are funded by the gas tax. The Road Maintenance and Rehabilitation Account (RMRA) is also funded by the gas tax and is expected to bring in \$19.6 billion in revenue. The managed lane revenue estimates are significant as the Managed Lane Network is expected to be built out. They are expected to be variably priced based on congestion, like the Managed Lanes on I-15 are today. The revenue expected to be collected from these future managed lanes are less than the revenues expected to be collected from gas taxes.</p> <p>In regard to farebox recovery ratios, the pre-COVID numbers were used. Fares are just one part of the revenues that transit receive to operate their services. The rest of the transit agency's funds come from other sources: federal, state, and local. Like every other</p>

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W353	Mike Harp		<p>Converting General-Purpose Lanes to Managed Lanes --NO! you cannot convert vehicle lanes that have been paid for (in some cases I-5 are being built) to Toll roads. Managed lanes is just another word for toll roads. We pay the highest gas tax in the country. Why do you need to get toll revenue from non-toll roads we already paid for?</p> <p>Well, because this SANDAG plan asks for \$50,000 per person in the county, \$168 Billion. That is absurd.</p> <p>Managed lanes==tolls by your SANDAGs own plan. I went four (4) miles, on the 73 toll road in Orange County, last Saturday. The toll was \$8.83, over \$2/mile. SANDAG knows this and this is in their models. We will be paying highest gas tax, highest per mile tax, and highest managed lane tax (AND all lanes are managed lanes--they will be variable by signs made up by SANDAG at the time).</p> <p>This amounts to a regressive tax (for poorer people who have to drive, and cannot be shoved into SANDAG/SD/NCTD busses that operate a 87% loss). The ones SANDAG wants to help will be hurt the worst.</p> <p>This whole plan stinks of people that want to get to a \$168B+ pool of money.</p>	<p>transportation service in the nation (highways, roads, air travel), without the subsidies from taxpayers they would not be able to survive.</p> <p>The 2021 Regional Plan maximizes our existing roads using technology to manage how lanes are used which reduces traffic congestion and delay. The proposed network of managed lanes also encourages carpooling, vanpooling and taking transit which creates more roadway capacity without adding additional lanes. This model is very similar to how the I-15 Express Lanes operate today.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p>
W354	Mike Harp		<p>“Transit Leap would create a complete network of high-speed, high-capacity, high-frequency transit services that connect major residential areas with employment centers and attractions throughout the San Diego region.”</p> <p>Wow..this is wildly underestimated, undefined and why would the tax payers be expected to pay for this??. I am against this.</p> <p>OK, so reality is, \$1.5 B won't be enough for this. SANDAG's plan says “would include new high-speed services that cover longer distances with limited stops, and these services would be separated from vehicle traffic with bridges, tunnels, or dedicated lanes.”</p> <p>Do you know how much a tunnel costs?? In case the folks at SANDAG forgot, as stated here (<a href="https://www.delmartimes.net/news/story/2021-04-27/study-shows-best-route-for-train-tunnel">https://www.delmartimes.net/news/story/2021-04-27/study-shows-best-route-for-train-tunnel</a>) a simple tunnel through sand stone (using your own words) “Construction alone is expected to cost \$3 billion or more”. Not to mention project, engineering, design and all that extra stuff SANDAG does. And for a service that has 13% cost recovery (customer pays \$13 round trip ticket, tax payers pay \$87=\$100 ticket (lets go to Vegas!))</p> <p>I'm wondering if you have some white-paper promising big things?</p>	<p>The Regional Plan envisions a transportation system that provides sustainable mobility choices in the region. Fast and reliable transit remains the most efficient way to move the largest number of people – particularly in our urban corridors that are carrying the largest number of trips the longest distances. Industry projections suggest that high capacity and higher speed rail will continue to be relevant into the future moving more people than any form of ground transit. In fact, a 2020 report by McKinsey &amp; Company found that by 2050, rail would carry about 13 times as many people as vehicles that are shared. Transit services will also be complemented by Flexible Fleets, which include shared, electric, and eventually autonomous vehicles. Flexible Fleets provide greater travel choices for connections to transit or areas where transit may not work well.</p>
W355	Mike Harp		<p>This whole attachment should be deleted. It is a collection of unaffiliated attachments, data, whitepapers, covering a number of topic areas and 303 pages.</p> <p>Who is Ascent? WSP? Who paid them? What does this mean to Tax Payers?</p> <p>The research and attachments should be attached to each topical areas as references, or you should delete this appendix, as it appears to “hide” the real data, groups and organizations behind influencing this plan.</p> <p>These documents should be clearly embedded in each attachment of the plan.</p>	<p>Appendix S includes documentation of SANDAG's travel demand model and off-model greenhouse gas reduction calculators. These documents are required to demonstrate to the California Air Resources Board that the 2021 Regional Plan will meet the region's greenhouse gas reduction target.</p>
W356	Mike Harp		<p>“Leveraging Next OS technology offers the capability to provide discounts to certain populations.” - Page 47</p> <p>No, first of all, what do you mean “certain populations”? How would you protect privacy? Are you going to do this by income? Race and DNA makeup? If by Race, how much DNA does someone</p>	<p>We understand there are concerns around the privacy and implementation of a road usage charge. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. These efforts will assess equity impacts and test mitigation strategies. At a minimum this plan is updated every four years with the</p>

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			<p>need to have?</p> <p>This is very much big brother technology that we should be as tax payers scared about. It is very Orwellian when the government can charge you based on the % melanin in your skin, zip code or other characteristics to use the roadways, freeways and transportation system.</p> <p>But hey! SANDAG said the quiet part out loud.</p>	<p>latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public's privacy.</p>
W357	Monique Clifford	Public School Teacher SDUSD and mother of San Diego youth	<p>I am a volunteer with Mid-City CAN. Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated. Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery, while connecting youth to school, work, medical care, internships, and other early-career opportunities. Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles. I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W358	Mulugheta Habtemariam	Concerned citizen	<p>Please no more taxes. We have been told that new taxes will fix our roads, traffic and environment still when I drive in San Diego I see the same road conditions our government promised those new taxes would fix. We can't breath anymore, we have to have a different solution than just raising taxes.</p>	<p>Nationwide states and regions are confronting the shortfalls of gas tax revenues to fund maintenance, operations, and construction of their transportation systems. The federal gas tax was the largest source of transportation funding for many decades. However, the federal gas tax per gallon has not changed since 1993, that is when the minimum wage in California was \$4.25. The federal gas tax does not grow with inflation and the purchasing power of that source has diminished over time. States and regions have implemented their own sales and gas tax measures to try and meet the needs of their transportation systems. However, the best tax measures tied to gas and diesel fuel consumption will continue to erode in time as vehicle technologies change.</p>
W359	Mylie Whipple	The San Diego LGBT Youth Center	<p>I am a supporter of The San Diego LGBT Community Center and I am writing to urge the Board to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>I believe that every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our region's equitable economic recovery.</p> <p>When young people have access to no-cost transit passes, they are better able to access school, work, medical care, and resources otherwise not accessible.</p> <p>I urge the Board to take bold action to build a healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity Passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W360	N/A		<p>I already pay taxes to drive on the roadways, why should I have to pay more? Wasn't there a bump up in gas tax just a few years ago? So, I'm going to be charged more to use the roads I'm already paying for? Really? Why don't you find more efficient ways to spend the crazy high taxes I already pay? How much do you want to bleed from people. How far do you want to push folks? This will be one more reason why educated residents will decide to leave the state.</p>	<p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.</p>
W361	N/A		<p>No freeway fees (use tax)!</p>	<p>Thank you for your comment.</p>
W362	N/A		<p>Lower income households are often forced into suburban or rural areas due to the price of housing in urban centers. People living away from the urban centers have to travel farther to get to work and services. These people rely on their cars to get places and still have time to spend with their families.</p>	<p>Every attempt has been made in the Regional Plan to provide viable high speed transit service in the region where it makes sense. High speed commuter rail is included in the Plan via Route 581 which will connect Downtown with El Cajon as fast or faster than driving.</p>



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			My community opposes the strategy to “prioritize non-solo driving” unless the alternatives shorten travel time. Current transit in our County is too slow, so few people want to ride it. Let’s not waste more money on that failed strategy. If there is a way to make it take less than 30 minutes to get from El Cajon to Downtown, that kind of speed, then I would support it. I definitely do not support making car travel slower to make transit competitive.	
W363	N/A		Regular traffic lanes should not be converted to managed lanes unless the managed lanes are going to be completely full. Otherwise it is just taking away traffic capacity that we already paid taxes to build.	<p>Experience and research have demonstrated that expanding roadways ultimately leads to more traffic and greenhouse gas emissions. For example, in the Houston area, a 26-lane-\$2.8 billion mega-freeway project was built to alleviate traffic congestion. Within a few years after construction was completed, congestion worsened and travel times increased 30% during the morning commute and 55% during the evening commute.</p> <p>The 2021 Regional Plan maximizes our existing roads using technology to manage how lanes are used which reduces traffic congestion and delay. The proposed network of managed lanes also encourages carpooling, vanpooling and taking transit which creates more roadway capacity without adding additional lanes.</p>
W364	N/A		I am opposed to any subsidies that are not applied to everyone. The rich have plenty of money to pay additional fees, the poor get special prices, but middle class families suffer (They have to pay higher prices to cover the subsidies). This causes more people to drop into poverty.	Thank you for your comment.
W365	N/A		Please reduce the magnitude of the plan to reduce the cost. We already pay too much of our income to government taxes and fees. The middle class already struggle to make ends meet.	Thank you for your comment.
W366	N/A		Sorry, but you are all a bunch of idiots (the Emperor has no clothes) spending OUR money! Defund SANDAG NOW.	Thank you for your comment.
W367	N/A		Wow I read it once through but it’s really thick with info and deep. I have to read it again but it sounds convincing that there is a real relationship going on at the border and economically it vital to us as a country... like you have convinced me we need TJ (Mexico) for more than one reason....and We actually have a standing economic relationship with them; I didn’t realize either how it all tied into travel means 🤔🤔wow!!! That’s such a cool place to be!! Who would have known these things!!!! 🤔👍	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W368	N/A	El Cajon Collaborative/Barrio Logan College Institute Parent Arabic	Our children want to go to college, but we only have one car in the family. Expenses are too great for college including purchasing a car. What means of transportation are available for them to access colleges and universities. I am happy that there will be trolley service to UCSD, USD and SDSU. Thank you.	<p>SDSU is accessible via the existing Green Line trolley, and UCSD will be accessible later this year when the Mid Coast Trolley Extension connects the Blue Line to University City. Additional future transit routes, highlighted by Corridor in Appendix A of the Plan, will increase transit access to colleges and universities in the San Diego Region.</p> <p>One of the Implementation Actions listed in Appendix B will be a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth. SANDAG also is currently working with the Social Equity Working Group to develop near-term solutions to address transit service improvements, amenities, and subsidized transit fares.</p>
W369	Nam Nguyen	Hillcrest Indivisible	<p>The market will not provide the number of affordable housing needed for our region. Any inch given to developers to build density will be towards market-rate. Nor will the traditional avenues give an opportunity for communities to gain home-ownership and generational wealth.</p> <p>What needs to be done to definitively make housing around transit zones, hubs, and corridors possible is a new push for public-private housing. This housing should be a hybrid of the cooperative and community land trust, where the residents have self-determination - removing the possibility of eviction by never-present landlords.</p> <p>City land. Public-Private funded construction. Resident Cooperative/Building Trust pays the city down for a portion of the construction costs as well as ongoing property taxes.</p> <p>The San Diego housing market will never serve the needs of the lower half of earners. It is within</p>	<p>SANDAG is currently developing a Regional Housing Incentive Program and will take several factors into consideration to ensure the program meets the goals of the proposed final 2021 Regional Plan. The program will consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with other SANDAG grant programs. Additionally, SANDAG will coordinate with the Social Equity Working Group and other interested stakeholders to ensure the housing program promotes equity and addresses issues like gentrification and displacement.</p> <p>Land use decisions remain under the discretion of local jurisdictions, but SANDAG looks forward to working closely with jurisdictions to promote fair and equitable housing throughout the San Diego region.</p>

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W370	Nam Nguyen	Hillcrest Indivisible	<p>the purview of the City, County, and SANDAG to put down the avenue for creating housing density and homeownership for more of its citizens.</p> <p>Every transit station at every level within the jurisdiction of SANDAG's regional plan should incorporate renewable energy. From a major Mobility Hub that has Megawatt-capacity to back-up the utilities grid, to a bus station that has a phone-charger hub, there should be renewable technologies integrated in. Solar panels, batteries, micro-wind turbines, and others can create a county-wide micro-grid that bolsters resilience to communities and the region.</p> <p>I would very much like to emphasize community and house-hold level engagement for how they can prepare and react to climate crises. If that means activating CERT to give seminars workshops, and a publicly-led distributed solar/battery program, then those are steps necessary to make sure no one gets left in the dark when the next wildfire threatens the grid. We know there will be more wildfires.</p>	<p>The 2021 Regional Plan includes a Sustainable Communities Strategy (SCS), as required by California Senate Bill 375 (Steinberg, 2008) (SB 375), for the San Diego region. This SCS describes coordinated transportation and land use planning, and identifies Priorities for Adaptation Planning, which include prioritizing resilience and developing innovative solutions. Appendix B describes both Near-term and Continuing Actions for 2021 Regional Plan implementation, integrating a resilient capital grants and innovative solutions program, the preparing a regional resilience framework, and serving as a resource for local agencies' Climate Action Planning efforts and the general public on the impacts of climate change.</p> <p>Regarding a network of EV charging stations and other amenities for the Mobility Hub network, SANDAG plans to implement measures to reduce GHG emissions from development projects to address climate resilience and energy redundancy including consideration of distributed energy resources to provide zero emission redundant power. That way, SANDAG can ensure charging stations and other amenities are reliable, accessible, and cost effective. Additionally, SANDAG will explore integrated renewable energy options for EV chargers throughout at Mobility Hubs while also considering valuable microgrid options to address climate and energy resiliency for an array of Mobility Hub amenities that rely on electricity.</p>
W371	Nam Nguyen		<p>To secure “complete corridors”, SANDAG should work with municipalities to produce 100% affordable public housing and commercial space along transit lines. Not only would these alleviate the housing crisis and increase transit use (thereby securing income for said transit lines), the diversity of people and culture will generate activity that draws middle/upper economic class residents and tourists.</p> <p>Please note that I have expressly stated affordable housing AND commercial space. Creating space for living and economic opportunities fulfills the full spectrum of habitation that, when combined with transit in close proximity, enables the current zeitgeist of the “15 Minute City”.</p> <p>SANDAG must see that public transit is a service like any other transportation corporation like FEDEX or UPS. The product is a service, and the service is to transport products. The product transported is people. If there are no people, there is no service. Likewise, if there is no customer to deliver products, there is no service. If major transit hubs become both homes and destinations for all San Diegans, then the transit will more likely be sustainable. If you build it, they will come, and they will come via public transit.</p> <p>It is my sincere demand that SANDAG works with every San Diego County municipality, with funds from the state and federal level, to push for wrapping the projected transit lines with Public Housing and Commercial and Cultural Projects. Blanket the region with thriving communities that will be the envy of the nation.</p> <p>Sincerely, Nam Nguyen</p>	<p>SANDAG wholeheartedly agrees in the value of mixed use development along transit corridors including the provision of affordable housing and commercial space. Supportive land use combined with high quality transit service and an array of on-demand Flexible Fleets can offer a ‘15-minute city’ experience in and around each of the regional Mobility Hub areas featured in the Plan. SANDAG will continue to work closely with local jurisdictions to concentrate future population and job growth within reach of transit while introducing a new housing incentive grant program that includes a focus on affordable housing. The Plan envisions a world class transportation system where anyone regardless of mode, age, income, or ability can travel safely and with ease to access work, school, shopping, recreation and services.</p>
W372	Nam Nguyen		<p>I think that there should be capital investments in each of the bus stops in San Diego, if not the county.</p> <p>While some are tied into larger stations, most are a simple bench and signpost.</p> <p>I think that each bus stop - each and every single one - should have a greater minimum level of structure to alleviate the stresses on riders.</p> <p>Minimum level: - Bench (without any anti-homelessness measures, as they are inhumane)</p>	<p>MTS and NCTD evaluate their bus stops for the potential to add amenities when budgets allow. When their budgets increase enough, they look to add features like you mention.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>

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			<ul style="list-style-type: none"> <li>- Signpost</li> <li>- Shade structure</li> <li>- Embedded Map with transit lines, fares, etc.</li> <li>- Waste Bins</li> </ul> <p>Increased level</p> <ul style="list-style-type: none"> <li>- Benches</li> <li>- Digital Signpost with ETAs of next buses</li> <li>- Shade structure with rooftop solar</li> <li>- Embedded batteries with USB Charging hubs, connected to utilities as a microgrid</li> <li>- Waste and Recycling bins</li> </ul>	
W373	Nam Nguyen		<p>If there are any plans by the Port of San Diego to redevelop Harbor Island, a ferry service from Downtown to Harbor Island would be nice.</p>	<p>Ferry service is being considered by MTS and the cities of San Diego and Coronado. As their plans develop, SANDAG may include them in future Regional Plans.</p> <p>Your comment was forwarded to the Port of San Diego.</p>
W374	Nam Nguyen		<p>I really want smart stoplights. We are living in the 21st century, with the Internet-of-Things, we should not be waiting at stoplights on an empty intersection because the lights are still on timers.</p>	<p>A regional Smart Intersection System (SIS) is in the proposed final Regional Plan to upgrade stoplights and improve overall traffic flow on major roads throughout the region. The SIS will implement advanced technologies that can adapt to traffic patterns in real-time and provide the optimal signal timing for all modes of transportation. Funding is proposed in the Plan for the implementation of the SIS.</p>
W375	Nam Nguyen		<p>I would like to add additional support for a uniform regional method of payment for all transit systems. If I could purchase one card and upload funds (online) and go from bus to trolley to train, that would make trips convenient not just in terms of saving the headache of multiple forms of payment, but also facilitating ad hoc, impromptu, unplanned trips.</p> <p>Imagine that if someone uses the card and, if there was insufficient funds on the card, they would be billed for the balance that could be paid later. A resident could go on a casual trip on transit recreationally without the hassle of pre-planning too much. Break down the barriers to ridership.</p>	<p>Next Operating System (Next OS) includes a system that would allow for a comprehensive fare payment system that would cover several modes. In the interim, MTS and NCTD just launched its Pronto Fare System which is a building block to a comprehensive fare payment system.</p>
W376	Nam Nguyen		<p>As a manner of creating more corridors for transit, one could recreate the “Streetcar Suburbs” with smaller-sized electric buses.</p> <p>Instead of the common 45’ or larger bus that runs through cities and major thoroughfares, a smaller sized bus could transport persons through the single-family residential zones with stops at major commercial and civic centers. These minibuses could also smoothly navigate suburban streets.</p> <p>For example, for all of the major routes along major streets, smaller Suburb Buses (SuBuses) could pass through and act as connectors from the suburb streets of Mira Mesa to Mira Mesa Blvd. Then a person could realistically walk from their door to their Sorrento Valley office.</p> <p>To wit, Electric Streetcar “Buses” could be the last mile service necessary to integrate the suburbs of San Diego county into the greater Transit System.</p>	<p>What is described is a good example of our proposed Flexible Fleet services. Micromobility can be provided via small buses, electric vehicles, scooters and bikes and e-bikes. These services can be utilized to provide on-demand travel within the community as described or provide first and last mile access to transit. SANDAG will be launching pilot programs in different communities for services similar to what is described.</p>
W377	Naomi Nussbaum	Synergy Arts Foundation	<p>San Diego County is home to hundreds of artists, most of whom are struggling to make ends meet with the cost of living increasing constantly. Please consider providing affordable housing specifically for our community of artists. We are beginning to lose them to other parts of the country. A city without artists has no soul.</p>	<p>SANDAG is currently developing a Regional Housing Incentive Program and will take several factors into consideration to ensure the program meets the goals of the 2021 Regional Plan. The program will consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with other SANDAG grant programs. Additionally, SANDAG will coordinate with the Social Equity Working Group and other interested stakeholders to ensure the housing program promotes equity and addresses issues like gentrification and displacement.</p>
W378	Naomi Nussbaum	Synergy Arts Foundation	<p>Having lived in San Diego for close to 40 years and being very active in the arts community here, I am requesting you consider how powerful the arts are as an economic driver for our County. San Diego, in its geographic location, together with Tijuana (which boasts a very vibrant arts culture), should be an international cultural destination.</p>	<p>The San Diego region benefits from a rich social and cultural exchange between the U.S. and Mexico, including a vibrant arts community and shared history. SANDAG supports all efforts to highlight arts and culture as a way to elevate quality of life in the region. For example, SANDAG has supported a recent bid to designate the San Diego-Tijuana</p>



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				binational region as the 2024 World Design Capital, which recognizes cities for their effective use of design to drive economic, social, cultural, and environmental development. SANDAG supports the incorporation of design of all aspects to further emphasize the unique cultural character of the region, including the arts. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W379	Natalie Rogel	TrueCare	I support the proposed “5 Big Moves” RTP and I want to see “flexible fleets” implemented in North County as quickly as possible, including Ramona. TrueCare has many patients coming from Ramona and has become a challenge with transportation.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.
W380	Nathan Wheeler		We pay a federal gas tax, we pay a state gas tax, we have high vehicle registration fee’s, we have horrible free ways, rail that is expensive and not as user friendly, we are told to buy more EV’s for “climate” concerns, we have housing that people can’t afford, water and electricity rates climbing, and yet we are going to be taxed even more with a fee to drive on the roads? Isn’t that what my gas taxes are for? Where do we stop. CA is already one of the highest states for taxes and yet you want more? I wonder why people are leaving this state?	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
W381	Neil and Marjie Larson		Children and youths 24 and under in age should be able to ride the transit for free. Please make this a priority.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W382	Nichole Rocero	You Belong Here	I am a resident and business owner in City Heights and have many concerns on the equity of a new transportation system. I applaud SANDAG and San Diego’s attempt to create a new transportation system. I do want to have a voice in the development of such an overhaul. As a small business I am greatly impacted by the ability to serve my community. Many of my patrons do not have access to transportation; bus rides can require multiple transfers that are not efficient for their time. Ridesharing is vastly overpriced post/during COVID, bikes are not always an option for the community I serve, as cost and space to store a bike is not always feasible. I would love to be able to serve my community/customers, but often there are many setbacks for them to access my resources. I would love to see a regional transportation plan that can consider subsidizing rideshare programs, bikes, and bus rides. I feel the city providing programs to those marginalized and underserved with a monthly transportation allowance will be a huge step to building accessible and equitable communities. Furthermore, I would love for the city to	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. The Mobility Hubs are intended to be a place where goods and services and multimodal options come together to provide access to all. The</p>

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			<p>subsidize the cost of a bus ride from certain regions traveling to culture hubs. For example, for those who may reside in Paradise Hills will they have the opportunity to hop on a bus for free that will be taking them to areas such as Barrio Loga, North Park, East Village, free of charge. If we are forever charging a price and delivering inefficiency to access culture then we stay away, and staying away means we are divided and miss out connection and outside experiences.</p> <p>Furthermore, I live in a region of town overrun by vast amounts of auto shops, where staying in your community for all of your needs (i.e., grocery, lifestyle, arts &amp; culture) cannot exist within a 2 mile radius. I'm fearful that because of all of these businesses being zoned in this region, that we will again, be overlooked for opportunities such as parks and transportation hubs because the City has to build past and around these types of businesses. How will this new regional plan ensure that marginalized and underserved communities will have easy access to the essentials and all the city has to offer. How can we ensure that the development of a new transportation system, will also lead to the development of new placemaking that can help us enjoy and stay within our communities, limiting the need for long distance travel just to access a grocery store?</p> <p>These are some things I hope SANDAG will keep in mind.</p>	access for low income communities of color living near Mobility Hubs triples access.
W383	Nichole Rocero	You Belong Here	<p>I live in City Heights and a great amount of my neighbors and community do not have access to the beach. The oceans are a great way to build family togetherness, allow community to participate in culture and arts, have access to alternatives to air conditioning, and build awareness of environmental justice and being advocates for our coastlines and beaches. If we do not have access to it, then for many of us, it is not our problem nor our fight.</p> <p>I propose that SANDAG develop regularly scheduled shuttles dedicated to Beach Days for those in our community who do not have access to transportation nor the time to spare transferring from bus line to bus line just to get to the beach.</p> <p>With the climate rising, more people in underserved regions need a way to escape the heat! what better way than to spend a day at the beach!</p> <p>We make it much too hard and unaffordable to get to the beaches. This looks like segregated beaches and communities. We lack diversity and are unable to occupy spaces such as the beach because they were not built with us in mind.</p> <p>Please develop easier, affordable, and faster ways for our marginalized communities to access communities that were not built for us to occupy.</p>	The transit network that has been developed for the Regional Plan includes faster access to the beach. There are Rapid and Commuter Rail routes that will operate between Mid-City and the proposed Central Mobility Hub. From that location you can seamlessly transfer to routes that will take you to Ocean Beach, Pacific Beach and La Jolla.
W384	Nicole	N/A	We need more transportation (bus stop), shade and benches at the bus stop.	MTS and NCTD currently provide shelters wherever it is physically feasible. As part of larger infrastructure projects like Next Generation Rapid, Trolley and Commuter Rail, all stations will have shelters.
W385	Nytziagisel Gallegos	Climate reality project	I am urging u to pass no cost passes to our youth	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W386	Oscar Gittemeier	San Diego Public Library	I would love to see transportation linked to public institutions like public libraries. (Ex. Bike racks with charging ports for residents that need to plug in their e-bike)	The 2021 Regional Plan envisions a network that provides various mobility options that connect travelers with residential, commercial, recreational, and employment centers.
W387	Paige Ball		As a soon-to-be resident of San Diego, I am very excited by this plan, particularly the expanded transit network. I think it has the opportunity to do great good for the county by removing cars from the road and making it easy to get around without a vehicle. This has the potential to make San Diego a real top transit city in the country and I couldn't be more thrilled!	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W388	Pamela Chambers		Defund SANDAG. Outrageous use of tax dollars.	Thank you for your comment.
W389	Pamela Vizcarra		While I would like more efficient public transportation I don't agree with the way the money will be acquired which is more fees and taxes such as the road charge. There was a surplus in 2021.	Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving

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			<p>Instead of spending it on a lottery to encourage people to vaccinate. Better use of that money was to implement it on fixing the roads and building public transportation. California has never been great at being frugal and responsible with money and I don't believe that SANDAG will be any better than other governmental institutions. Like the high speed rail that is costing far more than it should have and is already way past its deadline, the regional plan will as well turn into a boondoggle that is the high speed rail. Please do not use my tax money for frivolous things less than 20% of the population uses.</p>	<p>equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>SANDAG does not influence State budget decisions. While exploring implementation strategies for a regional road usage charge, SANDAG will work with Board Members, stakeholders, and community members to develop high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group is paying more than their fair share.</p>
W390	Patricia Rollison		<p>Environmental justice must be embedded in our mobility in San Diego. Therefore, I ask that the 10 Big Moves to Transportation Justice be included in the 2021 Regional Transportation Plan. I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.</p> <p>I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.</p> <p>I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.</p> <p>I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr. service on popular transit routes and present a clear implementation schedule.</p> <p>I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion</p> <p>I call for no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Further, I ask that it be accelerated for a 2023 implementation rather than the current delayed plan to implement in 2027.</p> <p>I call for an electrified bus fleet by 2030. Fund the implementation of California's Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.</p> <p>I call for the funding of to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan</p>

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			<p>income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study.</p> <p>I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations</p>	<p>supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here:  <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p>
W391	Patrick Trepanier	Private citizen	<p>Your 2021 Regional Plan is one of the reasons I am leaving California.</p> <p>Last year there was a net migration of Californians OUT of California. Why? Terrible governmental mismanagement at the state, local and regional level, absurdly high cost of real estate, utilities, transportation, taxation, rising crime, poor education...would you like me to keep going?</p> <p>The 2021 Regional Plan is not a bold reimagining - it is more of the same “let’s raise taxes” thinking which will continue to drive up the cost of living in California and drive more Californians out of the state.</p> <p>Let me give two specific items of feedback:</p> <p>1. Your proposal to raise “user fees” for freeways is absurd. You note that transportation tax revenues are declining in some small way due to the rise in EVs. Sandag’s bold thinking? Raise taxes. Because it’s fair. Seriously? The average driver in San Diego buys a \$20K new car and the average Tesla Model 3 is like \$35K. The EV owner (I had a Chevy Bolt) paid more for their car and often bought EV because they wanted to help the environment. Now you’re going to punish those drivers? You told us to buy EVs, we paid a lot for them and now you’re saying “you need to pay your fair share????” Along the lines of bold thinking - a couple of years ago, Newsom’s genius idea for improving transportation was to raise the gas tax - making already California gas tax the most expensive in the nation. He could have looked to cut spending - especially in the ridiculously expensive and inefficient bullet train in the middle of the state. More transportation taxes from Californians is NOT BOLD THINKING.</p> <p>2. In section 3, there was some language about reimagining transportation in San Diego, regardless of “racial, or ethnic background.” (p.44). Race and ethnicity have absolutely nothing to do with how many cars are on the road and how effective, safe and efficient our transportation system is. Seriously, when an Asian driver or a White driver is exiting the 805 freeway to the 52 freeway, do you think that the cement, asphalt and lane lines care one iota about the race of the driver of the car???? This is not a “bold reimagining of transportation in San Diego,” this type of thinking completely distracts people who should be thinking about transportation with issues like race and ethnicity which have nothing to do with traffic flow and improving traffic efficiency and safe roads.</p> <p>3. Here is some real bold thinking:</p>	Thank you for your comments.



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			<p>a. Tell the insurance companies to take a hike and implement “pay at the pump insurance.” It is much more fair than the current system and then everyone is covered. You can come up with some reasonable insurance payment scheme for EVs based on miles driven.</p> <p>b. Give large employers tax incentives to continue to allow workers to “work from home” more days of the week to significantly reduce rush hour traffic. The pandemic should have taught us bold reimagining of transportation.</p> <p>c. Get totally creative with Sandag employees. Instead of coming up with yet another tax on California citizens, why don't you give bonuses to Sandag employees who can be bold and reimagining transportation in San Diego by cutting costs???? I am 100% sure that there is plenty of waste within every government office in California (see bullet train above). Do more with less. instead of just “growing your budget,” look for ways to reduce your overall budget and spend money only where you can be more efficient.</p> <p>If you continue to tax Californians more and try and break everything down to race/ethnicity, more Californians will leave this state. And then you will have lower tax revenues, and your transportation problems will get even worse.</p>	
W392	Patrick Williams		<p>I am a teacher and can not afford to live near the school I work for, I therefore commute 25 miles each way in order to live. You are proposing a fee of up to 30 dollars per month for me to simply drive to and from work? We already pay exorbitant taxes for gas, income, and more. Stop taxing those that can't afford it!</p>	<p>Dramatic changes are necessary to address unprecedented challenges facing our region, and state. One component of these necessary changes are updates to how transportation systems are funded. The funding structure we grew up with, paying at the pump, will not carry us into the future as the state transitions to alternative fuel vehicles to address necessary climate change goals and alternate travel modes that still require funding support. As an alternative to traditional funding revenues through gas tax, road usage charges are becoming more commonplace across the country.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W393	Paul Vachal	SanDiego350	<p>I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.</p> <p>I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.</p> <p>I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action</p>

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			<p>should specifically call for 24 hr service on popular transit routes and present a clear implementation schedule.</p> <p>I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion</p> <p>I call for no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Further, I ask that it be accelerated for a 2035 implementation rather than the current delayed plan to implement in 2027.</p> <p>I call for an electrified bus fleet by 2030. Fund the implementation of California’s Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.</p> <p>I call for the funding of to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study.</p> <p>I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets.</p> <p>I call for the funding of the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.</p>	<p>(included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
W394	Peggy Foster	Private Citizen	<p>This whole thing is so misguided and tragic for the residents of San Diego County. “The 2021 Regional Plan is projected to cost \$163 billion.” And that’s where it ends? I don’t think so. A massive public transit system is not workable for geographically spread out San Diego county. We are not San Francisco.</p> <p>Fix and improve our existing freeways. You have more than enough funds to do that. And enough with the damn bicycle lanes. No, I am NOT going to ride a bicycle from my home in Scripps Ranch to my sisters house in North Park. Get real!!</p>	Thank you for your comment.

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			<p>As far as a “miles driven tax”, NO WAY. Everyone is so concerned with fairness, a miles driven tax is UNFAIR. I cannot express how disgusted I am with SANDAG. Under the “guidance” of Mr. Ikhata and the board, including Todd Gloria, SANDAG has become an enemy of the taxpaying citizens of San Diego.</p>	
W395	Pete Reinagel	Concerned citizen	<p>This is the second time I've written to express my concerns on the draft Regional Plan. This plan is almost solely focused on high speed transit and the costs are PROHIBITIVE! The taxes hikes to effect all this would drive even more residents from CA.</p>	<p>Dramatic changes are necessary to address unprecedented challenges facing our region, and state. One component of these necessary changes are updates to how transportation systems are funded. The funding structure we grew up with, paying at the pump, will not carry us into the future as the state transitions to alternative fuel vehicles to address necessary climate change goals and alternate travel modes that still require funding support.</p>
W396	Pete Reinagel	Concerned citizen	<p>What I don't see in this plan is anything to improve the transportation safety for the tens of thousands that live in the unincorporated parts of the county. SANDAG has been told for years that Ramona, Santa Ysabel, Julian, and other outlying communities rely on a few highways to our rural properties. Hwys 67 and 78 are not wide enough to handle emergency vehicles entering north county as residents flee during a major emergency. It's well documented that these highways were gridlocked during the fires of 2003 &amp; 2007. When planners realize these are agricultural areas that also have horse trailers that should also be considered in the evacuation routes design.</p> <p>Your Factsheet states SANDAG wants to “take everyone's needs into account” so prove that by (1) adding Hwy 67 &amp; 78 widening to save lives when the next conflagration occurs and (2) acknowledging my input. Buses and trains are not a panacea for all transportation ills! Ramona and other rural communities highly value our open space and agricultural properties. That's the reason we moved here from Mission Valley. We drive an electric vehicle to reduce our environmental impact. Please consider all SD residents not just those near the coast.</p>	<p>The 2021 Regional Plan includes safety improvements in the rural areas such as the SR 67 communities to address crashes and evacuation needs in the event of wildfire or other disasters. However, SANDAG has recently been exploring opportunities to improve broadband internet connectivity and has begun a project in partnership with Caltrans and the County of San Diego to expand fiber connectivity for high speed internet access on the State Route 67 corridor to Ramona.</p> <p>SANDAG and Caltrans are also currently working on the San Vicente Comprehensive Multimodal Corridor Plan (CMCP) to identify transportation projects to improve mobility along the SR 67 corridor.</p> <p>The CMCP study identifies ways to improve roadway safety, enhance the urban-rural transportation interface (with special consideration given to limiting impacts on surrounding environmental habitats and wildlife), engage with tribal nations, and create greater trip reliability and efficiency throughout the study area while supporting climate action initiatives. The suite of solutions will include active transportation, clean transportation, transit, resilience and environment, right- of- way and utilities, equity, and evacuation considerations.</p>
W397	Peter Fen	Sunrise Movement	<p>City Heights needs an extension of the line to serve that community's public transportation needs.</p>	<p>Commuter Rail Line 582 is included in the Plan to serve north-south travel needs in Sorrento Mesa, National City, Kearny Mesa, and University Heights. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is completing a more detailed ridership analysis of this route. The analysis is studying an alignment that would include stations in City Heights and at San Diego State University (west campus).</p>
W398	Peter Hoss		<p>No mileage tax. I already pay a gas tax. Plenty of other states have great roads with less money. Do your job and cut useless jobs and projects to make up for your need for money. Quit wasting the money you already have on mass transit that no one wants to use.</p>	<p>Thank you for your comment.</p>
W399	Philip Ellsworth		<p>I am totally against this idea of having a road tax, totally dumb. First of all you don't even have the infrastructure in place to give people the alternative to NOT drive their vehicles. Build it first , then they will come. Charging people who have to live further from their work is totally charging and punishing people because of their economic class , some people have to live in El Cajon , or lakeside where it's affordable because they can not afford in the city of San Diego. This is a BAD plan without the proper infrastructure in place to give people a CHOICE of either driving or using public transportation. Right now it takes over an hour on the trolley to get to downtown San Diego from Chula Vista and longer from El Cajon. Your plan is all about busses when it should be a light rail system. The trolley doesn't even go to the airport and if it does in the future I'm sure it will be riddled with NUMEROUS stops along the way creating a long commute. Look at the BRT low ridership you know why because it's a bus system, it takes about 25 minutes to get to one side of Chula Vista to the trolley station by the I-5. Fix what we have, put infrastructure in place to give us a choice THEN and only then charge people for using the roadways. We are taxed way too much in this state, we have one of the highest gasoline prices in the country when we make gasoline in this state.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be</p>



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W400	Philip Petrie	Interfaith Coalition for Earth Justice	<p>I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.</p> <p>I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. 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Further, I ask that it be accelerated for a 2035 implementation rather than the current delayed plan to implement in 2027.</p> <p>I call for an electrified bus fleet by 2030. Fund the implementation of California’s Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.</p> <p>I call for the funding of to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study.</p> <p>I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets.</p>	<p>charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p> <p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s</p>

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ID	Commentor Name	Agency	Comment	Response
			I call for the funding of the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.	housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.
W401	Pornthima DelMastro		Please prioritize reducing greenhouse gasses and fossil fuels in San Diego’s plan. We love taking public transit and biking and walking!	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375.
W402	R Michael Wilkinson		The plan to put mileage monitors into cars and charge a per mile fee should be aborted. This is a massive invasion of privacy and will not be tolerated. California has the hither gas taxes in the nation already and a \$76,000,000,000 surplus. Find your funding elsewhere!	We understand there are concerns around the privacy and implementation of a road usage charge. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public’s privacy.
W403	R. Michael Wilkinson		California is already too highly taxed! The idea of mileage transponders in private citizen cars is a bridge too far even for crazy California!	We understand there are concerns around the privacy and implementation of a road usage charge. There are several ways to implement the road usage charge that does not involve transformers or tracking devices in private vehicles. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public’s privacy.
W404	Rachael Cunningham	Nile Sisters Development Initiative	I would like the future plan to take into account our fellow San Diegans who do not have the same access to technology as some of us do. San Diego should focus on developing its bus/metro system before adding in other means of getting around.	Transit Leap will offer people a network of high-capacity, highspeed, and high-frequency transit services that will incorporate new modes of transit while also providing improved existing services. Transit Leap includes Next Gen Rapid Bus Service, local bus, and Flexible Fleet services to complete the Transit Leap network. This bus network would offer faster and more reliable service with increased frequencies and longer service hours.  Flexible Fleets can range from bikes and scooter to autonomous shuttles that provide on-demand service that are ADA compliant and provide options for users that may not have access to a smartphone or internet device to hail a ride.
W405	Rael Gisqu	El Cajon Collaborative/Barrio Logan College Institute Parent Arabic	We need better streets in El Cajon. Many do not have sidewalks and there are many pedestrian and bicycle accidents every year. How do we improve the streets around our school but also are they included in the Plan. After the focus group. . . thank you for including so many bicycle lanes, smart signals, crosswalks and more in the Plan.	Active travel to school is an important component of a transportation strategy. The plan includes funding for “Complete Streets in Mobility Hubs,” which will include active transportation improvements on local streets within the Hubs that will facilitate these kinds of connections. The intention is to make trips less than 3 miles more attractive for walking and biking. Local jurisdictions also have access to Safe Routes to Schools (Cajon Valley School District for example) programs and funding which can assist with infrastructure, outreach, and other elements. Please seek out opportunities to provide input and feedback to City of El Cajon traffic engineering and planning staff as well on more near-term projects at specific places in your community which may not be in the regional bike network in this plan but instead in your local Active Transportation Plan.

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				Your comment was forwarded to the City of El Cajon.
W406	Rafael Hernandez	National Latino Research Center	<p>I appreciate the emphasis on addressing regional transportation challenges including economic and social inequities, climate change, public health, and safety, as well as coordination with community-based organizations and tribal governments throughout the planning process. It is good to see that the plan includes working with community partners to develop affordable housing development incentives. The regional plan acknowledges issues that are unique to our U.S.-Mexico border region, as well as systemic racism, redlining, and the taking of tribal lands by settlers, but does not address the safety concerns affecting our communities from the presence of border patrol and law enforcement on public transportation.</p> <p>Technology innovation is an exciting part of the regional Plan, but equity in our regions is a must. It will be crucial to address the basic unmet needs in our marginalized communities like adequate shelter, functioning vending machines, and staff that speak the various languages of our communities in the transit stops and stations. While some communities will be gaining state of the art technology, we cannot allow other communities to continue to lack basic services, resources, and infrastructure.</p> <p>I support the 2021 Regional Plan’s mission to improve the transportation system in our region, and I want to emphasize the need to address issues of equity, especially for our historically marginalized and underserved communities.</p>	<p>Transit station security and operations are a function of MTS and NCTD. MTS’s website states that they have been making changes to its security policies and practices, to ensure their operations are in line with best in practice policies. Recent measures include increased training for internal and contract security staff, updated use of force policy, conducting an outside audit, using more visible and customer friendly uniforms, and more. NCTD’s website states that they contract with the San Diego Sheriff’s Office and local law enforcement agencies to patrol and provide law enforcement and security services at our transit centers. Your comment was shared with the Director of Planning at MTS and Chief of Planning, Strategy &amp; Innovation at NCTD. Additionally, SANDAG’s Public Safety Committee provides a forum for which regional public safety issues and concerns can be addressed. NCTD and MTS serve on the Public Safety Committee as advisory members.</p> <p>SANDAG will be applying a social equity planning framework throughout the implementation of the Regional Plan. As a near-term action, the proposed 2021 Regional Plan includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations and educational resources on transit are available to all San Diegans as we advance with our next OS system. Additionally, both MTS and SANDAG are working to provide enhanced amenities at transit stops and stations including comfortable shelters, bathroom facilities, and improved wayfinding kiosks.</p> <p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
W407	Ralph Nelson	SDBC, SDCBC, Swami’s.	<p>I understand that the current plan for completion of the Inland Coastal Rail trail in Oceanside is not scheduled for completion until 2035! This is unacceptable! We continue to prioritize projects in support of motor vehicle use at the expense of adequate facilities for alternate transportation like bicycles.</p>	<p>We are committed to complete this project and invite you to check out the project webpage at Keep San Diego Moving, sign up for updates at the link below if you have not already.  <a href="https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx">https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx</a></p> <p>I’d encourage you to be involved with the efforts of the North County CMCP too, again if you are not already doing so -  <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail</a></p>
W408	Randy Walton	Self Employed	<p>Thank you to the SANDAG staff and those board leaders who recognize that the status quo is unsustainable from a climate and congestion management perspective, and that any county that is expected to add 100K+ houses in the next decade deserves a comprehensive transportation system that moves people around without adding to the emission or the gridlock. We are a region known worldwide for innovations in science and technology, there is no reason our transportation systems can’t have that same reputation. If I had one specific request, it would be to make sure that North County receives equal attention and priority to any other part of the county when it comes to future projects.</p>	<p>The 2021 Regional Plan includes extensive transportation improvements focused on North County communities.</p>
W409	Reva Kareem	El Cajon Collaborative/Barrio Logan College Institute Parent Arabic	<p>How can we use the trolley and buses when we don’t speak English and there is no translation available for us? Will the Regional Plan include transit trainings and translation services and information for refugees and immigrants? This is the largest problem we all have. We don’t leave El Cajon because it is too scary to use the trolley when you don’t know what time and where to get off. Thank you for the Plan. I look forward to the new technology.</p>	<p>One of the proposed final 2021 Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, high-speed broadband internet access, technology, and digital literacy. We have been working with our Community-Based Organization partners (CBOs) to ensure that language translations and educational resources on transit are available to all San Diegans as we advance with our Next Operating System (Next OS). Additionally, the Metropolitan Transit System (MTS) is increasing its programs in assisting newcomers learn the transit system. This is an area we would like to support in partnership with local jurisdictions and organizations who support newcomers.</p>

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				<p>For more information, I would like to refer you to Appendix B: Implementation Actions, Table B.1 on more information on the Digital Equity Strategy and Action Plan. For more information on our community-based outreach please see Appendix H: Social Equity: Engagement and Analysis.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>
W410	Rhonda Delgadillo		Please do not tax us now on how many miles we drive!! It is ridiculous with the new ways you come up with. We can't even afford to live here any more. You need to budget better instead of taxing. Do your jobs and budget!!	Thank you for your comment.
W411	Ricardo Flores	LISC San Diego	<p>I would like to know how the SD Draft 2021 Regional Plan complies with AB 686 Affirmatively Furthering Fair Housing and the goal to desegregate neighborhoods? What I see in your draft plan is only providing equity through access to transit to ensure that Low-Moderate-Income (LMI) residents can travel to jobs, hospitals, etc.</p> <p>Will you please add to this DRAFT policies -- like subdividing all single family land parcels 4 times -- for cities in the county to use to desegregate and comply with AB 686?</p> <p>I look forward to your response.</p>	<p>The 2021 Regional Plan includes Appendix K – Regional Housing Needs Assessment (RHNA), which discusses the 6th Cycle RHNA Plan and is in compliance with state law in furthering housing supply, infill development, jobs/housing relationship, equity, and affirmatively furthering fair housing.</p> <p>To promote equity and fair housing, the RHNA methodology includes an Equity Adjustment that assists in overcoming patterns of discrimination and segregation, transforming racially and ethnically concentrated areas of poverty into areas of opportunity by allocating a higher proportion of low-income housing units to jurisdictions with a lower share of low-income households, which tend to be jurisdictions with a high concentration of resource-rich areas.</p>
W412	Richard Brown		Grand Central Station costing 5 billion dollars is a sick joke. Sandag needs to be disbanded.	Thank you for your comment.
W413	Richard Brown		Hasan Ikhata and SANDAG need to be eliminated and disbanded.	Thank you for your comment.
W414	Richard Irvine		Please do not attempt to inject "social equity" in your proceedings and stick to infrastructure!	A Title VI Analysis is required by state and federal law to ensure that the distribution of the benefits and burdens of the infrastructure investment is fair. By examining the San Diego region through the context of social equity, we as an organization can deliver infrastructure projects that have the greatest impact increasing mobility, alleviating the most congestion, and maximizing usage of the transit system.
W415	Richard Lund	Sunrise SD	For the final plan, I urge this Board to (1) maximize emissions reductions, (2) prioritize investments in the communities on the frontlines of environmental injustice and the climate crisis, create Youth Opportunity Passes (YOP); provide no-cost transit passes for all youth 24 years old, have a Purple Line Serve Central City Heights, create a Blue Line Express, and improve the transit bathroom network.	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Transit Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista,</p>



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				<p>and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p>
W416	Richard Martindell	Self	We do not need a per mile road use fee as proposed in the plan. Drivers already pay for road repairs and maintenance through the excise tax on gasoline. This year’s state budget estimates this income for the state to be \$6.6 Billion. If all that money is used to repair and maintain roads and highways rather than being diverted to other programs not related to roads and highways there is sufficient money to take care of our roads. Very simply, the more a person drives the more gas taxes that person pays just as the outrageous program being proposed. In addition, in order to implement a road use fee you would need to create a whole new administrative structure that would require funds raised by the usage fee to be used to pay for that overhead. Don’t burden us with another government program.	The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.
W417	Richard Sheresh	n/a	What I take away from the plan is a huge amount of money being spent to achieve very little impact on transportation effectiveness. I and many others live in the suburbs. I live in Chula Vista. From my residence, I can walk almost anywhere as long as my 3 mile/hour pace can get me to a destination. If I did not have a vehicle, I can either walk or use Uber-like transportation, a car option that would add more carbon because the driver has to also go from their residence to my residence and return in addition to my own destination and return. The bus option does not exist unless there is no other option. That’s because buses do not go where I want to go. To ride a bike in Chula Vista, on the street, is a non-starter because of dangers from cars. It’s no contest for a 3,000 pound car versus a 20 pound bike. And who rides bikes in the winter. This is not the Netherlands where the land is flat and bikes could actually be used safely.	The Regional Plan includes travel choices that are appropriate for different settings. For example, Flexible Fleets will offer people a variety of on-demand shared vehicles. Flexible Fleet services provide an option for people who may not want to drive a personal automobile in suburban communities where fixed route buses may not make sense. Flexible Fleets offer additional convenience, as the on-demand nature allow people to book a ride directly to their destination when they need it. Proposed Clean Transportation policies will ensure that Flexible Fleet vehicles transition to zero-emission vehicles to help meet air quality mandates. The Regional Plan also proposes investments in active transportation and Vision Zero policies to create a safer environment for biking. These strategies combined will make it easier to get around without driving a car. And for people who continue to choose to drive a car, they will benefit from the traffic reduction in their communities that result from other people who choose to take the alternative transportation options once they are available.
W418	Richard Sheresh	n/a	So what might work is to produce political policies that encourage a change in behavior. Such new laws proposed and enacted have been effective by urging and mandating changes needed. The record of CAL-EPA is a good example. They mandated vehicle changes that caused changes such as catalytic converters and better gas mileage resulting in the state, Los Angeles and San Diego almost eliminating smog and having much cleaner air. With the emphasis on electric vehicles, I can expect the automotive industry to come out with new approaches such as the Aptera and Ford electric truck and most car manufacturers will probably follow with hydrogen engines using renewable hydrogen. So using new laws, rebates, taxes and other encouragements should make an environment that makes changes that businesses and customers can support. Yes, the politicians are choosing winners and losers, but they always have done that. The tax giveaways to the fossil fuel industry is a good example. Will the public pay the bill? Of course, that will not change. But it won’t be on political actions that only benefit political supporters.	Regarding electric vehicles, the transition to cleaner vehicles will only exceed through efforts by government at all levels and industry together. California has enacted several clean vehicle laws for passenger vehicles, buses and trucks that signal the auto industry to produce cleaner vehicles. The auto industry has made major commitments and investments to shift to all electric in the coming decade(s). The 2021 Regional Plan supports incentives and other investments in the electrification of cars, trucks and buses and their supporting infrastructure (e.g., EV charging stations and hydrogen fueling stations) as one of the ways SANDAG helps reduce regional GHG emissions and improve local air quality. Appendices A (Table A.17) and B show SANDAG’s proposed EV commitments.
W419	Richard Sheresh	n/a	In driving in different parts of the county, I noticed that the freeway where 125/94 in La Mesa try to come together is a severe bottleneck almost anytime going either way. There is plenty of room to expand that section, but it was never done. It’s pretty obvious that expanding that area would reduce congestion, accidents, gas use, frustration, wasted time, etc. Now we see large buses on	The 2021 Regional Plan envisions several improvements for the SR 125 and SR 94 corridors. Projects identified in Appendix A intended to address this segment include improvements under the Complete Corridors and Transit Leap categories such as

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			the freeways that pick up people at few locations and take they to other specific locations mostly empty. You use the potential rider population to justify the use and costs, but can only hope at some time there will be enough riders to cover some part of the costs.	interchange and connector projects, managed lane conversions, and Next Gen Rapid transit service. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W420	Richard Sheresh	n/a	As far as I can see, this plan is for San Diego city and not county even though it indicates this is county-wide. I feel I'll be paying for something of little or no value to me or others, except making some good jobs while restricting parking or driving. Other than EV encouragement, I believe the use of rezoning near public transportation is a reasonable policy to accommodate those who can live in an area and make use of public transportation. But doing away with parking or restricting driving in some areas, I believe, will drive customers to shopping centers where parking will still be available.	SANDAG is proposing various policies, such as parking management, to complement proposed capital investments and achieve traffic congestion relief and meet mandated air quality goals. Parking Management may include policies such as reducing or eliminating parking requirements for new developments within Mobility Hubs where various travel options are available. Although such policies may result in less parking, developers can choose to provide parking based on demand and factors such as transit availability.
W421	Robert Means	self	This plan is terrible. It is a waste of money that will inconvenience the vast majority of people without providing benefits to them. Money would be better spent on improving roads and freeways.	Thank you for your comment.
W422	Robert Wright		I strongly oppose building a massive new rail system. Most neighborhoods are not located where residents could efficiently use it. The project will end up being up being an absurd fiasco like the bullet train. Spend the money maintaining and upgrading our roads and freeways.	The proposed transit system is designed to connect the more dense areas of our region. Connecting population centers with employment centers with fast, reliable service has been proven to generate transit ridership. Funds will also be spent to ensure motorists have a safe and congestion-free road network.
W423	Ronald Dibelka	SunCoast Properties	Your plan has ruined the end of 5th avenue near the hospital, very confusing and traffic restricting, especially with all the delivery trucks blocking access -	Thank you for your comment.  Your comment was forwarded to the City of San Diego.
W424	Roxana Cerna	Nile Sisters Development Initiative	I think this is a great idea for our regional community.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W425	Ryan Woodydy		The bike lanes are a complete nightmare. Unsafe at best and a disaster for the city. I'm actually fine with bike lanes but the way they've been installed provides for a bike lane an extremely wide concrete curb then parking with no room for a vehicle traffic. You get 2 full-size car and your white knuckling it, buses will now use both lanes to move down the roadway further blocking traffic This is also the huge trip hazard for the general population and creates an impossible area to traverse for a handicapped person. It gets worse at intersections. Not rounded corners but Sharp hard curbs and corners on the inside turns designed to force you to make wide turns into other lanes of traffic or inflict maximum damage to your tires and wheels. And they already have and will continue to be hit. New bus stops force the bus to stop in a lane of traffic blocking the road opposed to pulling to the curb where it's less likely to get hit (5th Ave @ Upas).The new bike lanes also create huge blind spots on the roadway and at intersections that are going to cause accidents as well as Bicycles and scooter injuries. Necessarily turn lanes and parking have been eliminated. All for the benefit of bike lanes that road bicyclist as well as scooters don't seem to be using. It's obvious the designers of the new bike lanes and roadways have no interest in the safe flow of traffic. I'm sorry I'm not more positive about this but the execution of the bike lanes on Fourth and Fifth Avenue leaves a lot to be desired.	It appears these comments relate to the Fourth and Fifth Avenue Bikeways which are currently under construction and not yet open to public. We are committed to complete this project in a timely manner, but please note it is an active construction site and all roadway users should be extra vigilant in light of these temporary and variable conditions. We invite you to review the project webpage at Keep San Diego Moving and sign up for updates if you have not already, <a href="https://www.keepsandiegomoving.com/RegionalBikeProjects/UptownSegment1_intro.aspx">https://www.keepsandiegomoving.com/RegionalBikeProjects/UptownSegment1_intro.aspx</a>
W426	Sage Rogalski	The San Diego LGBT Community Center	I am a supporter of The San Diego LGBT Community Center and I am writing to urge the Board to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.  I believe that every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, who have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes are a key investment that will provide a foundation for our region's equitable economic recovery.  When young people have access to no-cost transit passes, they are better able to access school, work, medical care, and resources otherwise not accessible.  Thank you	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.

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			I urge the Board to take bold action to build a healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity Passes as a priority.	
W427	Sama Alyas	El Cajon Collaborative/Barrio Logan College Institute Parent Arabic	We need more affordable housing for low-income families and shelters for the homeless. These should be near public transportation but with safe streets. The apartments in El Cajon are mostly very old and need updating. They are also not always close to transportation. We must use public transportation at night or in the early hours to access jobs that are in the north. We need more buses at night. Thank you for your help and for the Plan.	<p>SANDAG is currently developing a Regional Housing Incentive Program that will support the development and adoption of policies and process improvements to accelerate housing production for very low-income-, low-income-, and moderate-income housing while taking several factors into consideration to ensure the program meets the goals of the 2021 Regional Plan. Additionally, SANDAG will coordinate with the Social Equity Working Group and other interested stakeholders to ensure the housing program promotes equity and addresses issues like gentrification and displacement.</p> <p>Most of California's homeless population resides in major metropolitan areas; however, homelessness impacts communities of all sizes. Efforts to address homelessness are led by local jurisdictions in the region and SANDAG supports their efforts to seek funding sources from the State Department of Housing and Community Development (HCD) to address homelessness, begin initiatives, or conduct pilot programs. For more information, please visit: <a href="https://hcd.ca.gov/policy-research/specific-policy-areas/homelessness.shtml#">https://hcd.ca.gov/policy-research/specific-policy-areas/homelessness.shtml#</a>.</p>
W428	SAMANTHA CRUZ	SDEA/Teacher	<p>I am a High School Special Education teacher at San Diego Unified. Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Choose 2 talking points to include:</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego. No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities. Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.</p> <p>I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W429	Sarah Mahdi	El Cajon Collaborative/Barrio Logan College Institute Parent Arabic	<p>There are too many homeless in El Cajon. It makes it frightening for us to use parks and transit. We often see them urinating on trees and fences because there are no restrooms. I was very nervous during COVID-19 and the spread of germs. What can we do to make our community safer? Please add safe, clean restrooms with more shelters.</p>	<p>Buses currently receive daily maintenance. As part of COVID-19 safety protocols, buses are wiped and cleaned at the end of each run throughout the day. Additionally, all riders are required by federal mandate to wear a face covering or mask while on public transit. SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements. SANDAG will be working hard with the help of all of our passengers and representatives to ensure that this plan gets implemented.</p> <p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p>
W430	Sarah Vo	Nile Sisters Development Initiative	I'm concerned that communities that are not close to transit hubs will remain isolated. Currently it takes so long to reach your destination using public transit.	<p>The 2021 Regional Plan has redefined the transit network to include a 'support system' of regional Mobility Hubs and Flexible Fleets to expand the reach of transit to ensure major destinations are more accessible. Supportive land use combined with high quality transit service and an array of on-demand Flexible Fleets can offer a '15-minute city' experience in and around each of the regional Mobility Hub coverage areas featured in the Plan. Additionally, Flexible Fleets may be deployed to help make connections to high frequency transit more seamless and convenient. Please reference Figure 2.4 (in Chapter 2) of the Plan to see how many communities located beyond and in between regional Mobility Hub areas can benefit from a wide variety of Transit Leap and Flexible Fleet options in addition to complete streets improvements.</p>



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W431	Savahanna O'Toole	SanDiego350	<p>Environmental justice must be embedded in our mobility in San Diego. Therefore, I ask that the 10 Big Moves to Transportation Justice be included in the 2021 Regional Transportation Plan. I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document. I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system. I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego. I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr service on popular transit routes and present a clear implementation schedule. I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion I call for no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Further, I ask that it be accelerated for a 2035 implementation rather than the current delayed plan to implement in 2027. I call for an electrified bus fleet by 2030. Fund the implementation of California's Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources. I call for the funding of to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study. I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets. I call for the funding of the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive</p>

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				program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.
W432	Scott Ankers	N/A	I feel that the regional plan emphasizes huge, transformational capitalization projects requiring significant money, resources and time/effort. Alternatively, I believe there is an opportunity to keep San Diego moving and reduce travel times without huge capital expenditure or time to fruition. I've previously heard and read in SANDAG comments that if we could just get 10% of cars off the road, traffic would be significantly reduced...and during this pandemic, I've personally experienced this benefit first-hand!!! Why doesn't the broader term plan incentivize this continuation of less cars on the road by providing incentives to keep more cars off the road - for example, tax breaks to work from home, tax breaks for companies to support 1 work from home day a week, carpooling incentives, a stay at home day by license plate number, etc etc. Surely there are ways to incentivize less cars on the road combined with major construction projects. Additionally, a personal pain-point for me in San Diego County is the total lack of Permissive Left-Turns. Whenever I drive throughout the country outside of San Diego, I enjoy the freedom to turn left at an intersection whenever there isn't on-coming traffic. This greatly reduces travel time and, I presume, reduces traffic accidents at intersections where drivers cram to make turns in narrow time windows. I can imagine on my daily commute, I'd save 5 mins not having to wait at every protected left turn when there are no cars coming...it's especially infuriating at intersections which there's barely any traffic regularly... 5 mins a day would potentially save my over 24hrs in the car a year!!! Again, hopefully this would not require significant capital expenditure to update with current traffic signals, etc. Another small step that could have significant impact and improvement upon travel time to keep San Diego moving!!!	The Regional Plan includes a host of solutions to reduce traffic congestion but with projected growth in population, housing, and jobs, incentives for telecommuting and carpooling are simply not enough to keep pace with or reduce congestion. However, the Regional Plan advances many services early on that provide real quality transit solutions for the region. In terms of the permissive left turns, while falling within the purview of the local cities, the Regional Plan does include near-term (2025) investments in smart intersections throughout the region to reduce unnecessary delay and save people time.
W433	Sean Richards		Build sidewalks on the north and south facing slopes of Mission Valley to facilitate the north/south commute for bikes. Few will ride bikes down and out of MV on roads as a way to commute to work.	As an early action out of the 2021 Regional Plan, SANDAG will be developing a new Active Transportation Plan. The plan will take a fresh look at the network and the options to make it safe and comfortable to use active transportation.  Your comment was forwarded to the City of San Diego.
W434	Sebastian Ladron de Guevara	San Diego mts	I when getting pronto card in mail?	Please contact the Metropolitan Transit System at (619) 595-5636 or <a href="https://www.sdmts.com/fares-passes/pronto-fare-system">https://www.sdmts.com/fares-passes/pronto-fare-system</a> to receive information about your Pronto card.
W435	Simone Arias	Mid-City Can	We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W436	Stephen Lees		You can't do this, you are not competent enough. You can't even take care of the roads as it is. When you can balance the books and maintain the infrastructure, without lying (we haven't forgotten the scandal from 2017- you have not got our trust) and restored credibility with existing projects, come back. I refuse to pay for you to lie and fail at my expense, again.	Thank you for your comment.
W437	Steve Dow	self	I strongly urge that this plan be updated to be much more aggressive with solar power development. Such solar systems can and should absolutely be viewed as part of a modern transportation network. A network of solar power / battery systems can disconnect from the grid when necessary and	Reducing emissions from all sectors is critical for the state to meet its goal of "carbon neutrality" by 2045. Implementing the 2021 Regional Plan, while also facilitating the development and implementation of local Climate Action Plans (CAPs) across our region, will help everyone—the State, SANDAG, cities, and other public agencies—achieve their

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			<p>provide a stand-alone back-up system in the event of grid failure similar to what occurred in Texas several months ago.</p> <p>I recommend that this plan include detailed plans for solar cell shade structures at nearly every sidewalk and/or right-of-way possible in the SANDAG region. If the infrastructure is developed appropriately, such a system will start providing an immediate payback to our region. Solar-powered batteries can be strategically located (and made mobile as well) to charge electric vehicle stations (and/or buildings and communities). Systems could even be set in locations that might specifically benefit disadvantaged communities today.</p> <p>We need leaders who think BIG on this issue. Renewable energy can help solve many more problems than just climate change, but we need to think MUCH more aggressively than we have to date... and we need leaders who will champion this and act.</p> <p>The Rancho Bernardo Community Council sent a letter to Councilmember Mark Kersey in 2020 (and the letter was forwarded in 2021 to Councilmember Marni von Wilpert) that recommends area near the Rancho Bernardo Community Park for a test case of such solar / battery systems described above. Background on the idea and likely benefits of it are included in attachments to that letter.</p> <p>PLEASE INCLUDE THIS AS PART OF THIS PLAN.</p>	<p>climate goals. The Regional Plan does not include details on project designs, but SANDAG looks forward to partnering with local jurisdictions and others as it implements the Plan. Advancing renewable energy, including solar power, will be key to a carbon neutral future.</p>
W438	Steve Howie		<p>I am strongly against the overall vision for San Diego's transportation plan. I am not a proponent of public transportation, nor do I believe that it will be used by the majority of San Diegans. Taxing citizens to drive to try to stop people from driving cars is insane and does not have any place in San Diego. I have lived here all of my life. Please take your socialist "central planning" reimagined transportation plan somewhere else. The usage tax is a horrible idea and I pray that the voters will not succumb to this pie in the sky plan. How about you try fixing the roads - we don't need 163 billion dollars to do that!</p>	<p>Thank you for your comment.</p>
W439	Steve Sampiere		<p>Hi, I've been a cyclist for over 50 years of which just under 40 of those years have been in San Diego County. I participate in all forms of cycling: Sport(fast) Cycling, Commuting (Solana Beach to Downtown), and ebike for shopping and errands. I rarely use a car any longer except for out of region trips. I've seen the development of bike lanes go horribly wrong. In an effort to make cycling "safe" protected bike lanes have done the opposite in my opinion. They "trap" the cyclist within a narrow and often poorly maintained path that creates a very unsafe method of travel for a cyclist and they are extremely expensive to build and once built have virtually no flexibility for change. In my opinion, a safer and more efficient (cost and movement) is non-protected bikelanes with a buffer such as the newly constructed southbound bike lane adjacent to Torrey Pines Reserve. All bike lanes should be constructed this way. This portion of the bike lane has the following positive attributes: 1. two lanes in same direction which allows slower and faster cyclist (and pedestrians) to easily and safely co-exist; 2. A buffer between the cycle and auto lanes;3. Given there is no curb between the cycle and auto lanes it provides additional safety by allowing a cyclist to travers outside of the cycle lane in the event of slower or stopped cyclists, pedestrians, and/or unsafe obstacles. In addition it is lower cost and easier/faster to build/maintain. I feel very safe on this particular path as compared to the recently built path on the Coast Highway in Cardiff/Encinitas. I now avoid that stretch of road as much as possible and when I do use it I generally stay in the sharrows as there is rampant misuse of the protect lane and it often has excessive sand and glass. When using the Sharrows I'm constantly close passed by autos exceeding the 35mph speed limit. When driving that stretch I'm often buzzed by autos vastly exceeding the 35mph speed limit. I'm happy to share my thoughts further should you like to meet. Thanks for listening.</p>	<p>SANDAG follows national and international best practices in bikeway design to create safe facilities for users of all ages and abilities. Multiple studies show that most people feel safer in protected bikeways, and when well designed, they are safer than any other type of bike facility. The focus of our efforts is on people who may be "interested but concerned" in riding a bike alone or with family. For those who do not feel comfortable riding in protected bikeways, the California Vehicle Code allows people to bike in the roadway with traffic. While protected bikeways are a great solution in many cases, we know they are not always the best solution. Every project goes through a detailed and context sensitive design process which results in decisions regarding the best facility, which may include protected bikeways, buffered bikeways, shared use paths, or shared streets with significant traffic calming elements. The Regional Plan also includes funding for upgrading existing bikeways that may not meet current best practices in maintenance or bikeway design.</p>
W440	Steven Smith	Unaffiliated with any organization.	<p>My wife and I are senior citizens living in Fallbrook. We do not use, have not used, and have no desire to use public transportation to travel anywhere within the County of San Diego. We believe what will serve our interests the best it to have well maintained roads and other infrastructure with sufficient capacity along with programs and technology that best facilitates using one's personal vehicle to travel to different locations within San Diego County with the fewest delays possible. We would especially hope that funding is spent fairly to provide benefits to the overwhelming vast majority of San Diego County residents that prefer to drive their own vehicles to wherever they want to go. The I-15 and I-5 corridors along with Highways 76 and 78</p>	<p>The 2021 Regional Plan includes a managed lanes network proposed for I-15, I-5, SR 76 and supporting managed lane connectors, included in Appendix A. The Plan includes 4 managed lanes on SR 76, 4 managed lanes on I-5, and 3 managed lanes on I-15 north of Valley Parkway. In addition, technology improvements are planned for all freeway corridors and supporting arterials.</p>

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			are very important to North County residents and should absolutely get a fair and equitable share of any funding and project focus.	
W441	Steven Steppe	EWMC San Diego	In order for the plans to give the maximum benefits back to the communities entry level positions need to be offered to the communities in construction of all the projects. A project labor agreement that requires inclusion of lower income communities would bring money back into those communities. Writing in apprenticeship starting positions open to people from low income communities as a requirement would lift and support people while providing opportunities for advancement into the middle class. Not goals but requirements from every trade classification. They have been proven to work in other cities.	In an effort to invest in our region's underserved communities, one initiative SANDAG is currently working on is the development of a Community Benefits Agreement. In partnership with the San Diego County Building and Construction Trades Council, SANDAG received state funding through SB 1 to establish a 24-month pre-apprenticeship program to provide individuals throughout the San Diego region with resources and training for a career in construction. On July 23rd, 2021, SANDAG's Board of Directors voted to start negotiations with the San Diego County Building and Construction Trades Council to begin developing this program.
W442	Suki Glenn		I support the 10 Transit Lifelines be included in the Regional Plan. It is important to make sure all San Diegans have the opportunity to use affordable public transportation.	Many of the 10 Transit Lifelines are projects/programs in the 2021 Regional Plan. Many will require interinstitutional collaboration with other agencies. Nevertheless, they are or will be noted in the final draft, Appendix G. SANDAG is diligently working towards addressing the needs of disadvantaged and underserved communities.
W443	Sunny Soto	Sunny street outreach	For more marginalized communities and even age groups the access to a bike that can ride over big hills, as most of the city is, aren't affordable. Ride shares add up quickly also and you MUST have a bank acct and know how to guide apps to do this. For scooters those same technology and bank rules apply plus I know I don't have to touch on the safety of those scooters. The city hospitals see soooo many injuries and most people don't have the healthcare or access to good health coverage. Public transportation takes a long time to get places which is hard for scheduling as well.	<p>The deployment of Flexible Fleets such as e-bikes, shuttles, or ridesharing is envisioned as part of the 2021 Regional Plan to provide convenient and affordable options in different communities. SANDAG is developing a Flexible Fleet Implementation Strategic Plan to identify near-term opportunities for Flexible Fleet pilots that support mobility, equity, and sustainability goals.</p> <p>Ensuring there are options for all people to access Flexible Fleets is an important component of the 2021 Regional Plan. This includes designing services that enable all people to easily reserve a ride such as a call center, cash payment options, or trip planning kiosks in Mobility Hubs. As Flexible Fleet pilots are launched in the region, services will be designed to be inclusive and equitable for all.</p>
W444	Susan Durbin	Samahah Health Clinic	I worked at the Granger Clinic. One of the main complains of our patients is that there is no bus stop by or close to the clinic.	<p>While there are no proposed new fixed-transit routes that go to the Granger Clinic, Flexible Fleet solutions will be able to help provide that first and last mile connection from the nearby transit stations in the area.</p> <p>Your comment has been forwarded to San Diego Metropolitan Transit System (MTS).</p>
W445	Susan Escoffier	County Resident	This 2021 Regional Plan will not work for the unincorporated communities of San Diego county. The burden of the costs will be placed upon the county residents who are least able to afford these TAXES! We live in the outer areas of the county because we cannot afford housing more centrally located, we are retired on fixed incomes, we are lower income earning employees, etc. You are touting equity in this plan when in fact it is causing greater disharmony and dissention and placing greater hardship on a significant portion of the San Diego county population. Please do your due diligence in intentionally studying ALL affected communities in your "Plan".	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>



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W446	Susan Oliver		I would like to be certain that SANDAG is working towards providing growth/changes that reflect what the citizens want; not want a small group of people think they should want. With that in mind, we should be looking at more roads and less building. At some point we need to admit that we can't support any more people. We don't have enough water or room. Please consider making changes to reduce growth!!	The Regional Plan aligns with population growth projections for the San Diego region developed by the California Department of Finance.
W447	Susan Wilding		How do you plan to charge people who do not live in CA and drive their personal vehicle in CA. Out of state truckers. AZ, NV, UT, CO, OR. And military people?	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues.</p> <p>SANDAG will coordinate with other Metropolitan Planning Organizations in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management. As these implementation mechanisms are determined, SANDAG will develop strategies for out of State individuals and commerce that are using roads in the San Diego region.</p>
W448	Tamara Petersson		I commend SANDAG for scrapping the former plans and starting anew with the 2021 Regional Plan. The current plan is well thought-out and prepares San Diego for the next several years. There are so many positive possibilities!	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W449	Teresa Hernandez	Ucsd	I'm UCSD staff and my working hours are from 4:00a.m. at 12:30p.m., I want to know if the trolley schedule will be accessible so that we can use this transport? Teresa H.	<p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p>
W450	Theodore Cheung		Hi thank you for all the hard work you all are doing, I was wondering if SANDAG is studying the feasibility of Aerial cable/gondola transit considering that land is developed on mesa tops and that there's a lack of connections between mesas, especially between mesas around the Los Penasquitos Preserve in the North-South directions and in Sorrento Valley.	Gondolas had been considered in past versions of the plan but were replaced with additional Next Generation Rapid routes. MTS and SANDAG still continue to keep an eye on this mode and may reconsider it in future plans.
W451	Theodore Cheung		Additionally, considering the amount of tunnels to support the commuter rail projects, will SANDAG own a boring tunnel machine or will it be a contracted machine?	Construction methods will be determined during final design of the projects. It is unknown at this time what time of tunnels will be constructed and what equipment will be needed.
W452	Theodore Cheung		As for the commuter stations, will there be varying levels of commuter train service? Specifically, will there be center passing tracks in the stations that will allow express trains to bypass trains stationed at local serviced stations? This would allow more transit service flexibility for our region. Thanks! Ted	Yes, passing tracks are envisioned as part of the commuter rail network.
W453	Theresa Lane	Sunrise Movement	<p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego. No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities. Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.

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			I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority. Thank you.	
W454	Thi Vo		We are urging SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.
W455	Thomas Lichterman	Oceanside Bicycle and Pedestrian Committee	<p>The following are initial general comments regarding the Active Transportation Project listings in Appendix A.11 - North County:</p> <ol style="list-style-type: none"> <li>1. For each Active Transportation project listed in the table, please provide a sufficient project description so that the reader can understand what the project is and what city(s) it is located in.</li> <li>2. For each Active Transportation project listed in the table, please provide the geographic project limits in terms a lay-person will understand, such as nearest major roadway intersection or major landmark.</li> <li>3. For each Active Transportation project listed in the table, please indicate which project phases (e.g., planning, preliminary engineering, final design, construction, etc.) is funded by the cost estimate shown.</li> <li>4. Please correct the paragraph below - other pages of the Regional Plan website state comments can be submitted through August 6, not July 30.</li> </ol>	<p>1) As identified in Appendix L, these projects were approved by the SANDAG Board of Directors In 2010 with the development of a comprehensive regional bike network - Riding to 2050: The San Diego Regional Bike Plan. <a href="https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail</a> and again these Coastal Rail Trail segments were identified as a priority project in 2013 via the Bike Early Action Program (EAP) <a href="https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail</a></p> <p>2) Please see full Network Explorer here <a href="https://sandag.maps.arcgis.com/apps/Cascade/index.html?appid=897af882e8c14b1e996c33e48bc15347">https://sandag.maps.arcgis.com/apps/Cascade/index.html?appid=897af882e8c14b1e996c33e48bc15347</a> or specifically the “Adopted Regional Bike Network” layer in the standalone webmap from that Explorer linked here <a href="https://sandag.maps.arcgis.com/apps/webappviewer/index.html?id=11c84c1530084748a7fa410920370218">https://sandag.maps.arcgis.com/apps/webappviewer/index.html?id=11c84c1530084748a7fa410920370218</a></p> <p>3) If the project is in the 2035 or 2050 Year Built networks then the cost estimate funds all project phases. For 2025 most of these projects are already well past the Planning phase as they are in the Early Action Program - please see webpage here for the latest project information: <a href="https://www.keepsandiegomoving.com/RegionalBikeProjects/Introduction.aspx">https://www.keepsandiegomoving.com/RegionalBikeProjects/Introduction.aspx</a></p> <p>4) This item has been addressed.</p>
W456	Thomas Lichterman	Oceanside Bicycle and Pedestrian Committee	<p>The following are initial questions submitted on behalf of the Oceanside Bicycle and Pedestrian Committee to better understand Active Transportation project proposals in Appendix A.11, page A-35, of the 2021 Regional Plan, and thus be able to submit specific follow-up comments:</p> <p>Project AT003 - “Inland Rail Trail Phase 4” - Does this phase cover the entire segment within Oceanside?</p> <p>Project AT030 - “Coastal Rail Trail Broadway to Eaton” - Exactly what is this funding intended to cover? Would seem to be enough for a study but probably not design and construction.</p> <p>Project AT049 - “Inland Rail Trail Oceanside” - Is this funding the entire segment within Oceanside? How does this differ from project AT003?</p> <p>Project AT068 - “Camp Pendleton Trail” - Please provide the project limits of this proposed trail.</p> <p>Project AT073 - “Coastal Rail Trail Connections” - Where are these connectors? Are any in Oceanside?</p> <p>Project AT074 - “Coastal Rail Trail - Oceanside Segment 1 ALT” - What is this project and where is it located? What is it an alternative to?</p> <p>Project AT113 - “San Luis Rey River Trail” - What is this project? Is it an extension of the existing trail or a reconstruction of it? If an extension, what are the project limits?</p> <p>Project AT124 - “Vista Way Connector” - What is this project, and what are its limits?</p>	<p>AT003 Inland Rail Trail Phase 4: No, this is the section currently in final design, mostly in the City of Vista.</p> <p>AT031 Coastal Rail Trail Oceanside – Broadway to Eaton: This is to connect the Class 1 on Broadway from Vista Way to S. Coast Hwy via Eaton. It was conceptualized as Class 3 or bike boulevard. The project cost is an estimate for completing all project phases for this segment using median cost estimates from SANDAG EAP projects. The project costs will need to be updated once this project is included in SANDAG’s RTIP or CIP.</p> <p>AT049 Inland Rail Trail Oceanside: This is intended to fund the entire segment within Oceanside. AT003 is the segment east of this.</p> <p>AT068 Camp Pendleton Trail: I-5 SB ramps at Basilone Rd (northernmost extent) along Old Pacific Highway to ~ 33.335888, -117.503584 (southernmost extent).</p> <p>AT073 Coastal Rail Trail Connections: There are two connectors, both in Carlsbad: One on State St. in Carlsbad from Oak to Carlsbad Blvd, and one on Avenida Encinas from Carlsbad Blvd to Embarcadero Ln.</p> <p>AT074 Coastal Rail Trail – Oceanside Segment 1 ALT: The project is in Oceanside from the San Luis Rey River Trail connection at N Pacific St (northernmost extent) continuing south and jogging along Tyson St where the southeasternmost extent terminates west of the RR ROW. This alignment is an alternative to the 2000 CRT Project Study Report and</p>

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				<p>2009 Regional Bike Plan. Note, the estimated costs will need to be updated once this project is included in SANDAG's RTIP or CIP, and the alignment may change in the preliminary engineering phase.</p> <p>AT113 San Luis Rey River Trail: Proposed extension of the existing San Luis Rey River Trail starting at the current terminus just north of College Blvd. and ending at Old Hwy 395.</p> <p>AT124 Vista Way Connector: This project's alignment follows E Vista Way and Vista Village Dr from SR76 (northernmost extent) to IRT Phase 4 (southernmost extent)</p>
W457	Tom Lichterman		The residents of Oceanside have been waiting for their segment of the Inland Rail Trail to be built since 1995, when the cities on the Sprinter corridor agreed in writing that the IRT was a priority. That's 26 years ago! The draft Regional Plan now says that project won't happen until 2035, another 16 years. That's 40 years to complete a bike trail! We must do better than that. Please prioritize finishing the IRT in the next five years!	<p>We are committed to complete this project's Phases and invite you to check out the project webpage at Keep San Diego Moving, sign up for updates at the link below if you have not already.</p> <p><a href="https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx">https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx</a></p> <p>And, we'd encourage you to be involved with the efforts of the North County CMCP if you are not already</p> <p><a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail</a></p>
W458	Toshihiko Ishihara	SanDiego350	SANDAG RP (Regional Plan) must address the impacts of Climate Change as the highest priority along with the transportation transformation that the RTP envisions. We are seeing evidence such as big wild fires and severe droughts that indicate Climate Change is here and accelerating. According to the 2021 Draft RP, it will reduce per capita GHG emissions from transportation to 20% below 2005 levels by 2035. However, the County of San Diego's goal is to dramatically reduce the county's GHG emissions to reach net-zero emissions by 2035. I cannot logically understand how the 20% reductions of the GHG emissions from transportation sector will take us to the county's ambitious goal. Also, Appendix X shows that the GHGs from many sectors are mostly flat from 2035 through 2050, which is very concerning. All those projections lead to a conclusion that we will continue to generate GHGs at very high rates, which means that the current draft plan will not bring this region to compliance with the California state-wide goals listed in Chapter 1. Therefore, I hereby request SANDAG to clarify my above question and include specificities in the RP how it will conform to the ambitious GHG reduction goal.	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT, not through the use of zero emission vehicles.</p> <p>The GHG Inventory (Appendix X) analyzes emissions from all sources and the projections account for state and federal legislation currently in place, as well as strategies within the 2021 Regional Plan. The Local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
W459	Tov Aod	Oppressed Taxpayers	SANDAG betrayed the taxpayers before when they were obligated to repair, maintain & construct more freeway & highway lanes for drivers. You only made carpool & bus lanes and trolleys & rail. We cannot trust you thieves, dictators & autocrats. You want to steal from us using the authority of government, but you are not subject to the will of the people. We will vote every Marxist SOB out of office & fire each one of you overpaid tyrants every chance we get. We do not want to be forced into mass transit to catch Covid or the next disease de jour. We don't want to get mugged or killed by the criminals that prey upon riders. We can't spend 2 1/2 hours to get somewhere that only requires a half hour drive. We can't walk miles to & from bus stops to work or carry enough bags of groceries on a train. We refuse your oppressive gas taxes, tolls, and per mile charges! We already pay the highest gas taxes in the country, but it's never enough to satisfy you. Your social engineering repulses us. You spend & waste billions of our tax dollars without being accountable or following the law. We want to disband SANDAG as formed, since the county supervisors should be following the transportation desires of their constituents ( and getting voted out of office if they don't!). You unelected bureaucrats seek tax increases from us without any care that you are driving many to flee this Communist regime. We can't afford to live here if you get your way, but you would force grandma into danger & poverty. You are truly heartless. Go to Hell!	<p>Transit Leap greatly increases transit speeds, frequency, and span of service providing a compelling alternative to driving. Flexible Fleets help address access to transit facilities and travelers' final destinations. Complete Corridors with continue to provide mobility and access to all modes throughout the region.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all. Oversight of public agencies is important and SANDAG welcomes public review of its work and processes. Federal and state agencies regularly review SANDAG and there are two ongoing local oversight processes with the Office of the Independent Performance Auditor and the Transnet Independent Taxpayers Oversight Committee.</p> <p>SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.</p>
W460	Valentina Molteni		<p>SANDAG's plans for the SR-94 in the 2021 Regional Plan and all relevant planning processes ought to achieve the following:</p> <ul style="list-style-type: none"> <li>- Honor the spirit of the SR-94 Complete Corridor community visioning process from 2015</li> <li>- Our priorities from the 2015 community-led visioning process remain -- Transit priority lanes, freeway cover park between 25th St &amp; 22nd St, Centerline Bus Stations at 25th St for Rapid 235 &amp;</li> </ul>	<p>The 2021 Regional Plan advances several of these ideas including managed lanes along SR 94 from Interstate 5 to SR 125, transit leap service, and several active transportation enhancements. Please see Appendix A for more project details. As projects advance into implementation additional planning, public involvement, and design will be necessary. Please continue to follow along and participate at <a href="http://SDFoward.com">SDFoward.com</a>.</p>



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			<p>225, bike path from City Heights (Home Ave) to Southeast San Diego (Market St), improved active transportation connectivity throughout corridor</p> <ul style="list-style-type: none"> <li>- Support for lane conversions from general purpose lanes into Managed Lanes or Transit Only Lanes</li> <li>- Build on the Bus On Shoulder Pilot results</li> <li>- Transit Only Lane connector between SR-94 &amp; SR-15</li> <li>- Meaningful community engagement throughout upcoming SR-94 CMCP -- Comprehensive Multimodal Corridor Plan</li> <li>- Center equity in the CMCP</li> <li>- Project should incorporate additional community needs identified through CMCP process</li> </ul>	
W461	Victoria Lopez	National Latino Research Center	<p>No me gusta que a veces los buses pasan tarde y llegamos tarde al trabajo. Nuestro sistema de transporte público no es confiable. Espero que este plan cambie esto.</p> <p>***</p> <p>I don't like that the buses arrive late and we arrive late to work. Our transportation system is unreliable. I hope this plan changes that.</p>	<p>SANDAG está consciente de que se debe hacer algo ahora para tener un transporte público rápido, frecuente, confiable y accesible, particularmente en la rutas de mayor uso. Nuestro personal llevará este asunto ante el Comité de Transporte y la Mesa Directiva de SANDAG antes de la aprobación del Plan Regional 2021 para modificar el presupuesto de la agencia y tomar medidas ahora para invertir en un transporte público que beneficie a las comunidades de justicia ambiental. Esta acción trata de aumentar los servicios en las líneas del transporte público que tienen un servicio poco frecuente en las noches y madrugadas y/o crear subsidios para hacer que las tarifas sean gratis para los jóvenes usuarios. También se añadirá lenguaje aclarando aún más las mejoras propuestas para la red de autobuses, incluyendo mejoras en la frecuencia y en el alcance del servicio, al Anexo A del Plan Regional 2021 final propuest.</p> <p>***</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
W462	Victoria Lopez	National Latino Research Center	<p>A veces hacen juntas así en las escuelas, pero creo cuando pasa algo (que no está bien) es cuando hacen algo así como este plan. También, a veces hay seguridad...pero las mismas personas no respetan al peatón...por las prisas. Nuestras aceras deben ser más seguras. Aquí en Vista tenemos un lugar donde los estudiantes necesitan caminar a la escuela como RMMS y no hay aceras seguras para ellos. Necesitan caminar por donde conducen los autos, lo cual es muy peligroso.</p> <p>***</p> <p>Sometimes they have school meetings in the schools, but only when something bad happens is when something is done, like this plan. Also, sometimes there is security, but those same people do not respect the pedestrians during the rush. Our sidewalks need to be safer. Here in Vista we have a place where the students need to walk to school, like RMMS (Rancho Minerva Middle School), and there is no safe sidewalks for them. They are forced to walk in the street with cars, which is very dangerous.</p>	<p>El borrador del Plan Regional incluye un programa Visión Cero para hacer que el sistema de transporte sea seguro para todos los usuarios. Las acciones a corto plazo incluyen el desarrollo de un Plan de Acción Regional Visión Cero que incorpora una Política Regional de Seguridad y la creación continua de proyectos que enfatizan la seguridad de todos los usuarios de la carretera para implementar la Visión Cero. Puede encontrar más detalles en el Anexo B. Proyectos regionales para bicicletas y peatones están en marcha a lo largo de la línea del Sprinter, en el Sendero Ferroviario del Interior, pero estos proyectos no mejorarán las condiciones en las áreas que ha identificado. El Distrito Escolar Unificado de Vista puede ayudar a mejorar las condiciones alrededor de las escuelas y usar guardias de seguridad en los cruces peatonales. Las banquetas locales son jurisdicción de la Ciudad de Vista. Por favor también considere participar en los esfuerzos del Plan Integral del Corredor Multimodal del Condado Norte.</p> <p>Su comentario ha sido compartido con las agencias gubernamentales que supervisan estas instalaciones.</p> <p>***</p> <p>The draft Regional Plan includes a Vision Zero program to make the transportation system safe for all users. Near-term actions include developing a Regional Vision Zero Action Plan, incorporating a Regional Safety Policy, and a continuing action to build projects with an emphasis on safety for all road users to implement Vision Zero. See Appendix B for more details.</p> <p>Regional bicycle and pedestrian projects are occurring along the Sprinter line, the Inland Rail Trail; however, they will not directly improve the areas you've identified. The Vista Unified School District can help improve the conditions around the schools and with the Crossing Guards. Local sidewalks are under the purview of the City of Vista. Please also</p>

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				<p>consider participating in the efforts of the North County Comprehensive Multimodal Corridor Plan.</p> <p>Please use the following links for more information:  <a href="https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx">https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx</a>  <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail</a></p> <p>Your comment was forwarded to agencies that oversee these facilities.</p>
W463	Vincent Colavin		Please amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W464	Wanda Curtis		This plan does not address issues for taxpaying south bay residents. The trolley corridor, Eastlake via I-125 is no longer, now a bus to the border. Our college students cannot easily get to colleges (owners were told Trolley corridor via I-125 to I-8 Mission Valley trolley). I-125 became a toll road when it was originally free. How does this plan move our Chula Vista residents to college and work? It moves border crossers to downtown. I do not see a benefit from any of your last plans for my family and neighbors here in Eastlake.	This plan includes several new Next Generation Rapid routes that will serve South County residents and provide them with access to Southwestern College, SDSU, and UCSD. The Next Generation Rapid fleet is the best option for ensuring that as many people as possible across South County and the region have access to employment centers.
W465	Wanda Curtis		South bay plan should include removing the toll from I-125. Making North and East counties more accessible and useful for students (SDSU, Mesa, Grossmont) and workers.	There is a plan to remove the toll from SR-125 once the toll road's debt service has been paid off.
W466	Wanda Curtis	Tax paying home owners /self	I do not agree with the priorities set forth for the south county/Chula Vista area. I am a native IB/CV resident and do not see the current plan benefitting us. The original plan that connected the eastern parts to the north directly benefitted residents. Students could take direct transportation (trolley lines) to SDSU and east. The current plan only supports border crossers not residents, students, families. You have changed plans so often (125 from free to fee, no trolley corridor to the east and north, etc.) I feel like residents are not being considered or listened to at all. The best option is to complete the ring of transportation east and north in the south bay. Contact me for more comments.	The Regional Plan includes substantial new services throughout South County. While the border is emphasized with new services and facilities there are a number of new Next Generation Rapid routes, improvements to the existing trolley and bus lines. Many of the changes identified were the result of extensive data analysis and land use development.
W467	Webb Lana	N/A	Please make student transit passes a priority.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W468	Will Micklin	Ewiiaapaayp Band of Kumeyaay Indians	Why does the plan not include, or depict in any map, east San Diego County that is east of central Alpine?	The proposed final Regional Plan will be updated to include a map of entire county. The Data Viewer on <a href="http://SDForward.com">SDForward.com</a> provides interactive maps that can zoom and pan across the region to explore eastern San Diego County and the rural corridors included in the draft plan. There are a number of full county maps throughout the technical appendices: Appendix I - Tribal Consultation; Appendix J - Megaregion; and Appendix A includes a Rural Corridors map showing the full county.
W469	Yasmin Musse	Nile Sisters Development Initiative	good presentation	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W470	Yolanda Flores	Bayside Community Center	Yo en un futuro veo mas carros electricos en San Diego y consumiendo menos gasolina y menos contaminacion para nuestras generaciones futuras ojala todos tuvieramos mas conciencia de mantener nuetra comunidad mas limpia menos basura y menos contaminacion paraque nuestros hijos. *** I see more electric cars in San Diego's future using less gas and producing less pollution for the	Gracias por su comentario. El Plan Regional 2021 incluye inversiones en la infraestructura de transporte y en programas que incentivan el uso de vehículos eléctricos para reducir la contaminación en nuestra region. *** The 2021 Regional Plan includes investments in transportation infrastructure and electric vehicle incentive programs to reduce pollution in our region.

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			future generations. I wish we all were more conscientious and that we kept our community cleaner and produce less trash and pollution so our children.	
W471	Yolanda Rodríguez	Mid-City Can	Necesitamos pases gratis para nuestros estudiantes de la comunidad. *** We need free passes for the students of our community.	<p>Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio permitirá que las partes interesadas publicas tengan la oportunidad de expresar su opinión sobre las alternativas. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los jóvenes menores de 19 años.</p> <p>***</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
W472	Yuliya Pidcock		Please, consider replacing all abandoned street lights in Rancho Del Oro, Oceanside. It is not safe.	<p>Maintenance of transportation infrastructure is critical to a well-functioning and safe system. Maintenance of streetlights is generally the responsibility of the jurisdiction's department of transportation or Public Works Department.</p> <p>Your comment was shared with a Principal Civil Engineer at the City of Oceanside.</p>
W473	Yvonne Elkin		I have been watching the development of the 5 Big Moves for, I think, almost 3 years. This is absolutely the direction San Diego needs to take. I understand the cost and time are daunting, but this is something Southern CA should have begun decades ago. Now we have no more time to delay. Please move forward with the 5 Big Moves.	We appreciate your support and feedback. SANDAG is working on designating pilot programs and near-term projects to begin implementing some of the elements outlined in the proposed final 2021 Regional Plan. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W474	Zachary Robertson	The San Diego LGBT Community Center	I am a part of the Youth Queer Leadership Committee, and not only will free transportation benefit me, but it will also help the people I support like underprivileged and queer youth who cannot afford a car or are too young to drive. Making transportation free would allow more students to go places without their parents having to spend gas money or take time off work to take the child there. Free transportation would allow them to get there safely. Also students are needing more jobs because of college as well as to help with family bills. With more students traveling makes for a more diverse community as well. In my personal experience someone from South Bay took the bus to their job in Mission Beach. They said they took it every time they worked. Many people depend on public transportation to get to work, and spending money for bus passes is a lot for them, and they would have to earn it back, and many jobs that are being offered to teens and young adults are minimum wage. So I encourage you make transportation free for youth and underprivileged young adults. Cars are scarce in the market as we speak and many youth can't afford one either that is why public transportation is becoming more popular. Also since our economy was just hit with unforeseen causes many families are struggling to get the funds to even buy a bus pass, not including saving for a car. So I incline you, make public transportation free so that the future of this country can be a diligent as the collared workers before them.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W475	Zenaida Lim		Waiting time is ok.	Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W476			<p>You are out of your minds, wanting to charge people per mile to drive on the road network. Firstly, nobody is going to be honest with you; implementing the tax is going to cost more than the revenue it brings in. Second, we already pay some of the highest DMV registration fees in the country, which is supposed to cover the cost of the infrastructure, but has been so significantly mismanaged that you are running a deficit. Third, this plan will have a cascading effect on goods and services: a not insignificant amount of people use their vehicles for work and are reimbursed for their mileage. Adding a fee per mile would increase the cost of employment, which will inflate the product price of the business which is impacted.</p> <p>Your plan is incredibly dumb, and I honestly don't know how you thought it would be a good</p>	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources. The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and

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			idea, other than getting aroused by bleeding the citizens dry to cover your money management shortcomings. This state is getting worse and worse by the second.	community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.
W477			This plan is municipal robbery from innocent taxpayers who will never see any benefit. Leave well enough alone. Telecommunication, flex working hours, declining birth rates, rising home prices will all contribute to changing transportation needs. Also Amazon, US Mail, FedEx, and UPS should be restricted to deliveries every other day in all areas. Delivery vehicles should be all electric, carbon free emissions.	<p>The 2021 Regional Plan envisions a transportation system that will evolve as our mobility needs continue to change well into the future. One of the key strategies in the Regional Plan is to support the expansion of Flexible Fleets like on-demand rideshare, microtransit, and last mile delivery services to move people and goods more sustainably.</p> <p>These technology-enabled services are available on-demand and vary in size to cater to different trip purposes. Flexible Fleets also include last mile delivery services like those provided by electric bikes, autonomous shuttles, and drones to deliver packages to our homes, work, or Mobility Hubs. SANDAG intends to collaborate with local jurisdictions and the last mile delivery providers to plan and test delivery services that contribute to our mobility, equity, and sustainability goals.</p>
W478			Proposed Grand Central Station would be a huge waste of money. It would add a stop and increase time required to get to the airport. Money should be spent on freeway corridor trolley lines and branch bus lines. I use the trolley and bus every day. Getting to the airport is no problem. Travelers with light luggage can easily use trolley and bus to get to the airport. Travelers with a lot of luggage do not use public transit and will not use a Grand Central Station.	The Central Mobility Hub will have fast, frequent, and convenient connections between existing and planned transit and the airport. The MTS Route 992 bus will continue to serve the airport from Downtown San Diego.
W479			I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.	SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
W480			I see and agree with some of your ideas and plans but there is much that I don't agree with. I think that the Hub Centers are too big and costly and will not work until you have enough population density to support & use it.	Each regional Mobility Hub coverage area was identified based on a variety of factors including existing and projected population and job growth along with information on where and how people travel. Many existing trip destinations fall within areas that have been identified as a regional Mobility Hub, yet some of these communities lack convenient transit service or safe streets to walk, bike, or use other micromobility options. While not every regional Mobility Hub may feature a large transit station like the Central Mobility Hub, there may be opportunities to add mixed-use infill development near existing and proposed transit lines in locations that can accommodate growth. Funding Mobility Hubs is a truly collaborative effort between SANDAG, local jurisdictions, transit agencies, private developers and employers, and more. Given the large number of Mobility Hub stakeholders, innovative public-private partnerships can be forged to fund, design, and implement various aspects of Mobility Hubs including stations, complete corridors improvements, and other Mobility Hub amenities.
W481			I disagree with your projections of both funding and population. In order to pay for your infrastructure you say we need higher population therefore increase density which justify residential high rise building. I will not live in a place like Miami with a wall of buildings blocking the coast. You can better use the tax revenue you are getting now to modify what we already have. Instead of having to reinvent the wheel. i.e., I would probably use the trolley more today if there were a micro transit system to get me from my house to & from the station easily.	SANDAG updates population and funding projections as it updates the Regional Plan every four years. The 2021 Regional Plan includes investments in Flexible Fleets that would offer services such as microtransit.
W482			Sometimes I ride my bike places and sometimes I drive my car. I don't like the removal of parking spaces happening now and supported by this plan. Please keep parking spots on the streets in front of retail and restaurant locations. Most importantly, do not plan to compel drivers to not drive by increasing costs to do so.	The 2021 Regional Plan includes a variety of projects and programs to improve the transportation system for all modes of transportation in the San Diego region over 30 years. This includes investments to improve roads and freeways as well as public transit and active transportation. Every bike project will go through a detailed planning and design process focused on providing the safest facility but also considering factors like



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				parking demand. Regarding your comment about costs to drive, gas tax revenues have been declining as vehicles become more fuel efficient and more electric vehicles are on the roads. A road usage charge would be a new funding mechanism to replace the gas tax. Road usage charges are being considered by transportation agencies across the country.
W483			Please consider no cost transit passes for youth to receive priority when transit fares are allocated.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.
W484			I don't see any performance measures for average commute time, or for average trip times overall. Please include a performance measure for average commute time for ALL of the region's population.	For information regarding performance metrics, travel times, and other such data, please see Appendix H.
W485			This comment is in reference to the proposed tax increases in order to fund these asinine new projects that only a handful of people will take advantage of. It is shameful for SANDAG to propose new mileage taxes on working class citizens, especially when we are coming out of the Covid-19 pandemic. Why are hard working San Diegans being penalized for having a job and commuting to work? Working families and individuals are already struggling with an extremely high cost of living in San Diego, and most of us are barely making ends meet. We already pay the highest income tax, we have the highest sales tax, high property taxes, and we already pay \$1.19 per gallon for gas! ENOUGH! I have yet to see the road repairs that the revenue from gas taxes were allotted for. The only "improvement" I have seen is painting the freeway numbers on the road. Can we please have an audit to show exactly where those gas tax funds were diverted to? Clearly those funds are not being used for their intended purpose. I am a third generation San Diegan who can no longer afford to live in the city where I was born and raised. My parents, elderly grandmother, aunts, uncles, and cousins who are all born and raised San Diegans are being forced to leave our city due to no longer being able to afford to cost of living here. San Diego politicians and agencies don't care about San Diegan's, this is clearly evident with the audacity to impose new taxes and mileage tracking. It is a slap in the face to each and every working class San Diegan. NO NEW TAXES!!	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.  The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.
W486			How will the new per-mileage tax effect Uber, Lyft, and food delivery drivers? Since these workers will be penalized for driving extra miles as the result of the new tax, individuals will likely stop working for these companies. Please consider how this tax will effect the individuals who work for these companies in order to support themselves.	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. This study will also assess the potential impacts on businesses, particularly those relying heavily on transportation to do business. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. Whether Uber, Lyft, and food delivery drivers would be subject to a road usage charge, and if so, how it may impact the drivers and users of those services, will be analyzed as part of this effort.
W487			Why isn't SANDAG focusing easily implementable projects in areas that WANT them? Why not prioritize throwing down bike lanes extravaganza in communities that wont fight them like in equity communities? Where is there not an "ease of implementation" weight (along with equity considerations, since obviously at times there are more challenges within equity communities)	As an early action of the 2021 Regional Plan, SANDAG will be developing a new Active Transportation Plan. The plan will take a fresh look at the network and the options to make it safe and comfortable to use active transportation. SANDAG prioritizes community engagement and will develop these connections in partnership with the community so that we can make sure the routes take people where they want to go.
W488			Do not go forth with the Mobility Hub at former Navy - SPAWAR building. It will be a failure since people will have to do out and backs to the airport, wasting time. Multi modal should be from Santa Fe station to the terminals.	The Central Mobility Hub is being considered at the Navy's Old Town Complex formerly known as SPAWAR as well as other locations as part of an ongoing environmental review. A fast, frequent, and convenient transit connection to the airport is a key component of the project.
W489			Supports this plan and wants there to be more connection hubs near the schools so all the students are able to use public transport to get to their destinations. Parent has to leave for work early in the morning, and can't drop their students off at school. Would like for there to be a more valuable and reliable way to get to schools. Uber is too much to pay when we receive	The 2021 Regional Plan has redefined the transit network to include a 'support system' of regional Mobility Hubs and Flexible Fleets to expand the reach of transit and ensure major destinations like schools are more accessible. Funding for an array of Flexible Fleet options is included in the Plan to help make these services more affordable and

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			minimum wage, and even then, there is an element of safety that cannot be overlooked. Is willing to consider ride-sharing with public but as long as it's affordable and safe.	accessible. Additionally, the Plan demonstrates how 41% of low income residents will be within ½ mile of a commuter rail, light rail, or Next Gen Rapid stop by 2050.
W490			I think it's good for us who have no choice but to drive somewhere. I support this plan and all the proposals. I used to ride the bus a lot, but I found it complicated when the schedule was too far apart, and that meant that I had to keep in mind the fact that they might be late on their route, so I would have to leave my house far earlier than I would with my own car. Its own lane for the bus could help it keep on schedule and ease traffic.	We appreciate your support and feedback. The 2021 Regional Plan includes increased service spans for the trolley and bus service up to twenty hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24 hours.
W491			This would be good for all people in NC, especially if it can help ease the traffic on roads and highways. It would also be good to people who take the train to be able to reach their destination faster and closer to their actual goal.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W492			Why is Vision Zero apparently relegated to two measly paragraphs buried in appendix L? If this is really a bold new vision, Vision Zero should be a major tenet of that. People are dying because they don't use or own earth and people killing two machines to get around. This is atrocious and public agencies cow to bigger priorities as if providing safe ways to get around is just a second thought because an aspirational "CMH" is sexier or god forbid people sit in traffic on the freeway. I am losing friends and community members to being hit by cars in bike lanes and crosswalks and I hear just the barest of lip service. Where are your "info bites" on this epidemic against healthy mobility? Of course people don't go anywhere by foot or bike - someone might just run you over because the streets are designed for people to go fast and pay minimal attention. SANDAG has shown it can be a leader, but it is failing the most vulnerable (and cleanest) modes. I'm depressed when I decide to drive a mile to the store because I don't feel safe walking or biking with my kid there. I am actively choosing to produce GHG and make the environment worse for others because I don't want to die on the way there. SANDAG Exec Dir is "fearless" when it comes to demanding a world class public transit system, but he is decidedly less vocal about using his agency to elevate the plight of walkers and bikers. Bike advocates are dismissed for turning out and being vocal and having an outsized voice. We have to because this is literally life and death for us. Please hear us. (Sidenote: aside from safety, we need more secure bike parking that isn't just tied to transit stations please! I want to patron businesses but when hooked to a lamppost, I am less likely to stay for long or go somewhere like the movies or long dinner where I can't have eyes on my bike.	This is the first time SANDAG has included Vision Zero in our Regional Transportation Plan. For all the reasons you pointed out, it's entirely necessary and cannot wait any longer. SANDAG has a unique position in the region to help coordinate Vision Zero efforts happening at each individual local agency into a regional approach. The mention of Vision Zero here initiates that process but we clearly have much more to do. Additionally, as you mentioned, we at SANDAG include bike racks and secure parking in conjunction with our transportation projects but have also provided grant funding for the City of Oceanside to set up a secure bike parking area near their City Hall. We will continue to work with local agency jurisdictions through our Smart Growth and Active Transportation Grant programs to increase the number of secure parking areas for bikes and personal micromobility devices. Thank you for your comments.
W493			Any plans to have a ferry that goes to Ensenada and other Baja ports? I see Seattle and Miami has ferries that take tourists to other countries. One reason why I can see some people wanting to use a ferry is to not have to wait in line driving back.	SANDAG appreciates your support and feedback. The 2021 Regional Plan calls for continued collaboration with partners at the local, state, and federal levels in Mexico to plan and implement projects and programs to better facilitate crossborder mobility. SANDAG looks forward to exploring opportunities to enhance multimodal access between the San Diego region and Baja California via land and seaports in our ongoing collaboration with binational partners. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W494			Please...let's not get breathlessly caught up and over-perform in the trendy, political topics of "sustainability, social equity and climate change". Be careful not to knee-jerk your approach in developing tactics and solutions to convey an appearance of "doing something" about these hyper-hot, media-driven issues...most of which are hyperboles, anecdotal, and unproven. Take a logical, pragmatic approach to our regional growth planning and leave the political crap out of the strategy please.	Thank you for your comment.
W495			In the general bicycle guidelines, you write: "There is increasing interest in applying sharrows in conjunction with bike lanes on steeper slope roadways. Bike lanes are placed on the uphill side of the roadway and sharrows are placed on the downhill side of the roadway to encourage fast moving bicyclists to position themselves away from parked cars." This is excellent, many cities (e.g. Seattle) use this widely with much success. But this area (i.e. the challenges of San Diego's unique topography) is still comparatively underdiscussed. I think there needs to be more focus on how to encourage biking when many routes are challenging due to topography (steep uphills), not just infrastructure (lack of bike lanes). This could mean constructing more bikeways that traverse easiest-way-up routes for steep roads, instituting frequent shuttle services for steep routes, etc. Painting bike lanes and building bikeways will not necessarily spur ridership if the routes are still inherently too challenging or too dangerous for many riders.	The bike network shown in the plan is the Adopted Regional Bike Network, which was adopted in 2010. As an early action out of the 2021 Regional Plan, SANDAG will develop a new Active Transportation Plan. Although the original plan considered topography, we will take a fresh look in the new one. With the ever increasing popularity of e-bikes, we do feel it is important to build bike network in both flat and steep areas so provide as many network connections as possible.

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W496			The airport connection should be extended Liberty Station/Point Loma/Ocean Beach/Mission Bay. This would make it a much more useful transit line than just an airport connection. I think people would also sacrifice some speed in public transit for a more extensive network. Turn every six lane street into four lanes and every four lane street into two lanes and add protected cycle tracks and bus lanes and wider sidewalks. A lot of San Diego streets are really wide and should be able to add this easily.	The Central Mobility Hub will have fast, frequent, and convenient connections between existing and planned transit and the airport. The MTS Route 992 bus will continue to serve the airport from Downtown San Diego.  Regarding the reduced travel lanes, the Active Transportation and Demand Management, complete streets, and Mobility Hubs included in the Plan will consider these types of improvements during the project development process.
W497			There should be more short term spending instead of projects finishing by 2050. Bike and bus lanes can be done really quickly.	Projects within the 2021 Regional Plan are phased for different beginning and completion dates based on a number of factors. The construction timeframe of different types of projects is one of those factors. There are many projects that can be completed quickly, such as bike and bus lanes, that are scheduled to be completed towards the beginning of the plan.
W498		NLRC	I don't use public transport, but my son does. I do think there is room to have more bus stops, since they have taken many of them away over the last few years. I really use my own car more than not, but my son does need to rely on public transport. I'm in support of anything that decreases traffic, and adding multimodal lanes that have specific purposes.	The 2021 Regional Plan includes substantial investment in public transportation that will make your son's commute and others around the region significantly easier to navigate.
W499		NLRC	This plan sounds great, especially the part of flexible fleets resulting in better access to public transport and not having to walk to far away bus stops. I drive mostly everywhere, but I've had to give rides to people to their bus stop that was too far to walk. I support this plan fully.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W500			I think that the 2021 plan is a great start to creating a San Diego where you can easily get around by transit or cycling as opposed to driving. I'm very excited about the future of the region. Hopefully the cycling network can be expanded past what is recommended by SANDAG here.	We are excited as well and have seen a lot of great projects implemented by our local agency partners directly on or connecting to the adopted regional bike network, as that is more competitive in the scoring, via Smart Growth and Active Transportation Grant Projects SANDAG administers. Still there are plenty of instances where local agencies are doing great work with their own local streets and roads projects to improve neighborhoods for all roadway users through bike and pedestrian countermeasures in conjunction with sewer replacement projects and the Streamview Drive project in the City of San Diego is a good example.
W501			I will not use public transit until it is more efficient and cleaner. Right now to take the trolley downtown it can take 20-30 minutes not to mention dealing with the homeless and sanitary conditions on the trolley. I can drive my own vehicle downtown and be there in 10-15 minutes.	The Transit Leap in the 2021 Regional Plan will make the public transit system faster and safer. Travel times for many riders will be much better than in the past.
W502		El Cajon Collaborative/ East Co. Senior Service Providers	Love that there will be a transit center located in El Cajon. It will make accessing transit (downtown) other than the other trolley stops. Thank you.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W503			On Pages 38 and 42 regarding the road user mileage tax. This is unfair. There does need to be a way to offset the all-electric plug-in car not paying the tax at gas pump. The answer is to apply a mileage tax on those cars only. Taxing all cars would be a double tax on cars using gas. Please if you are going to apply this tax, only apply it to the all-electric plug-in cars as that would be a fair offset to them not paying at the pump which they should be paying as they use the roads too! This will balance the funds if done properly. Thank you	Nationwide states and regions are confronting the shortfalls of gas tax revenues to fund maintenance, operations, and construction of their transportation systems. The federal gas tax was the largest source of transportation funding for many decades. However, the federal gas tax per gallon has not changed since 1993, that is when the minimum wage in California was \$4.25. The federal gas tax does not grow with inflation and the purchasing power of that source has diminished over time. States and regions have implemented their own sales and gas tax measures to try and meet the needs of their transportation systems. However, the best tax measures tied to fossil fuel consumption will continue to erode in time as vehicle technologies change.  The 2021 Regional Plan is a long-range planning document and includes reasonably feasible funding options. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan. At a minimum this plan is updated every four years with the latest in planning ideas and concepts.
W504		El Cajon Collaborative/Barrio Logan College Institute Parent	When will the transit center be built? It is wonderful that it is coming to El Cajon and will provide lots of new jobs.	The 2021 Regional Plan includes two new higher speed commuter rail lines that will connect the core of the El Cajon community to both Downtown San Diego and the Central Mobility Hub near the San Diego International Airport by 2050. However, some improvements to the existing light rail services connecting to El Cajon will take place by



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				2035, including increasing the miles of light rail track to support more frequent Trolley services (every 10 minutes during peak periods). Please refer to “Table A.7: Interstate 8” in Appendix A for more information.
W505			Congestion pricing and/or pricing general travel (freeway) lanes is the most effective way to make the regional system function efficiently and then the proceeds can fund transit and active transportation. The world over has proven the effectiveness and NY is trying to get onboard. Don't let the SD region waste years when the solution is so obvious. Be the big move that you purport to be.	Thank you for your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W506		El Cajon Collaborative/Barrio Logan College Institute Parent Arabic	The ticket price for the trolley is too expensive. We need affordable tickets for low-income families to use the service. It is difficult to purchase tickets and they cost too much. Thank you for the Plan and I approve.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W507		El Cajon Collaborative Meeting	This is exciting! I support the plan and excited to see what the future looks like.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W508		El Cajon Collaborative Meeting	So exciting! Great presentation. Thank you for sharing such innovative ideas on moving people and goods from one place to another, safely, affordably, and fairly.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W509		El Cajon Collaborative Meeting	Is SANDAG planning on widening and/or straightening Hwy 94 from El Cajon (Rancho San Diego) down to the border? This is one of the worst roads now. We have people speeding, crossing double yellow lines to pass (and this is with oncoming traffic), passing on curves, running stop signs/signal lights, etc.	Project CC062 is a Complete Corridors: Rural project to improve SR 94 from the Jamul Reservation to Tecate Road, expected to be complete by 2050. The improvements are focused on safety and include shoulder widening and straightening the highway.
W510		El Cajon Collaborative Meeting	Great meeting with great information. I enjoyed the presentation and seeing the final product. We have been talking about this for a long time and happy to see the final product. It includes the 5 Big Moves and transit centers in each subregion. Great job!	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W511		El Cajon Collaborative/ East Co. Senior Service Providers	Stations need to be cleaner and safe for people to use them. Thank you for such an inclusive plan that brings services to East County.	Buses currently receive daily maintenance. As part of COVID-19 safety protocols, buses are wiped and cleaned at the end of each run throughout the day. Additionally, all riders are required by federal mandate to wear a face covering or mask while on public transit.  SANDAG will continue to work partners, MTS and NCTD, to bring high quality, reliable, and clean transportation options.
W512		El Cajon Collaborative/Barrio Logan College Institute Parent Arabic	I appreciate the new transit centers that will be in each of the subregions. We really need a transit center in El Cajon, but our trolley stations are in dark, industrial areas that are frequented by drug deals and homelessness. They are not safe. They are also dirty and have no restrooms. Thank you for a plan to make transit centers safe and to add restrooms. I will use it in the future.	SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements. SANDAG will be working hard with the help of all of our passengers and representatives to ensure that this plan gets implemented.  The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.
W513		El Cajon Collaborative/Barrio Logan College Institute Parent	There are too many trucks on the freeway that cut in front of traffic. Will there be a separate lane for them and how will SANDAG control traffic? I approve the Plan and look forward to improvements to our freeways to protect people.	The shipping of goods fuels the regional economy. The flow of goods by truck, rail, air, and sea – throughout our region and across borders – generates a constant stream of raw materials, parts, and finished goods. They all keep us supplied with food, clothing, shelter, vital consumer goods, and discretionary items.  The 2021 Regional Plan includes a truck climbing lane on State Route 52. In addition, the 2021 Plan includes strategies through Next OS to improve overall efficiency and accessibility for people and goods to move throughout the region. For example, the Harbor Drive 2.0 project will include technologies to manage the flow of passenger and commercial traffic on Harbor Drive between the Port of San Diego's marine terminals.

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W514		El Cajon Collaborative/ East Co. Senior Service Providers	Seniors often need assistance getting into vehicles. Volunteer programs need to be equipped to handle these needs. Thank you.	Seniors who need assistants may identify a personal care attendant that can ride for free. Please visit <a href="https://sdcommute.com">SDCommute.com</a> for more information on this.
W515		El Cajon Collaborative/ Community Health Working Group	Wonderful! It's about time! Thank you for such an innovative plan that includes our underserved communities. I love the equity statement and hope to see SANDAG stick to it.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .
W516		El Cajon Collaborative/ Community Health Working Group	If it is truly high speed with short travel times, I will use it. Both rapid buses, trolley and trains.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .
W517		El Cajon Collaborative/ Community Health Working Group	Seniors need rides so making it easier to access public transit will get them using it.	The 2021 Regional Plan aims to improve access to a quality public transportation system for all San Diego residents, especially for seniors and other disadvantaged populations. These improvements include transit fare subsidies for seniors and on demand Flexible Fleet services that are accessible to seniors. The 2021 Regional Plan projects a growth in senior access to parks and recreational facilities via walking, biking, and transit (see Appendix H for more information). In every metric senior access to transit, retail, medical facilities, and parks improves through 2025 and 2050.
W518		El Cajon Collaborative/ Community Health Working Group	Great idea to increase funding for senior volunteer driver programs and community-based organization funding. Seniors need more options, and the needs are growing.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .
W519		El Cajon Collaborative/ Community Health Working Group	Most senior volunteer driving programs are limited to 1 ride per week. We need additional services so they can continue to shop and access doctor's appointments. Thank you for the Plan.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .
W520		El Cajon Collaborative/ Community Health Working Group	Mobility choices for seniors need to have handicap access including volunteer drivers and CBO options.	The 2021 Regional Plan aims to improve access to a quality public transportation system for all San Diego residents, especially for seniors and other disadvantaged populations. These improvements include transit fare subsidies for seniors and on demand Flexible Fleet services that are accessible to seniors. The 2021 Regional Plan projects a growth in senior access to parks and recreational facilities via walking, biking, and transit (see Appendix H for more information). In every metric senior access to transit, retail, medical facilities, and parks improves through 2025 and 2050.
W521		El Cajon Collaborative/ Community Health Working Group	The backcountry (rural East County) needs buses and transit options now!	The proposed 2021 Regional Plan includes investments in all parts of the San Diego region. These are described in Appendix A and include access to buses and Flexible Fleet services for East County.
W522		El Cajon Collaborative/ Community Health Working Group	I used the Sprint when I lived in Escondido to Oceanside for work. I appreciated the ease of using public transit. Creating additional opportunities for transit travel will continue to bring new riders.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .
W523		El Cajon Collaborative/ Community Health Working Group	Many of our newcomers do not drive highways so are limited to the City of El Cajon. By creating safe travel options and education for them in their native language will open their world up to many new San Diego locations including better jobs.	The 2021 Regional Plan includes two new higher speed commuter rail lines that will connect the core of the El Cajon community to both Downtown San Diego and the Central Mobility Hub near the San Diego International Airport by 2050. However, some improvements to the existing light rail services connecting to El Cajon will take place by 2035, including increasing the miles of light rail track to support more frequent Trolley services (every 10 minutes during peak periods). Please refer to "Table A.7: Interstate 8" in Appendix A for more information. SANDAG will be applying a social equity planning framework throughout the implementation of the Regional Plan. Through this framework, one of the Regional Plan's near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. Within digital equity, we

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				have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations and educational resources on transit are available to all San Diegans as we advance with our next OS system. For more information, I would like to refer you to Appendix B: Implementation Actions, Table B.1 on more information on the Digital Equity Strategy and Action Plan. For more information on our community-based outreach please see Appendix H: Social Equity: Engagement and Analysis.
W524		El Cajon Collaborative/Community Health Working Group	Newcomer students are often limited to colleges within their community because of travel challenges. The new trolley to UCSD and increasing options to other local colleges would make college choice more available to them.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W525		El Cajon Collaborative/Community Health Working Group	Safety is always a concern. I had a bad experience traveling the trolley with my child. Obscenities were shouted by riders, and we didn't feel safe. We need a method to alert security if there is a problem on a bus or trolley. Safety is a huge priority. Thank you.	SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.
W526		El Cajon Collaborative/Community Health Working Group	Many transit stations do not feel safe because of location. Both of El Cajon's stations are located in dark, industrial areas frequented by our unsheltered population.	SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.
W527		El Cajon Collaborative/Community Health Working Group	Many people are now teleworking since the pandemic. Was the change in travel to work taken into consideration when developing this plan? Will freeways continue to see traffic reductions as more people work from home? I am glad that you are looking into the future of transportation as the needs change.	The 2021 Regional Plan accounts for changing trends and technologies that may impact how we travel including telework, on-demand mobility services, and connected vehicle technologies.
W528		El Cajon Collaborative/Community Health Working Group	Technology is extremely important to trip planning when taking a trip by public transportation. Will my Uber be waiting or my shuttle? Will I make the connection to the next bus? What are real travel times? Thank you for taking these into consideration.	Flexible Fleets use demand-responsive technology to provide on-demand services, real-time arrival times, and optimize routing for the fastest route. With the Next Operating System (Next OS) proposed in the Regional Plan, real-time information from transit and Flexible Fleets will be integrated in the back-end. This data will be used to provide trip planning tools that provide accurate travel information and make planning, booking, and paying for a ride as seamless as possible.
W529		El Cajon Collaborative/Community Health Working Group	Wow--50 years is a long time!	The 2021 Regional Plan is a long-range planning document and is required by federal law to provide a reasonably feasible funding strategy for the projects, policies, and programs of the plan. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan. At a minimum this plan is updated every four years with the latest in planning ideas and concepts.
W530		El Cajon Collaborative/Community Health Working Group	Coastal rail line super exposed to climate change. Please fix.	SANDAG and NCTD are currently developing a resiliency plan for the LOSSAN rail corridor that will address the impacts of climate change such as sea level rise, floods, fires, earthquakes, landslides, and other catastrophic events. The regional plan identifies LOSSAN corridor double tracking, bridge replacements, and other state of good repair improvements. Each of these capital projects consider the risks of climate change and are designed to withstand these effects to keep the rail line in operation.
W531		El Cajon Collaborative/Community Health Working Group	What happens when the grid collapses when you are in an "autonomous" car? At the time, the hope was that people would take trolley more, reducing wait time at traffic lights. We expected people to leave their cars for the trolley, but that did not happen.	SANDAG plans for emerging mobility technologies, like autonomous cars, and various considerations to ensure they are implemented safely. The 2021 Regional Plan includes frequency and span of service improvements for the trolley to make it more convenient for many people.
W532		El Cajon Collaborative/Community Health Working Group	Wow! A transit center in El Cajon. This is going to be so great!	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.
W533		El Cajon Collaborative/Community Health Working Group	Any talk about financial assistance for public transportation bus/trolley passes to address equity needs for community members? We encourage free transportation for students and seniors.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway,

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				staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
W534		El Cajon Collaborative/Community Health Working Group	Wow! This is an amazing opportunity for El Cajon.	Thank you for your comment. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.
W535		El Cajon Collaborative/Community Health Working Group	Very cool! I support the Plan and all that it encompasses.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
W536		El Cajon Collaborative/Community Health Working Group	Wow! This is incredible! Thank you for putting together such a complete plan! We encourage SANDAG to look at a shuttle option in El Cajon to move residents around the valley floor.	SANDAG is developing a Flexible Fleet Implementation Strategic Plan to identify near-term opportunities for Flexible Fleets including opportunities in East County. SANDAG intends to launch pilots to test different applications in 2022.
W537		El Cajon Collaborative/Community Health Working Group	Yeah, El Cajon!!! We are finally getting noticed.	Thank you for your comment. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.
W538		El Cajon Collaborative/Community Health Working Group	Amazing! Equity in the Plan. Thank you so much.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
W539		El Cajon Collaborative/Community Health Working Group	This is fantastic! Do we know how many jobs it will create and what kind of skills we will need for these jobs? Please bring us more updates as they come and encourage SANDAG to continue to look at East County for future projects.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area. More information about the growth in overall jobs in the region can be found in Appendix F, according to the Regional Growth Forecast, we expect to see about 440,000 more jobs in the region by 2050.
W540			A tax on how many miles someone drives, is a tax on the poor. White collar workers can afford to work from home or live close to their offices downtown, the people we rely on the most for society to function like hospital workers, food service workers, they have to drive long distances to work. Don't punish people for commuting to work, the character of San Diego will start to suffer as a result. Also, the public transportation alternatives in San Diego are a joke. Everyone over at SANDAG should have to take the city bus for a year before making any public transit decisions.	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as low-income residents or residents with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W541			Please don't do the mileage tax. Maybe when EVs are more prevalent, or add it to car registration but not this. Also, make heavier trucks (like trash trucks) pay more! They tear up the roads!	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.



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				<p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. The fee structure could be related to the weight of the vehicle or its impact on the roadways. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as drivers with fuel powered vehicles, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W542			<p>Adding another tax for driving on the roads is a horrible idea. This is punishing people for not being able to afford living by their place of employment. I am furious that this is being considered.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as residents with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W543			<p>NO to Road User Charges.                      San Diegans and likewise Californians already pay a lot in taxes.                      This is too much and too overreaching.                      Taxing our miles driven also means tracking our behavior with the proposed Next OS. This is another step in the erosion of our civil liberties and freedom of movement.                      Yes, taxes should pay for San Diego roads but we do not NEED more taxes. Especially in the form of one that double dips and erodes our freedom.                      Please operate and maintain our roads within the taxes already gathered.                      Set budgets/policies that match those taxes.                      Do not “drive” up taxes now based on future speculation.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources. The road usage charge provides an alternative to replace an old tax system that is no longer relevant.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. The mechanism to collect a future road usage charge has not yet been determined, but as the State of California transitions from the gas tax towards a road usage charge, SANDAG is anticipating leveraging the mechanism selected by the State. SANDAG is committed to privacy - we take it seriously and exercise that commitment with our current operations on both the I-15 managed lanes and the SR 125 toll road.</p> <p>SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving gas fueled vehicles, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W544			<p>With costs of living so insanely high in this city, all that this proposition does is hurt the lower income people who can't afford to live near their place of work. The people who are wealthy</p>	<p>The 2021 Regional Plan envisions forecasted growth to be concentrated in Mobility Hubs throughout the region. Building more infill development near transit and jobs offers</p>

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W545			<p>enough to live downtown will be less impacted than those who commute 30/40 minutes in to work.</p> <p>I disagree with the proposal to tax drivers based on mileage driven. This unfairly targets those who cannot afford to live close to work, those same people who have the most to lose by paying more taxes</p>	<p>options for people that are looking for more affordable housing and the ability to live without the expense of car ownership.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as low-income residents or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W546			<p>I live up in Vista and work as a registered nurse in the ER all the way down in La Mesa. Not only do I have to drive down there to take care of patients in the busiest hospital in the city but you're going to tax me on the mileage it takes me to get there?! That is not acceptable. What the hell is wrong with you people? King James would be proud for nickel and diming us peasants to death. You're going to tax all us hard working nurses for driving to work to care for patients of this city? How greedy are you? It's disgusting. This city is already so expensive for so many people who run this city (cops, teachers, paramedics, nurses, firefighters, etc.), it's not right that you're going to tax is while we drive the distance to our jobs.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as low-income residents or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p>
W547			<p>Your idea to tax drivers per mile is absolutely abhorrent. A sure way to bring San Diego's workers to ruin.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be</p>

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				charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.
W548			Proposing a mileage tax is nonsensical and would be another nail in the coffin in terms of motivation for my family to move out of this city due to even more ridiculous cost of living expenses. We already pay more for electricity in our sub-1000 square foot apartment (with NO AC) than any relative of mine who does not live in San Diego. Stop killing your citizens financially!	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p>
W549			It's nice to know the out of touch career politicians on the SANDAG board have no issue passing a regressive tax that disproportionately affects the less wealthy who have to commute since home prices are insane in this city.	Social equity disparity analysis is required by both state and federal law via Title VI of the Civil Rights Act of 1964 and Executive Order 12898. During the process of evaluating the 2021 Regional Plan, calculations were made to determine improvements in mobility by percent point difference, between a No-Build projection and the Build projection. A percentage point difference was then compared between a disadvantaged population and its counterpart (in both Build and Non-Build scenarios) to determine whether the difference between each population was substantial enough to merit further evaluation. Anything above a 20-percentage-point difference would result in further analysis. SANDAG found marginal percentage point differences between each population, with slight advantages leaning in favor of low income, aging populations, and other disadvantaged populations. For more information regarding social equity, methodology, and state requirements see Appendix H.
W550			Real bad inflation is harming us all financially. Quit steering us to public transportation. No more expenses, stop it!	Thank you for your comment.
W551			<p>I fully support the use of a VMT based fee, as a way to supplement fuel taxes as ICE cars are phased out. However, those fees should be proportional to the damage caused, using something akin to the <math>((\text{weight per axle})^4) \times \text{number of axles}</math> formula. If another formula more accurately estimates damage caused to the roadway by a certain vehicle, that's just as well.</p> <p>Cargo e-bikes should be a major part of the future of delivery services in San Diego for many reasons, one of those reasons being the negligible damage they cause to the road surface compared to cargo trucks. If heavy trucks are made to pay their fair share of road damage, it'll help incentivize lower-weight and more efficient modes.</p>	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving including degradation to the roadways, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program and developing a fee structure proportional to damage caused to the roadways is a component that will be explored.SANDAG will be exploring the regional use of cargo e-bikes through the upcoming San Diego and Imperial Counties Sustainable Freight Strategy, which will begin this winter.



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W552			<p>I strongly oppose the usage mile tax, Californians pay the highest taxes on vehicle registrations, gas , sales tax etc., you are punishing those that have to commute to work because they cannot afford to move closer to the communities they work in . This will affect a disproportionate amount of minorities, people in the service industry, hospital , emergency service workers etc. Absolutely asinine that an additional tax would even be entertained in the midst of a pandemic and a shaky economy.</p>	<p>Social equity disparity analysis is required by both state and federal law via Title VI of the Civil Rights Act of 1964 and Executive Order 12898. During the process of evaluating the 2021 Regional Plan, calculations were made to determine improvements in mobility by percent point difference, between a No-Build projection and the Build projection. A percentage point difference was then compared between a disadvantaged population and its counterpart (in both Build and Non-Build scenarios) to determine whether the difference between each population was substantial enough to merit further evaluation. Anything above a 20-percentage-point difference would result in further analysis. SANDAG found marginal percentage point differences between each population, with slight advantages leaning in favor of low income, aging populations, and other disadvantaged populations. For more information regarding social equity, methodology, and state requirements see Appendix H.</p> <p>SANDAG recognizes the need for more affordable housing for people of middle to low incomes households that are near employment centers and a variety of transportation options. SANDAG is currently developing a Regional Housing Incentive Program and will take several factors into consideration to ensure the program meets housing needs and the goals of the 2021 Regional Plan. The housing program will consider climate change, climate resilience, and consistency with the transportation improvements and land use goals included in the 2021 Regional Plan. SANDAG will also coordinate with the Social Equity Working Group and other interested stakeholders to ensure the housing program promotes equity and addresses issues like gentrification and displacement.</p>
W553			<p>The new taxation system derived on a basis of miles driven is asinine. Lower-income individuals often cannot afford to work in proximity to their employees, or must report physically for service jobs, unlike higher wage earners who have the flexibility to work remote. This will unfairly discriminate against lower socioeconomic pillars of our community that have been ravaged enough, and unnecessarily so: there are plenty other ways to secure the requisite funding to maintain infrastructure and reduce traffic congestion without penalizing the poor. If you're unable to fathom the ways in which this can be accomplished I reckon you're unfit for the work for which you've been assigned.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p>
W554			<p>F___ this tax by the mile bull_____.</p>	<p>Thank you for your comment.</p>
W555			<p>A tax on mileage disproportionately affects people who can't afford to live in the areas they work. Tax semis and amazon, who use/abuse our infrastructure 10x more than the average consumer.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents,</p>

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				visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.
W556			Please improve public transportation options to increase access to the beach. Inland communities like mine have less opportunities to enjoy the beach as a public resource. As climate change continues to worsen, having options for free cooling recreational opportunities is critical to public health as well.	The transit network that has been developed for the Regional Plan includes faster access to the beach. There are Rapid and Commuter Rail routes that will operate between Mid-City and the proposed Central Mobility Hub. From that location you can seamlessly transfer to routes that will take you to Ocean Beach, Pacific Beach and La Jolla.
W557			I like the various steps mentioned in the 5 Big moves, especially if it helps passengers get to their destinations a lot faster. I think the better option would be the multimodal roads for me because it could help ease traffic and prevent accidents and fines to those who fall under the right circumstances. It would also be better if these flexible fleets could serve the areas that the bus doesn't simply because of street conditions or for the lack of sidewalks. A more frequent schedule could also help people by not having to wait so long for their routes, so they might be less inclined to get into dangerous situations in order to catch it. Therefore, I support this plan.	Flexible Fleets provide sustainable and multi-modal options for traveling around the region. Since Fleets use technology to adapt to changing demands or needs, they serve as a great option in areas where traditional fixed transit may not work well. SANDAG is developing a Flexible Fleet Implementation Strategic Plan to identify near-term opportunities for Flexible Fleet services in partnership with transit agencies.
W558		El Cajon Collaborative/ East Co. Senior Service Providers	This is exciting! Thank you so much!	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W559		El Cajon Collaborative/ East Co. Senior Service Providers	Many senior volunteer programs are funded through SANDAG. Glad to see they will continue to support these programs with hopes to increase them in the future.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
W560			Public transport sucks...takes me 30 minutes to an hour more time to go anywhere by MTS. So people don't have much of a choice but to use their cars. Not all of us have the luxury of living close to work. Taxing the basic necessities in an over taxed city is not right. Also please evaluate the incomes of electric car owners and judge who will be unfairly impacted.	<p>SANDAG intends to use emerging technologies to provide a fast, safe, and reliable transportation system to the San Diego region. Personal vehicles will continue to be part of our transportation system, but we also intend to provide competitive transportation methods to the personal vehicle. By providing alternatives to the personal vehicle, we could actually alleviate highway congestion, make our roads and streets safer, and make our whole transportation system operate more efficiently.</p> <p>SANDAG recognizes the need for more affordable housing for people of middle to low incomes households that are near employment centers and a variety of transportation options. SANDAG is currently developing a Regional Housing Incentive Program and will take several factors into consideration to ensure the program meets housing needs and the goals of the 2021 Regional Plan.</p> <p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to</p>

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ID	Commentor Name	Agency	Comment	Response
				<p>make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.</p>
W561			The SANDAG Transportation Regional Plan sounds very promising for the community, businesses, tourism, and the people that live in Southern California.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .



# Appendix G Attachment 7B: Email-Sourced Public Comments and Responses

The table below contains all comments received via email at SDForward@sandag.org during the public comment period for the draft 2021 Regional Plan. Comments and corresponding responses are sorted by commentor name, if provided, in alphabetical order.

Table G7B: Draft 2021 Regional Plan Responses to Comments – Email Sourced

Draft 2021 Regional Plan Responses to Comments – Email Sourced				
ID	Commentor Name	Agency	Comment	Response
E1	Abby Bateman	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>24 hour service is necessary to fill the service jobs in our economy. Please consider extended hours if nothing else.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions to achieve state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p>
E2	Alejandro Martinez	Outdoor Outreach	<p>As a member of Outdoor Outreach, a community organization addressing the inequities and disparities regarding access to outdoor spaces and within this addressing, as well, transportation justice, I can passionately say our communities need youth prioritized now. If their access to transportation is hindered by economic status, their opportunities infinitely diminish. Prioritize no-cost youth free passes now. Our youth deserve better.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under</p>
E3	Alex Wong		<p>Your 2021 Regional Plan features an impressive but expensive plan to link the region with \$100 billion+ of commuter rail to far flung suburban regions. This would be a very hard sell to voters.</p> <p>Instead, why not build just one fully-grade separated, frequent trolley line that serves dense, low-income neighborhoods, for \$10 billion or less? Designed correctly, this trolley line would attract massive ridership and be much more likely to be approved by taxpayers.</p> <p>This trolley line would go from Downtown through Balboa Park, on to North Heights, City heights, and all the way to La Mesa.</p> <p>As transit planner Jarrett Walker says, the best case for a rail project is an overcrowded bus line. Not only are lines 7 and 215 the busiest in the county, they run through some of the densest, largely low-income, parts of San Diego. Already there are complaints that route 215 is even slower than the bus line it replaced. A trolley line in that corridor would be a welcome alternative.</p> <p>I am glad that your 2021 plan includes a rail corridor from downtown to La Mesa. But I strongly believe that this corridor should be served by Trolley, not commuter rail. This corridor is one of the most densely populated in San Diego. Residents there would certainly prefer several neighborhood trolley stations within walking distance rather than having to take the bus to one giant regional rail</p>	<p>The mid-city trolley line (Purple Line) is included as the first major new rail project in the Plan. Additionally, grade separated rail is considered in the I-8 corridor as you mentioned but at higher speeds. Traditional trolley speeds are limited, especially when running with traffic as most of the trolley system does. Additionally, Rapid services are planned that can use dedicated roadway space to increase speeds and avoid congestion. The vast majority of these Rapids also are planned in near-term phases of the Plan.</p>

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			<p>station further away.</p> <p>Your plan stresses that you want mass transit to be at least as fast as car travel. El Cajon Blvd and University Ave are congested streets, and a fully-grade separated trolley running through that corridor would easily be much faster than car traffic. With full grade separation, trolleys could run very fast and frequent and make many stops in dense neighborhoods without interfering with traffic at all.</p> <p>I strongly believe that a Mid-City trolley line should be built first. If successful, it would convince taxpayers that other rail lines are needed.</p>	
E4	Alexander Han	Sunrise Movement	<p>I am a volunteer with the Sunrise Movement. Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated. Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego. No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities. Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles. I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E5	Alicia Rodriguez	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>Hola mi nombre es Alicia Rodriguez, y yo estoy muy contenta con los proyectos en El Cajon City, gracias por dejamos saber los planes para nuestra ciudad, y gracias por los apoyos para las familias de Bajos recursos. A mi me gustaria que tambien tuvieran mas programas para nuestros ninios y tambien para que pudieran hacer also con los Homeless que hay en El Cajon, porque hay muchos por todos lados. Gracias por todo. ***</p> <p>Hello. My name is Alicia Rodriguez, and I am very happy with the projects in the City of El Cajon. Thank you for letting us know the plans for our city, and thank you for support programs for families with low economic resources. I also liked that it had more programs for our children, and also they could also do something about our homeless in EL Cajon, because there's so many everywhere. Thank you for everything.</p>	<p>Gracias por su comentario. Favor de continuar siguiendo el plan regional a: <a href="https://www.sdfoward.com/mobility-planning/2021-regional-plan">https://www.sdfoward.com/mobility-planning/2021-regional-plan</a>. ***</p> <p>Thank you for your comment. Please continue to follow that 2021 Regional Plan at: <a href="https://www.sdfoward.com/mobility-planning/2021-regional-plan">https://www.sdfoward.com/mobility-planning/2021-regional-plan</a>.</p>
E6	Alysson Snow	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions to achieve state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E7	Amanda Essoh		<p>Thank you for acknowledging the need for updates in the transportation plan for San Diego.</p> <p>As an admirer of the city and hopeful future resident, I find it greatly important to invest in</p>	<p>The 2021 Regional Plan includes a Sustainable Communities Strategy (SCS), as required by California Senate Bill 375 (Steinberg, 2008) (SB 375), for the San Diego region. This SCS describes coordinated transportation and land use planning, and identifies priorities for</p>



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			<p>alternative transportation solutions that do not harm the environment and are inclusive to all citizens of San Diego. As current trends demonstrate, our dependence on fossil fuels has caused irreversible damage not only in California but on a worldwide scale.</p> <p>We now have the opportunity to prevent further destruction of our atmosphere, coastlines, and wildlife by investing in renewable sources of energy. This step is vital to ensure that the precious monuments of our civilization, which we have spent centuries building, can withstand the impending challenges of climate change.</p> <p>If we do not invest in the research and development of more efficient, sustainable, and inclusive transportation, we will pass down the increasingly destructive burdens of air pollution and global warming, just as our predecessors have done to us. In addition to this, increasing fuel prices have exacerbated preexisting economic inequities, which may soon render cars, buses, and airplanes a luxury for those who can afford it, despite being a necessity to most people in the United States.</p> <p>I urge you to hear our case against current means of transportation in the city of San Diego so that this great city can lead the way for the widespread change that is necessary to begin repairing anthropogenic damage to our environment.</p>	<p>Adaptation Planning, which include prioritizing resilience and developing innovative solutions. Appendix B describes both Near-term and Continuing Actions for 2021 Regional Plan implementation, integrating a resilient capital grants and innovative solutions program, preparing a regional resilience framework, and serving as a resource for local agencies' Climate Action Planning efforts and the general public on the impacts of climate change. Additionally, the 5 Big Moves will enhance connectivity and result in people having more travel options and operating solutions, reducing per capita VMT.</p>
E8	Amy Huie	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E9	Amy Krajec		<p>I am an Oceanside resident. I work in Healthcare. My office is home-based and I travel in my own car to hospitals, clinics, Dr. offices etc., for work. I have a large territory and can drive up to 1000 miles per month just for work. I provide education to nurses and staff to allow them provide care to their patients. I think this fee is ridiculous and double dipping. We already increased taxes on gas to help pay for roads and infrastructure. We are already taxed to death and do not need further taxes.</p> <p>Also with healthcare, we have pushed care outside of offices, hospitals etc. and patients go home and have home health, wound care, physical therapy and other treatments at home. These healthcare providers have to use their own vehicles to care for these patients and now you want to add fees for them as well as myself to do our jobs which is caring for others. Usually we drive larger cars to hold all of the equipment we need to take to care of patients. Will those of us who do these types of jobs get some sort of rebate or reimbursement for the miles we travel to provide care/education? We shouldn't get punished because we have to drive to facilities or patient's homes to provide services.</p> <p>This fee will have a large impact on the outpatient Healthcare community. May find less employees who want to do these jobs due to being charged for driving, companies/insurance companies charging more for services due to having to pay higher wages to help offset the cost for employees.</p> <p>This fee is not a good idea and shouldn't be put in place. Until all the money we already pay in taxes for roads and infrastructure gets used for these things, we should not be adding anymore.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
E10	Ana Ierlick		<p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway,</p>



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			<p>Choose 2 talking points to include:                      Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region’s equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego. No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities. Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles. I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E11	Andrea K. Hetheru	Southeast Neighbors Together (SENT)	<p>A Mobility Hub in our community preferably located at our current Orange Line Trolley station.</p> <p>Youth pass given to youth to age 24.</p> <p>Fiber optics underground to ensure we are ready for the state of the art Transportation System that is in the design stage, (IOS system/smart phones) and to more appropriately address the digital divide in our “Redlined communities”</p> <p>Covering on our MTS bus stops (structures).</p> <p>Consider 24 hour service on the lines that are taking our residents to work.</p> <p>Focus on transitioning to an all electric buses in the first 2-3 years of implementation.</p> <p>Improve the frequency and reliability of our bus routes.</p> <p>Ensure all of our streets are designed with the “Complete Streets” designs.</p> <p>Increased maintenance of the trolleys and busses proportionate to the heavy usage in our areas (southeast area of the city of San Diego).</p>	<p>The proposed final 2021 Regional Plan identifies three Mobility Hubs along the Orange Line Trolley in Lemon Grove, La Mesa, and El Cajon. You can visit <a href="https://sdforward.com/envision">SDForward.com/envision</a> to see more details about proposed projects in your community.</p> <p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. For more information, please refer to Appendix B: Implementation Actions and the Digital Equity Strategy and Action Plan.</p> <p>Bus shelters are provided wherever there is sufficient right of way to locate them. Any new infrastructure build would include shelters. Complete Streets designs are an important component of SANDAG’s planning today and will be included on projects in the future. As part of larger infrastructure projects like Next Generation Rapid, Trolley and Commuter Rail, all stations will have shelters.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>The 2021 Regional Plan also proposes transit fare subsidies for youth, increased frequencies and spans of service on core bus routes, high frequencies and all-day service on new Rapid and Commuter Rail routes, investments in zero emission buses and charging/fueling infrastructure, and investments in complete streets and Vision Zero programs.</p>
E12	Andrea Smith		<p>A Mobility Hub in our community preferably located at our current Orange Line Trolley station.</p> <p>Youth pass given to youth to age 24.</p> <p>Fiber optics underground to ensure we are ready for the state of the art Transportation System that is in the design stage, (IOS system/smart phones) and to more appropriately address the digital divide in our “Redlined communities”</p> <p>Covering on our MTS bus stops (structures).</p> <p>Consider 24 hour service on the lines that are taking our residents to work.</p>	<p>Through this framework, one of the plan’s near-term Implementation Actions listed in Appendix B will be a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth. SANDAG also is currently working with the Social Equity Working Group to develop near-term solutions to address transit service improvements, amenities, and subsidized transit fares. Another near-term action of the Regional Plan includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy.</p> <p>For more information on the Regional Fare Impact Study and Digital Equity</p>

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			<p>Focus on transitioning to an all electric buses in the first 2-3 years of implementation.</p> <p>Improve the frequency and reliability of our bus routes.</p> <p>Ensure all of our streets are designed with the “Complete Streets” designs.</p> <p>Increased maintenance of the trolleys and busses proportionate to the heavy usage in our areas (southeast area of the city of San Diego).</p>	<p>Strategy/Action Plan, please see Appendix B: Implementation Actions of the draft 2021 Regional Plan. There, you will also find the plan's near-term and continuing key actions and strategies which include complete streets and improving maintenance programs like the Fix It First program.</p> <p>There will also be multiple mobility hubs where the Orange Line will operate through (specifically Project TL15). Beginning in the El Cajon Mobility Hub, the Orange Line operates through the La Mesa, Lemon Grove, and Southeast San Diego Mobility Hubs to Downtown. For a visual representation, we would like to direct you to our interactive Data Viewer map on the SDForward website at:  <a href="https://sandag.maps.arcgis.com/apps/Cascade/index.html?appid=897af882e8c14b1e996c33e48bc15347">https://sandag.maps.arcgis.com/apps/Cascade/index.html?appid=897af882e8c14b1e996c33e48bc15347</a>.</p>
E13	Andres Cazares	N/A	Good service.	Please continue to follow along in this process by visiting <a href="https://www.sdforward.com">SDForward.com</a> .
E14	Andrew Aguilar	N/a	Just saw this on NBC news. Hopefully you won't reject this comment due to being a day after the comment period ends. Please do not impose a mileage tax. We do not need the government tracking and taxing our every move and penalizing those who need to commute farther due to quality of life and even affordability issues.	<p>We understand there are concerns around the privacy and implementation of a road usage charge. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public's privacy.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
E15	Andy Cardona	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E16	Angela Castro	San Marcos Unified Sch. Dst.	I support the proposed “5 big moves” RTP and want to see flexible fleets implemented in North County.	Thank you for your support and feedback. SANDAG is in the process of developing a Flexible Fleet Implementation Strategic Plan in partnership with the transit agencies to identify different opportunities for Flexible Fleets including in the North County. Pilots

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				will be launched in 2022 to test different applications for Flexible Fleets. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E17	Anne Sheridan	SanDiego350	I want to thank you for including climate and equity concerns in the Regional Transportation Plan draft. However, we need a plan that public transit system a meaningful alternative to cars. That means improving the frequency of service and speeding up the addition of new bus and trolley lines. I would also like to see no cost youth passes implemented sooner.	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E18	Annie Hafer	SanDiego350	<p>I am so happy to hear about transportation updates happening. Thank you to the SANDAG staff for their strides in addressing climate and equity in this Regional Transportation Plan draft.</p> <p>I am someone who does not have a vehicle and relies on public transportation. That combined with the urgency of the climate crisis the need for these updates is not moving fast enough to give those reliant on transit the relief we need.</p> <p>I kindly ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>The planet and the people can't wait.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E19	Anthony Hamm	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E20	aPebbleInYourShoe	N/A	I do not understand why SANDAG says we need to spend all this money "grade separating" the trolley when in fact it already gets priority at a traffic light. I've never seen it stopped for cars. Cars stop for the trolley. So SANDAG talks about this being about VMT and then goes and proposes spending billions to elevate the trolley out of the way of cars. How is this making sense except in a few cases at most ? Maybe this helps a few local bus routes but let's be honest this sounds like mostly a benefit to cars (maybe pedestrians, but there has to be a cheaper way to address that)	There are several circumstances where the Trolley must wait for traffic signals to proceed (e.g. downtown San Diego) which impacts operating speed and reliability. Moving rail off the street network enables for much faster running times and higher-speed trips which are competitive with driving. Grade separations also have safety benefits by removing conflict points between rail transit, vehicles, pedestrians, and cyclists.
E21	Araceli Hernandez	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>Solicitar mas limpieza en las paradas de autobus. Hay demasiados carros estacionados en las calles por meses en los mismo lugares, quiza una</p>	<p>Su comentario ha sido compartido con MTS y la ciudad de El Cajon. *** Your comment was forwarded to MTS and the City of El Cajon.</p>

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			<p>revision mas constante.                      Renovacion de carretera Main St. algunas partes estan muy viejas.                      ***                      Clean the bus stops more often.                      There is too many cars parked in the streets for months in the same location, I want more consistent revision.                      Renovations for Main Street, some parts are very old.</p>	
E22	Armin and Rhea Kuhlman		<p>Please focus on equity and environmental justice in the Regional Plan projects.</p> <p>This is a great opportunity move forward to meet the needs for affordable, accessible transportation for jobs, healthcare and education in underserved communities.</p> <p>Please include an equity specific project list in the RTP Appendix A: Transportation Projects, Programs and Phasing document.</p> <p>A fast, reliable and affordable bus system with increased frequency is vital on popular lines and overcrowded areas.</p> <p>Improve the Blue Line track with express 24 hour service and additional frequency.</p> <p>The Purple Line needs planning and funding to connect central City Heights and South Bay to Sorrento Valley.</p> <p>Thank you for your attention to these environmental and transportation justice priorities in the RTP.</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p>
E23	Arysa Gonzalez Romero, M.S., RPA.	Agua Caliente Band of Cahuilla Indians	<p>A records check of the Tribal Historic preservation office’s cultural registry revealed that this project is not located within the Tribe’s Traditional Use Area. Therefore, we defer to the other tribes in the area. This letter shall conclude our consultation efforts.</p>	<p>Thank you for your comment.</p>
E24	Ashley Bridgewater	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E25	Ashley Jabro	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005</p>



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			the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	<p>levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E26	Azalya	N/A	The public transportation here in national city has been very helpful in ensuring that we are able to make it to appointments on time. The bus stops are in convenient places and I am very satisfied.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E27	Balsam Hannawayya	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>في الواقع، المشروع مفيد لكافة افراد المجتمع. ما اعجبني بالايخص هو قطار النقل السريع (الترولي) الذي يختصر وقت التنقل مقارنة باستخدام الحافلة (الباص)</p> <p>اشفي ان يقوم الجميع بالاستفادة من استخدام القطار السريع و بشكل مستمر كذلك، هذا المشروع سيقوم بتحويل مدينة الكاهون الى مدينة اكثر جمالا</p> <p>***</p> <p>Actually, the project is very useful for all people, what I especially liked is the high-speed train which reduces the time a lot to get to work or to any other place because, as we all know, transportation by bus takes a long time, and I hope that the largest number of people will benefit from this project and use it continuously. Also, this project will turn El Cajon area into a more beautiful city.</p>	<p>نشكر دعمكم و تفاعلكم معنا. يبغى الاستمرار بمقابلة تطورات المشروع عن طريق زيارة موقعنا <a href="http://SDForward.com">SDForward.com</a></p> <p>***</p> <p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E28	Barbara Ryan	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>I participated in the Collaborative Meeting and was very pleased to hear the SANDAG Transportation Plan. Good plan. Well represented.</p>	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E29	Barry Bernstein	UCCA pres.	As part of our new community plan I would like SANDAG to include in their optional plans to consider what has been titled the grand compromise. It is based on SAFETY IN U.C./Clairemont and La Jolla. Basically it is an emergency vehicle only bridge connecting North and South U.C. over the existing RR TRACKS at the Regents end points. It would serve and meet the City plans for safe bicycle and pedestrian modes, and provide access only to emergency vehicles serving the three above mentioned communities. No regular traffic...and would also provide an evacuation option that may not exist due to the congestion on Genesee, the only north/south artery on U.C. Thank you for giving this planning option your consideration.	<p>Your comment and the concept of an emergency only connection of Regents Road across Rose Canyon has been shared with San Diego County Office of Emergency Services. The County's Operation Area Emergency Operations Plan was last updated September 2018.</p> <p>Your comment was forwarded to the City of San Diego.</p>
E30	Benjamin Martinez	SanDiego350	While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>

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E31	Bill Sutton	Catholic Charities/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>I am really excited about the plans that you presented regarding SANDAGs long-term vision for the community and San Diego county. It was well presented and included great details in a well throughout plan from this organization. Thank you for sharing with the members of East County Collaborative. It was well received and appreciated.</p>	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E32	Billy Abston		<p>In reference to this story. No new taxes. Also, where in the heck do I leave a public comment? Seems buried. The sandag.org pages isn't very mobile friendly.</p> <p>Grumble. Grumble. Grumble. Not very helpful web page. :(</p> <p><a href="https://www.nbcsandiego.com/news/local/another-tax-for-san-diegans-sandag-considers-mileage-tax-for-drivers/2685884/">https://www.nbcsandiego.com/news/local/another-tax-for-san-diegans-sandag-considers-mileage-tax-for-drivers/2685884/</a></p> <p>--</p> <p>Computer Science is the science of solving problems using computers, that we wouldn't have if we didn't have computers.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p>
E33	Brendan Bartnik	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on public transit the relief they need.</p> <p>In addition to this please move toward a 24 hour public transit system. This city deserves round the clock access to core transit lines. Perhaps once an hour or 90 minute intervals but the dead time between 12 and 5am makes for occasionally difficult planning for travelers.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p>
E34	Breton Peace	March and Ash	<p>Our business, March and Ash, a licensed cannabis retail outlet, is located in the City Heights community near the corner of Home and Fairmount, and close to the I-805 Freeway Home Avenue ramps. We began construction of this site in 2019 and opened in mid 2020.</p> <p>This project represented a significant investment for our company into a property that was formerly an auto repair shop. We are proud of the work we and our partners have concluded, and are especially proud that this is the location for our founders that is closest to where we were born and raised in El Cajon.</p> <p>Having partnered with our neighborhood businesses, we've taken concrete steps to improve the facilities, sidewalks, bust stops and open spaces that comprise our "block". We understood the challenges and opportunities of revitalization when we pursued this project, and are committed to seeing truly localized revitalization occur.</p> <p>We know the travel patterns of our customers at our retail outlet and the surrounding businesses,</p>	<p>While Home Avenue is not on the Adopted Regional Bike Network, the 2021 Regional Plan includes the nearby and parallel Chollas Creek Bikeways: North Fork - Bayshore Bikeway to University Bikeway and South Fork - Petway Park to Market Creek Plaza which will improve the connections described in this comment. The project alignment and details can specifically be found in the updated data viewer and Appendix A. The City of San Diego and Metropolitan Transit System are the implementing agencies for these improvements. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is in development and provides another opportunity to provide input on transportation solutions for this area. Establishing special districts is under the purview of the City of San Diego.</p> <p>Your comment was forwarded to the City of San Diego.</p>

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			<p>including the stacking of traffic at the freeway off and onramps and at the intersection of Home and Fairmount. Local neighborhood traffic utilizes longer direct freeway trips to and from the Mt. Hope community and the Gateway employment and shopping centers, as well as our business. Buses, Bicycles, vehicles, and pedestrians cannot go directly to Market Street.</p> <p>The Fairmount Park, Azalea Park and Hollywood Parks residents are cut off from the Gateway Centers jobs, visiting deceased loved ones at the Mt. Hope cemeteries, and the significant shopping areas between the I-805 and the SR-15 freeways.</p> <p>To do more we need the support of governmental authorities in pressing for structural changes that will further open up this area to the opportunity for further revitalization by eliminating congestion and creating the conditions for a City Heights business corridor that surrounds and can cross the 94, while improving the residential areas we serve.</p> <p>Our experience to date is that governmental authorities have looked at this area with too narrow of a focus. This area presents a great opportunity for smart community oriented revitalization on corridors (Home up Euclid) that are already predominantly occupied by locals ready and willing to make this happen.</p> <p>Our list of priority projects for our D9 /D4 are as follows:</p> <ol style="list-style-type: none"> <li>1. Extension of the Home Avenue Route to Market Street for Pedestrians, Bicycles, and Vehicles. The Home / Market connection would provide significant economic development stimulus to the Mt. Hope and City Heights areas. It would assist in congestion relief by providing an alternate to freeway traffic on the SR 94 - Martin Luther King Freeway.</li> <li>2. Completion of the Transportation markings along Home Avenue. Curbs are not marked for safety, to promote proper parking, traffic movement, and access for Buses and the Disabled. The Bicycle route is not fully painted and warning ramps for the visually impaired are not in place. Bulbing out at key intersections should be funded to increase pedestrian crossing safety.</li> </ol> <p>We believe that the business community along Fairmount and Home Avenues would be open to the establishment of a Business Improvement and Maintenance Area to assist in cooperative funding of some of these improvements.</p> <p>While some have pressed for the establishment of a business improvement district City wide to support marking the cannabis industry we firmly believe that our economics would be better rooted in this type of neighborhood oriented business district - if the opportunity presented itself to establish the same.</p> <p>We would appreciate assistance in establishing such special districts.</p> <p>As one of the more controversial businesses in the area when we entered, we have a hyper focus on what matters to our neighbors. This matters and we will be a willing partner.</p>	
E35	Brett McIntosh	N/A	<p>I highly oppose this “proposal” and I’m sure a lot of citizens feel this way as we are already one of the highest taxed states in this country. This new tax is not for the citizens of this state. This proposal shouldn’t have even been drafted because it is ludicrous. Vehicle registration is insanely high , gas prices are insanely high , income tax is insanely high , consumer taxes are high. We are literally taxed multiple times per dollar we earn and spend. This proposal is a no for me. I’ll be making sure this email address is publicly available for everyone to voice their opinions. Thank you.</p>	Thank you for your comment.
E36	Brian Janey	Allegro Piano Service, Inc.	<p>I have been following news with some interest in regards to a proposal before SANDAG to impose an additional tax on miles driven. I do hope you pass my concerns on or perhaps direct them to the appropriate place.</p> <p>I live in the rural unincorporated town of Fallbrook where applying an extra tax on miles driven</p>	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing



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			<p>would be a unfair burden. I run a service business that services many in the rural areas of north county and I may spend 2+ hours a day driving. Taking some kind of public transportation is not an option in my line of work.</p> <p>Imposing such a tax on those in rural communities to fund projects that clearly favor urban areas is just wrong. I have many clients that live in more affordable, rural outlying areas and bedroom communities that commute that no doubt would also find such additional taxation unsavory.</p> <p>SANDAG needs to focus on making main arteries of road travel more free flowing and ensure an even hand in the spending of funds collected in taxation that do not unfairly punish those in more rural areas.</p>	<p>revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
E37	Brian Krohne	SanDiego350	<p>Please prioritize public transit over roads. Public transit is just less convenient than a car for lot of trips right now, but if you made it more convenient that driving, more people would take it. Plus this give more mobility to people who don't have cars.</p> <p>Also - protected bike lines with physical barriers please. Painted lines are not protection.</p>	<p>The 2021 Regional Plan seeks to offer fast, safe and reliable transportation options for the San Diego region that make public transit a competitive alternative to personal vehicles. Investments in roads also support efforts to create complete streets and offer dedicated space to transit and people biking and walking.</p> <p>SANDAG follows national and international best practices in bikeway design to create safe facilities for users of all ages and abilities. Every project goes through a detailed and context sensitive design process which results in decisions regarding the best facility, which may include protected bikeways, buffered bikeways, shared use paths, or shared streets with significant traffic calming elements. The Regional Plan also includes funding for upgrading existing bikeways that may not meet current best practices in maintenance or bikeway design.</p>
E38	Briana C. Wills	Vista Hill - ADAPT/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>Hello! I was extremely excited to hear about all of the various transportation plans that will be happening in the future for East County, especially. I appreciate all of the hard word that is going to be put into making transportation more accessible and efficient. I loved hearing that more scooters, shared rides and transportation outlets are coming into East County because I feel that we don't have enough of that here. I have lived here my whole life. I am also excited to hear about the new train and more frequent trolleys that will be coming to Downtown El Cajon. I would propose that there be more Park and Ride places in East County to cut down on car travel. I would also propose that some of the giant empty lots be used as community parking lots around central El Cajon. I also propose to put money and efforts into the local bus stops around El Cajon, and adding more scooter, bikes around the rural El Cajon areas and not just in the middle. I also feel like transportation costs for at risk persons should be low or none; those struggling with mental illness, single parents, low income individuals. Thank you!</p>	<p>We appreciate your support and feedback regarding mobility improvements in El Cajon. El Cajon is on the of the areas identified as a Mobility Hub area in the proposed final Regional Plan. SANDAG looks forward to working with the City of El Cajon, community members, and other community stakeholders to identify mobility improvements such as the ones mentioned in your comments to better connect the local community to public transportation. The proposed final Regional Plan includes a Regional Transit Fare Impact Study as a near-term implementation action that will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E39	Bruce Higgins	N/A	<p>The aftermath of the COVID epidemic has left our region in a state of flux. Many things are uncertain, how will the reopening go? Will the hospitality industry be able to find sufficient workers to fully reopen? What is the state of the traditional office workers, particularly downtown? Is what we are seeing temporary, just an artifact of the reopening process or is it a permanent change in our relationship to work? How will all of this effect our transportation needs going forward?</p> <p>I would submit that SANDAG's grand vision could be out of date given the changes that are happening now. It is too expensive, it has too many long-term consequences to take a chance on during a period with this much uncertainty. If the plan and its bond funding is submitted for approval this November, I believe it will go down to defeat by a large majority. I would strongly urge you to delay this plan until at least 2022. Gauge the effects of the changes, and how that impacts our transportation needs. It may be that changes will be required to the plan, admitting that and submitting a revised plan that accounts for those changes will gain back some of the credibility SANDAG lost in its previous "Bait and Switch" stunt on the last bond plan.</p>	<p>The 2021 Regional Plan is a long-range planning document and is required by federal law to provide a reasonably feasible funding strategy for the projects, policies, and programs of the plan. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan. At a minimum this plan is updated every four years with the latest in planning ideas and concepts.</p>

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E40	Bryan Pate	ElliptiGO, Inc.	As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E41	Candelaria Rojas	N/A	Transportation publica.  ***TRANSLATION*** Public Transportation.	Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E42	Candy Garner	Bayside Community Center	<b>**Comment Submitted via Bayside Community Center**</b>  Yes. I agree with the Plan of Zero Emissions, because the environment needs all the help we can offer. I feel safe when walking on the sidewalk or when crossing a street. We definitely need more bus routes if anyone wants the public to use more public transportation.  The street quality. The streets are in poor condition with so many pot hole, one can't miss them at all. Better maintenance is required. To improve our transportation system with the CMCP, more mini MTS busses to more locations are needed.	SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E43	Carlos Alessandrini	FHCSD/El Cajon Collaborative	<b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b>  Excited about a greener, connected and more reliable public transport system in SD. Thank you Carol!	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E44	Carole Morales		I live in East County and public transportation is not easy.  Environmental justice must be embedded in our mobility in San Diego. Therefore, I ask that the 10 Big Moves to Transportation Justice be included in the 2021 Regional Transportation Plan. I call for an environmental justice centered RTP to ensure the projects included in the RTP will prioritize environmental justice (EJ) communities identified by CalEnviroScreen (CES) by listing projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement.  Therefore, in the RTP, I ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document. I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones.  Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system. I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. The information for the Blue Line needs to be clarified; it is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.  I call for a 24-hour service by 2025 on popular transit routes to connect late night and early morning workers to their job. Therefore, the information in the RTP needs to be clarified; the language in both Appendix A and Chapter 2 should specifically call for 24 hr. service on popular transit routes and present a clear implementation schedule. I call for the funding of the planning, environmental review, engineering, and capital for the Purple Line as a rail line that connects EJ communities in Central City Heights and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights and the South Bay region, and a 2035 completion I call for no-cost transit passes for all youth 24 years old and	The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050

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			<p>under in order to ensure generations of lifelong transit riders and encourage significant mode shift.</p> <p>Further, I ask that it be accelerated for a 2035 implementation rather than the current delayed plan to implement in 2027. I call for an electrified bus fleet by 2030. Fund the implementation of California's Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs. Therefore, I ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.</p> <p>I call for the funding of to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study.</p> <p>I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transit stations. It is unclear if a bathroom network is included in the capital operations budgets. I call for the funding of the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.</p>	<p>along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
E45	Cecilia Villarreal Torres	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>Pues yo estory muy contenta y agradecida por tomar en cuenta a las personas que como yo no manejamos y asi con estos nuevos proyectos nos facilitan las cosas, y sobre todo a generar ingresos para la ciudad de El Cajon. Y también la facilidad de poder transportamos a otros lugares, muchas gracias. ***</p> <p>Well, I and very happy and grateful to be counted amongst the persons, who like myself, do not drive. And with these new projects they provide us with things, and regarding everything, they provided more revenues for the City of El Cajon. And also, the ability to transport ones self to other places. Thank you.</p>	<p>Gracias por su comentario. Favor de continuar siguiendo el plan regional a: <a href="https://www.sdfoward.com/mobility-planning/2021-regional-plan">https://www.sdfoward.com/mobility-planning/2021-regional-plan</a>. *** Thank you for your comment. Please continue to follow that 2021 Regional Plan at: <a href="https://www.sdfoward.com/mobility-planning/2021-regional-plan">https://www.sdfoward.com/mobility-planning/2021-regional-plan</a>.</p>
E46	Charles Ross	n/a	<p>RE: 2021 Regional Plan Insanity</p> <p>I am opposed to the 2021 Regional Plan ideas regarding expanding public transit (homeless transportation for them to travel freely to homeless camps for drug use) and taxing vehicles by the mile (we already pay extreme gas and other taxes to build new roads all the time but don't) to fund overpaid union contractors (prevailing wages). I will work with other groups, talk radio and community organizers to aggressively fight these idiotic ideas that really are giveaways to developers to build high-density projects around mass transit that no one wants, and virtually no</p>	<p>The 2021 Regional Plan includes an expanded network of public transit to provide more transportation options to current and future residents of the region. Gas tax revenues have been declining as vehicles become more efficient and more electric vehicles are on the roads. The road usage charge would be a new funding mechanism to replace the gas tax. Building more infill development near transit offers options for people that are looking for more affordable housing and the ability to live without the expense of car ownership.</p>

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			one uses. They hurt families like mine the most and promote the idea that California is not representative to its citizens needs.	
E47	Christina Capella	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>We want an enhanced transit system that is more frequent, reliable, accessible and will lower Greenhouse Gas emissions. Prioritize the bold changes that our communities need for universal mobility and to reduce pollution and emission!</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E48	Chuck Mitchell	N/A	Why do we pay gas taxes? Your organization is out of control and unrealistic. There needs to be an independent audit of SANDAG to see where this money goes. Criminal.	Thank you for your comment.
E49	Cindy Gilchrist	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. I take the trolley every time it's feasible; unfortunately there are many places I cannot go without adding in busses and/or significant wait times. I would love to be able to leave my car in the garage much more often than I can now.</p> <p>Please move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E50	Cindy Jerromes	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E51	Cindy Page	Crawford High School; Mid-City CAN	<p>I am a teacher at Crawford High School and a supporter of Mid-City CAN. Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery.</p> <p>No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>



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			I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.	
E52	Clif Williams	LATHAM & WATKINS LLP	Is the North University City area (Golden Triangle) considered a Major Employment Center in the 2021 Regional Plan? I'm pretty sure it is, since it is part of the Sorrento Valley Employment Center which is the largest employment area in the County. But is there any place where the Community Plan areas are listed with their designation? Or somewhere where this is mentioned in an appendices to the Regional Plan.	Responses to comments received during the public comment period for the draft 2021 Regional Plan will be included in the proposed final 2021 Regional Plan anticipated for release in late 2021. More information on the Employment Centers: Live/Work Data can be found at: <a href="https://www.sdfoward.com/economy-jobs/data">https://www.sdfoward.com/economy-jobs/data</a> .
E53	Dan Gallagher	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. We want an enhanced transit system that is more frequent, reliable, accessible and will lower Greenhouse Gas emissions. Please prioritize the bold changes that our communities need for universal mobility and to reduce pollution and emissions.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E54	Dan Summers	Ramona State Routes Subcommittee	I'm Chairman of the Ramona State Routes Subcommittee. We support the completion of the San Vicente Corridor which will serve well over 50,000 "back country" residents. The TransNet tax funds were supposed to improve SR 67 32 years ago, but the funding was transferred to the coast for trolleys and transit lines that have a 3% occupancy rate. We want to make our voices heard. Unfortunately, we were not aware of the July 7th meeting in which funding priorities were discussed. However, even though we missed the meeting, we still want to make comments on the topic. So I will advise my committee members to send their comments to your email address unless directed otherwise.	<p>When <i>TransNet</i> was adopted the anticipated future land use pattern included significant development in east county. Those developments are no longer expected due to expanded land preservation, slower regional growth rates, and state regulations focusing development near existing facilities. Many of the <i>TransNet</i> projects that have not yet been built were designed to support the East County growth that has not happened and is no longer anticipated.</p> <p>The 2021 Regional Plan includes mostly safety improvements in the rural areas to address crashes and evacuation needs in the event of wildfire or other disasters. SANDAG has recently been exploring opportunities to improve broadband internet connectivity and has begun a project in partnership with Caltrans and the County of San Diego to expand fiber connectivity for high speed internet access on the State Route 67 corridor to Ramona. SANDAG and Caltrans also are currently working on the San Vicente Comprehensive Multimodal Corridor Plan to identify transportation projects to improve mobility along the SR 67 corridor. Additionally, Caltrans is currently working on a draft environmental document for SR 67 which will explore multimodal transportation options to improve mobility and safety. We appreciate your participation in these efforts.</p>
E55	Danny Fuchs	SanDiego350	<p>Thank you SANDAG staff for creating this RTP. It is definitely supporting the direction we need to move in to reduce our climate impact.</p> <p>In addition to the plan you've already established, I would like to see extended/late hours for the Coaster (going back to north county) and trolley added, as well as, more train times added on the weekends.</p> <p>If I am flying back to San Diego at night during the week and I arrive after 7/8p, it's almost impossible to take public transit back to north county and I, and many others, end up having to catch an Uber/taxi.</p> <p>Furthermore, since the Coaster only has 6 trains that run on Saturday to downtown San Diego, I usually end up driving down because the times don't align with my schedule.</p> <p>Adding late night trains to north county and more Coaster times during the weekend I think would significantly reduce the amount of cars on the road and allow more people to take public transportation reducing our overall emissions.</p> <p>Thanks for listening and thank you for your hard work you all put into this plan.</p>	The Regional Plan includes both increased frequency of COASTER service and greater service throughout the day. The Central Mobility Hub will provide a quick and convenient transit connection to the airport so that catching the train for airport trips can be made much easier. The Regional Plan includes a significant capital investment in the LOSSAN rail corridor increasing capacity and speeds that lead to more frequent, reliable, and faster Amtrak and COASTER service including on nights and weekends.

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E56	Danny G	N/A	<p>I am unable to find on the website for public comment for the mileage tax.</p> <p>But as a resident of San Diego County I'd like to make the statement for public comment:</p> <p>Mileage tax for cars are you kidding me? I understand this may replace some of the gas tax due to electrical vehicle usage and try to encourage more public transportation usage. But many people have bought electric vehicles because gas has become unaffordable. Many people live 20 + miles from work. Secondly to enforce will be difficult. This tax will Target people who rely on cars for their livelihood. For public transportation people such as myself where I work would take 2 hours to get there plus I have to pick up kids at daycare. This would make a 45 minute car ride home possibly 3 hours via public transportation.</p> <p>Solution: make the gas tax lower, then less people will then drive electric cars or Increase registration fees for cars. Making the fee equal for all and not just people who live closer to work or daily life.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p>
E57	Darrell Wenhardt		<p>Why is there no plan for Rail up the 15 corridor?</p> <p>This plan ignores communities like Scripps Ranch, Poway and alike.</p>	<p>Current data and modeled projections show that there is not enough demand to warrant the more costly rail for that section of the corridor. Busses and Flexible Fleets can better serve those areas.</p>
E58	Dave Robertson	SDGNDA	<p>I hope SANDAG will amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth (ages 24 and under) receive priority when transit fare subsidies are allocated. Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery. Additionally, no-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and more equitable San Diego.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E59	David Harris	SanDiego350	<p>I commend the planning staff and leadership at SANDAG for proposing a visionary transit system with multiple modes to make commuting without a personal vehicle more efficient and convenient. However, I am concerned that the plan still builds highways first and schedules public transit projects too far out in the future. Instead we need an enhanced transit system that is more frequent, reliable, accessible and will lower Greenhouse Gas emissions. This needs to happen within the next 10 years, not thirty years.</p> <p>I recommend that SANDAG accelerate the timeline for all transit (trollies, buses, rail) and biking infrastructure improvements. In the interest of equity, the RTP should prioritize the Environmental Justice communities that need transit solutions the most. Environmental Justice communities cannot afford to wait; they need immediate improvements while the long-term infrastructure projects are being planned.</p> <p>Finally, I am in favor of locating the central mobility hub and airport people mover at the Navy site, as long as it does not substantially delay the timeline for development of the project.</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. SANDAG is currently studying the potential impacts of developing the Central Mobility Hub in an Environmental Impact Report (EIR). The EIR will analyze all aspects of the project, including two potential locations for the Central Mobility Hub including the Navy's Old Town Campus, a Trolley extension alternative, a direct transit connection to the airport, and improvements to local roads and highway access. Learn more about the Central Mobility Hub at: <a href="https://sandag.mysocialpinpoint.com/CentralMobilityHub">sandag.mysocialpinpoint.com/CentralMobilityHub</a>.</p>
E60	David Oddo		<p>I would like to request a printed (color) copy of the following document:</p> <p>"Appendix H. Social Equity: Engagement and Analysis, San Diego Regional Plan 2021."</p>	<p>A SANDAG staff member will be in contact with you regarding how to obtain a printed copy of the requested documentation. Appendix H: Social Equity: Engagement and Analysis can be viewed/downloaded on our website at: <a href="https://sdforward.com/docs/default-source/2021-regional-plan/appendix-h---social-equity---engagement-and-analysis.pdf?sfvrsn=c944fd65_2">https://sdforward.com/docs/default-source/2021-regional-plan/appendix-h---social-equity---engagement-and-analysis.pdf?sfvrsn=c944fd65_2</a>.</p>

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				The full draft 2021 Regional Plan, including all chapters and appendices, can be found at: <a href="https://www.sdfoward.com/mobility-planning/2021-regional-plan-draft">https://www.sdfoward.com/mobility-planning/2021-regional-plan-draft</a> .
E61	David Smith		As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community. I would also like to see the transportation be affordable to those that depend on it, and are limited by cost.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfoward.com">SDFoward.com</a> .
E62	Dena Stark	Family Health Centers of SD/El Cajon Collaborative	<b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b>  It's been interesting to watch the process of the development of the upcoming transportation plans. It has been a long time coming and long over due. As a resident and employee of El Cajon, I am eager to see and use the transportation in the future. The community and environment will benefit from the Regional Plan.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfoward.com">SDFoward.com</a> .
E63	Dennis	N/A	Please stop spending money on trolleys that go very slow, and do no go to the airport. Spend the money on roads, and maintaining weed removal from sidewalks and medians. Sorrento Valley Blvd. and Sorrento Valley Road need repaved.	State laws have changed from requiring congestion relief (usually solved in the short term by widening roadways) to reducing vehicle miles traveled and greenhouse gas emissions (usually solved by people living closer to destinations and using alternative modes of transportation such as walking, biking, carpooling and taking public transit).
E64	Destiny Garcia	San Diego College of Continuing Education/El Cajon Collaborative	<b>**Comment submitted to SANDAG via El Cajon Collaborative**</b>  I really appreciate everything you're doing, as someone who works in education it is so important for me to stay up to date with the community and be informed of what changes to expect. I look forward to attending future meetings and working with you to possible provide further outreach to the community. It looks like a very comprehensive [plan] that will work for everyone.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfoward.com">SDFoward.com</a> .
E65	Diane Lopez Hughes		San Diego needs an environment justice centered RTP.  We need funding to protect vulnerable communities living near transit corridors by anti-displacement efforts developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections. Therefore, I request an update on the status of the anti-displacement study.  We need funding the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. Currently, this is not included in the RTP.  Thank you for the opportunity to share my concerns as a grandmother, retired nurse, and resident of San Diego.	The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.  Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.  MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.
E66	Diego Lynch	SanDiego350	While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.  We ask that you move faster in meeting targets for emissions reduction, transit projects, and the	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to



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			hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	reduce emissions beyond what is included in the 2021 Regional Plan.  Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E67	Donald L. Waggett Jr.		How can I obtain a paper copy of the regional draft plan?	A SANDAG staff member will be in contact with you regarding how to obtain a printed copy of the requested documentation. The full draft 2021 Regional Plan (including all appendices and chapters) is available for view/download on our website at: <a href="https://www.sdforward.com/mobility-planning/2021-regional-plan-draft">https://www.sdforward.com/mobility-planning/2021-regional-plan-draft</a> .
E68	Edlinda Bailey	SanDiego350	While I appreciate the SANDAG's current regional transportation proposal, I want to share that I think it's important to be even bolder in ensuring that our region prioritizes efficient, reliable and environmentally conscious plan. We have very diverse industries here and should have transportation meet the needs of the community with forward thinking while also prioritizing environmental issues. For example, while I see that north coastal is finally getting a trolley stop @ UCSD, an expansion of this should really be considered to Escondido & Oceanside. Even if cars are going to be electric in the future if reliable transportation is available then, people won't feel the need to have vehicle ownership as important today. I ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.  The COASTER and SPRINTER will both be receiving much needed upgrades to operate more quickly and efficiently.
E69	EJ SHIRING	N/A	I just heard SANDAG is proposing a per mile tax for residents to collect EVEN more fees from the most heavily taxed drivers in the country!!! ARE YOU OUT OF YOUR FRIGGIN MIND!!!! The state just raised gas taxes AGAIN July 1 and now you want even more money!!!! For those of us with gasoline powered vehicles we are already paying for every mile we drive with the TAX on GASOLINE!!!!!! start spending responsibility and stop driving people out of the state who cannot afford to live and work here as you TAX THEM TO DEATH!!!	Thank you for your comment.
E70	Elaine Dorsey	SanDiego350	I am with San Diego 350.  I applaud SANDAG's leadership in transforming regional transit, but I am very concerned that the transit projects are so far in the future that they will not meet the urgent need to reduce GHG emissions soon enough to avert the worst effects of climate change.  Additionally, we need 24hr service with frequency of every 10 min on bus and trolley to meet needs of riders on the most popular routes.  Please address these issues in the RTP so that our public transit system can truly be a meaningful alternative to cars--highways should NOT continue to be the priority in the plan.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.  Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E71	Elizabeth Chopp	SanDiego350	While I want to thank the staff at SANDAG for addressing climate and equity in this Regional Transportation Plan draft, there are still areas where improvement is necessary. One big issue I have also had with transit is that public transportation is OK if you are going downtown but not anywhere else. I live in the College and worked in downtown Chula Vista. Although it took me 25 minutes to drive, it would take 1 1/2 to 1 3/4 hours by transit. Better service, speed and frequency of transit is needed so that our public transit system can be a meaningful alternative to cars.	SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E72	Elizabeth Tate	Mid-City CAN	I am a volunteer with Mid-City CAN.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The

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			<p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Choose 2 talking points to include:</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region’s equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego. No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities. Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles. I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p>
E73	Ellen Williams	SD350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E74	Elneda Shannon	Community Member/resident	<p>A mobility hub in our community (So. East San Diego) preferably located at our current Orange Line Trolley station. Youth passes given to youth under 24.</p> <p>Fiber optics underground to ensure we are ready for state of the art transportation system that is in the design stage, (iOS systems/smart phones) and to more appropriately address the digital divide in our “Redlined communities”.</p> <p>Covering our MTS bus stops. (Structures/bus shelters.)</p> <p>Consider 24 Hour service on the lines that are taking our residents to work.</p> <p>Focus on transforming to an all electric bus fleet in the first 2-3 years of implementation. Improve the frequency and reliability of our bus routes.</p> <p>Ensure all our streets are designed with the “Complete Streets” designs.</p> <p>Increased maintenance of the trolleys and buses proportionate to the heavy usage in our areas (Southeast area of the City of San Diego.)</p>	<p>The proposed final 2021 Regional Plan identifies three Mobility Hubs along the Orange Line Trolley in Lemon Grove, La Mesa, and El Cajon. You can visit <a href="https://sdforward.com/envision">SDForward.com/envision</a> to see more details about proposed projects in your community.</p> <p>One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. For more information, please refer to Appendix B: Implementation Actions and the Digital Equity Strategy and Action Plan.</p> <p>Bus shelters are provided wherever there is sufficient right of way to locate them. Any new infrastructure build would include shelters. Complete Streets designs are an important component of SANDAG’s planning today and will be included on projects in the future. As part of larger infrastructure projects like Next Generation Rapid, Trolley and Commuter Rail, all stations will have shelters.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus</p>

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				<p>(ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>The 2021 Regional Plan also proposes transit fare subsidies for youth, increased frequencies and spans of service on core bus routes, high frequencies and all-day service on new Rapid and Commuter Rail routes, investments in zero emission buses and charging/fueling infrastructure, and investments in complete streets and Vision Zero programs.</p>
E75	Ester David	Mid-City CAN	<p>I am a volunteer with Mid-City CAN. Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under and seniors will receive priority when Transit Fare Subsidies are allocated.</p> <p>Choose 2 talking points to include:                      Transit-dependent youth and seniors have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery.                      No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego.                      No-cost transit passes will connect youth and seniors to school, work, medical care, internships, and other early-career opportunities.                      Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.                      I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E76	Frances Motiwalla	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. Our planet can't wait, and our people deserve better transportation services. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E77	Frederic O'Hara	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. I'm asking that faster action be taken in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful, positive, realistic alternative to cars for San Diegans.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E78	Gladys Swensrud	N/A	<p>I want you to VOTE NO on the Track and Tax plan now proposed by SANDAG. Our various road taxes to date have already not been used for their intended purposes, so DO NOT approve this</p>	<p>We understand there are concerns around the privacy and implementation of a road usage charge. Significant additional work, including public involvement, pilot testing,</p>

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			<p>ridiculously, new invasive tax as well.                      A few years back I refused to allow State Farm to lower my bill by letting them track my mileage by reporting it to them. Where, when and how far I choose to drive is my business, paid for by buying my own vehicle and by paying the vast array of road/highway/gas taxes and charges already levied upon us as Californians. Being able to move around our community is a freedom we have always enjoyed. This taxation invasion of our driving freedom is even more invasive because it uses a tracking device attached to my private property. As decades long San Diegans, we do not want to move, but the more ridiculous tax pressures placed upon us, the closer we come to make moving a necessity.                      Please vote NO on this new tax scheme!</p>	<p>legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public's privacy.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p>
E79	Gloriani Weiss	SanDiego350	<p>I am humbly asking on behalf of the citizens of San Diego who along with Comic Con Attendees, Baseball fans and residents of the post populated of communities are screaming PLEASE PRIORITIZE PUBLIC TRANSIT!!                      That includes making it more affordable, and accessible to all.                      ***While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.                      We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The Regional Plan prioritizes early implementation of increased frequency on existing transit lines and upgrading many routes to Next Generation Rapid routes which increased frequency and spans of service.</p>
E80	Grace van Thillo	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.                      We ask that you move faster in meeting targets for emissions reduction, EV transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E81	Halle Shilling		<p>As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E82	Haneen Mohamed	City Heights CDC	<p>Thank you all for taking the time to speak in depth with City Heights CDC staff on Monday about SANDAG's plan for managed lane expansions and general purpose lane conversions throughout City Heights. The conversation was highly informative and will help us better frame our ongoing community engagement and dialogue efforts with Mid-City residents, including the City Heights Built Environment Team.                      The Built Environment Team is a City Heights based community group that works towards achieving an equitable, accessible, and dignified transportation experience. Since the release of the draft 2021 Regional Plan in May, City Heights CDC has worked to engage the Built Environment Team in the public involvement process through disseminating critical information surrounding the Regional Plan. This includes preparing residents for the public comment opportunities offered at SANDAG's virtual public hearings and informational open houses, and through the Social Equity Working Group. Most importantly, City Heights CDC has utilized our monthly Built Environment Team meetings as an open forum for members to discuss the 2021 Regional Plan and continue refining their vision for transportation in the region.</p>	<p>Thank you for your comment and for supporting your community in facilitating their involvement in the development of the 2021 Regional Plan. The letter will be included in the public comments and responses as part of Appendix G in the proposed final.</p>



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			<p>As an exciting product of these engagement efforts, the Built Environment Team has assembled a letter outlining their transportation priorities for the 2021 Regional Plan. If feasible, we would like to add the attached letter onto the agenda for tomorrow’s Regional Plan Social Equity Working Group meeting. We would also like to include this letter as part of public comment for the 2021 Regional Plan overall. If there are any specific avenues SANDAG would like us to share the letter through before the August 6th deadline, please let us know.</p>	
E83	Hannah Samuels	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>Climate change is accelerating quickly and every day we are seeing new adverse effects. We need to start preparing now for what the future holds and do our best to try to lessen the damage we’ve already caused. The current plan to reduce emissions 40% by 2030 is not the assertive action that is needed. I urge San Diego to consider a bolder plan and to help lead the nation to a more sustainable future.</p> <p>Public transportation has the power to help so many people. However, the current transit system is unappealing to many. In order to encourage more community members to use the transit system, updates to the transit stops needs to be made to ensure equitable access to all. Benches, shade trees/elements, increased lighting, and ADA compliant bathrooms should all be considered and added. This will not only help increase ridership, but it will also ensure more equitable access to the transit system.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>MTS is working to provide shelters throughout the region. Bus shelters are provided wherever there is sufficient right of way to locate them. Any new infrastructure build would include shelters. Complete Streets designs are an important component of SANDAG’s planning today and will be included on projects in the future. As part of larger infrastructure projects like Next Generation Rapid, Trolley and Commuter Rail, all stations will have shelters. Additionally, the proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p>
E84	Hayden Schill	SanDiego350	<p>First, I’d like to thank the SANDAG staff the climate progress in the Regional Transportation Plan draft.</p> <p>However, given the urgency of the climate crisis, I want to encourage the staff to accelerate the goals outlined in the draft. Specifically, I urge you to move up the timeline for GHG reduction goals and transit improvements goals.</p> <p>Finally, I want to support no-cost youth passes for individuals 24 years old and younger. There are a plethora of “pros” for instating this.</p> <p>Thank you again for prioritizing climate goals, and I hope you consider this opportunity to be even more bold in the face of such a large crisis.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E85	Heather M Fenwick	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E86	Holly Young	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state</p>

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			We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	<p>goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E87	Hugh Moore	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E88	Ida Naughton	N/A	We are in a climate emergency and we need you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. This is an urgent matter and all of our futures are on the line.	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E89	Ivan Cavallino	SanDiego350	<p>Please build public transit. I live in Tierrasanta, which is a wasteland in terms of access to the rest of the city. There is a singular bus line out of the suburb and I live several miles away from it. There is only freeway access in and out of Tierrasanta, making leaving the suburb without a car not just a long trip, but also dangerous as traffic coming on and off the freeway is often far faster than residential traffic.</p> <p>It is clear that expanding freeways has not solved the issue of commutes in San Diego. Every afternoon through the evening traffic around my suburb prohibits most movement in and out via car, and there are no alternatives to get in and out of San Diego. Even if Climate change and reducing vehicle emissions is not a priority, lessening the commute car trips can only make freeways more accessible and usable to those that still use cars.</p>	The Regional Plan includes substantial increases in public transit. Both existing services and new services. That being said, Tierrasanta is difficult to serve for just the reasons cite. It is very suburban, spread out, and has very high auto ownership. A new transit route will connect to Tierrasanta on the west side of I-15 and Clairemont Mesa Boulevard.
E90	Jade L	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to</p>



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E91	James Long	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. I ride the Orange Line from Arnele to Civic Ctr. It takes 50 minutes. If you upgraded to include express trains with less stops, I can cut time to compete with car travel, because parking is a hassle downtown. If the express trains can reduce travel times, more people will give up cars and ride the train.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E92	Jamie Mark		<p>I am a resident of San Diego. I am writing in response to the proposed taxes and tax increases coming to San Diegans, including the State Mileage-Based Road User Fee, the Local Road User Charge, the Local Sales Tax Ballot Measure, and the MTS Sales Tax Ballot Measure.</p> <p>As someone who heavily relies on our roads for both livelihood and pleasure, I am emphatically against all four of these new taxes and any mandatory vehicular tracking technology. Not only does tracking private vehicles for tax purposes stifle freedoms, but the county (and state) have continually failed to live up to their promise to improve the roads with funding from other taxes, including the gasoline taxes, of which California has the highest in the nation.</p> <p>I am urging you to take these taxes and vehicular tracking technology off of the table, and to speak up for the right to move freely throughout San Diego County.</p>	<p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.</p> <p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>We understand there are concerns around the privacy and implementation of a road usage charge. There are several ways to implement a road usage charge without the use of tracking devices in personal vehicles. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum</p>

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				this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public's privacy.
E93	Janet Castanos		I have worked over 40 years as an educator in San Diego. I strongly urge you to amend Appendix A of the 2021 regional plan to allow no-cost transit passes for all youth ages 24 and under. This change will help create generations of lifelong transit riders who become a part of our long-term strategy to build a greener and equitable San Diego. Our youth must grow up viewing mass transit as a way of life.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
E94	Jared Birrenkott		You guys and your tax proposals need to stop! We have had it, are fed up and willing to fight! Your not tracking my vehicle! I pay taxes when I get paid, taxed on gas, taxed on groceries, taxed when I buy a truck, taxed on my house, property tax, etc. I'm sure you see the point. We are sick of government overreach and constant taxes!	Thank you for your comment.
E95	Joan Raphael	SanDiego350	While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. I have a 2 year old grandson who will inherit the Climate Change Crisis. We need to move faster than you are proposing! We also need 24 hour transit. When my adult son was a teenager, it was taking him two hours on the bus to reach school that was 20 minutes away by car. We need to stop putting freeways first! We need transit that is easy to reach, at times we need it. Please think more boldly than this current plan!	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E96	Joanne Gonzalez	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>Very thankful for all the information given to us. I learned so much I wasn't aware of and I think the plan in progress for the El Cajon community is going to be great and very helpful for many of us. What I look forward to the most and hope we get is the free shuttle service, it will be a huge help to many.</p>	Thank you for your comment. Please continue to follow that 2021 Regional Plan at: <a href="https://www.sdforward.com/mobility-planning/2021-regional-plan">https://www.sdforward.com/mobility-planning/2021-regional-plan</a> .
E97	Joe LaCava	District One, City of San Diego	<p>I am writing this letter to request changes related to the City's Coastal Rail Trail Project included in the draft 2021 Regional Transportation Plan (RTP).</p> <p>SANDAG's Draft 2021 RTP is a valued report for my constituents and the surrounding community. I value the hard work that has gone into the RTP and am excited to see what the future holds. The City's approved Coastal Rail Trail Project route was selected through a multi-year public process and has been fully designed. The project is on the City's CIP list to begin construction in 2022. This project redesigned the originally proposed route through Rose Canyon and Roselle Canyon noting conflicts within the Multi-Habitat Planning Area (MHPA) to acquire Right-of-way. The original route was also rejected after extensive engineering analysis because of grading impacts, safety along the remote sections, potential conflicts with MCAS Miramar, and other reasons. However, the Draft 2021 RTP includes costs for segments of the Trail that continue to reflect the original route and not the current route.</p> <p>As a result, I request that the RTP's Appendix A: Transportation Projects, Programs and Phasing reflect the City's segment of the Coastal Rail Trail project as updated, including the following changes:</p> <ul style="list-style-type: none"> <li>• Page A-6, Project ID AT032, Active Transportation Category: Remove reference to Roselle Canyon</li> </ul>	<p>Thank you for the update on the City of San Diego's Coastal Rail Trail project S00951. Portions of that 1.63 mile project are identified as the Gilman Connector in our project list and will be updated to reflect the status in your CIP list. It is going to be a vital connector to SANDAG's recently upgraded Rose Canyon Bike Path and our newly constructed Rose Creek Bikeways to the south. Extending north, however, there remains a desperate need for safe, direct, all ages and abilities active transportation alternatives extending into currently underserved residential (University) and employment centers (UTC, Sorrento Valley) to improve alternatives in this major transportation corridor. In order for SANDAG to stimulate the shift from personal motor vehicle use to people choosing to bike, a network of well-designed routes is essential. The City of San Diego's project on Gilman Drive is greater than 2 miles away from, and represents just 25% of, the entire length of the projects you are requesting be removed.</p> <p>The Coastal Rail Trail segments you've identified for removal from the transportation network represent 6.2 miles of regional bikeways connecting to the existing Sorrento Valley Coaster Station, as well as future Transit Leap services. As you may know, these</p>

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			<p>to state “Carmel Valley to Sorrento”</p> <ul style="list-style-type: none"> <li>• Page A-6, Project ID AT036, Active Transportation Category: Remove this segment through Roselle Canyon</li> <li>• Page A-6, Project ID AT037, Active Transportation Category: Remove this segment through UTC to Rose Canyon</li> <li>• Page A-31, Project ID AT023, Active Transportation Category: Remove this segment through Rose Canyon</li> </ul> <p>Making these changes should reflect the current Coastal Rail Trail project as connecting to the two Connecting Corridors of I-5 North County Coastal (I-5-NCC) and Coast, Canyons and Trails (CCT). Updating the Appendix as requested will eliminate \$54 million in project costs. I ask for your full and fair consideration to continue these efforts by updating the 2021 Draft RTP as requested.</p>	<p>projects and this alignment were first identified in the 2000 Coastal Rail Trail Project Study Report:  <a href="https://www.keepsandiegomoving.com/Libraries/Transnet-doc/Coastal_Rail_Trail_Project_Study_Report_reduced.sflb.ashx">https://www.keepsandiegomoving.com/Libraries/Transnet-doc/Coastal_Rail_Trail_Project_Study_Report_reduced.sflb.ashx</a>.</p> <p>These projects were approved by the SANDAG Board of Directors In 2010 with the development of a comprehensive regional bike network - Riding to 2050: The San Diego Regional Bike Plan:  <a href="https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail</a>.                      And again, these Coastal Rail Trail segments were identified as a priority project in 2013 via the Bike Early Action Program (EAP):  <a href="https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail</a>.</p> <p>We will not be removing these projects from the Regional Plan. We respect and appreciate your notes of caution and conflict regarding the challenges of constructing Rail Trail projects like these particularly with the myriad stakeholders here. Our recently completed Inland Rail Trail, Coastal Rail Trail, and Bayshore Bikeway projects have proven to be extraordinarily complex for these reasons, and often encountered great opposition from concerned residents. All of the effort is worth it to serve the most vulnerable users of our transportation system with the healthiest modal options available however, and these bikeways are now universally appreciated elements of our transportation network and communities. We plan to deliver the 3 projects you've identified here with a commitment to achieve this same level of success and look forward to partnering with you to ensure that happens.</p>
E98	John Fischer III	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>The presentation was above average. There was somebody in the audience who wanted to only focus on Highway 67. I believe it would have been hood to have follow-up information, through an email with an attachment. If there was to much information to make a presentation within 1 hour, maybe give links before the meeting in email.</p> <p>Toastmasters teaches how to make presentations, which would improve the skills of the presenter.</p> <p>With rolling black-outs, there was no mention of how the Governor Newsom plans on being 100% electric cars by 2030.</p>	<p>The transition to cleaner vehicles will only exceed through efforts by government at all levels and industry together. California has enacted several clean vehicle laws for passenger vehicles, buses and trucks that signal the auto industry to produce cleaner vehicles. The auto industry has made major commitments and investments to shift to all electric in the coming decade(s). For the San Diego region, the 2021 Regional Plan supports incentives and other investments in the electrification of cars, trucks and buses and their supporting infrastructure (e.g., EV charging stations and hydrogen fueling stations) as one of the ways SANDAG helps reduce regional greenhouse gas (GHG) emissions and improve local air quality. Appendices A (Table A.17) and B show SANDAG's proposed EV commitments.</p>
E99	John Peters	N/A	<p>I strongly oppose the new proposed “per mile tax”. I do not want any more tax dollars to go toward roads and highways. What happened to all the tax dollars from the “gas tax”? The public deserves to see a full account of those “gas tax” dollars and where they went. Proposing a new tax is out of the question.</p>	<p>Nationwide states and regions are confronting the shortfalls of gas tax revenues to fund maintenance, operations, and construction of their transportation systems. The federal gas tax was the largest source of transportation funding for many decades. However, the federal gas tax per gallon has not changed since 1993, that is when the minimum wage in California was \$4.25. The federal gas tax does not grow with inflation and the purchasing power of that source has diminished over time. States and regions have implemented their own sales and gas tax measures to try and meet the needs of their transportation systems. However, the best tax measures tied to fossil fuel consumption will continue to erode in time as vehicle technologies change.</p>
E100	John Shaffer	SanDiego350	<p>I would like to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. Please consider soonest as Spring Valley and other unincorporated areas are in desperate need of public transportation. 24-hour service and increased transit frequency: Make the transit system fast, frequent, reliable, and accessible by increasing passenger capacity, hours of service, and frequency on popular lines. This means 24-hour service and 10-minute frequency on many popular bus and trolley routes to connect</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>

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			<p>people to jobs, school, and more. Improve transit amenities: Make immediate improvements to amenities at transit stops, including benches, shade from the elements, and bathrooms that are accessible according to ADA regulations. Improving transit amenities increases ridership and is crucial to providing our disabled community access to public transportation in an equitable way. As a member of a Planning Group, we hear from the public consistently the need for more public transit.</p>	<p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p>
E101	John Stump		<p>Thank you for providing the public and businesses with the opportunity to comment on the draft Regional Plan. I have been a resident, business owner/manager, and residential/commercial property owner in Southeast and Mid-City San Diego for more than 50 years. I have served as an elected redevelopment official, Bond oversight committee member, and Chaired many of the infrastructure oversight committees for major projects in these areas. I have served as Counsel to most of these areas Business Improvement Districts and many local businesses.</p> <p>My comments are prioritized by those that would address 1. Immediate Dangers to Human Life and Health and Real Property losses; 2. Short Term Environmental and &amp; Climate Change infrastructure; and 3. Immediate improvement to Congestion Relief and Economic Development in council Districts 4 and 9. My families projects are as follows:</p> <p>1. IMMEDIATE DANGERS TO HUMAN LIFE AND HEALTH AND REAL PROPERTY LOSSES: The Auburn Creek tributary has been channelized, permeable flood plains replaced by impermeable concrete; and Auburn Creek road under crossings are undersized, creating storm water backups and flooding. The school route sidewalks, at Wightman Park , regularly overtop creating drowning dangers to children and floods the adjacent apartment housing causing mold infestations. The City of San Diego needs and has long had on its CIP projects list a redo of the undercrossing at University Avenue and needs to address the undersize nature of the four (4) downstream undercrossing that back up and cause flooding of streets and real property. Further, all adjacent street storm water drains directly in to Auburn Creek and thus, through the impaired Chollas Creek into San Diego Bay. Infiltration basins need to be constructed to improve and control storm water quality. CALTRANS dumps i-805 road wash directly into the creek at Home Avenue.</p> <p>2. SHORT TERM ENVIRONMENTAL AND &amp; CLIMATE CHANGE INFRASTRUCTURE: Safe Pedestrian sidewalks, like those being installed along Market Street-between Euclid and 47th Street are requested for the North side of Home Avenue -between Fairmount and Euclid Avenue. Designation of much of the Mid-City's and Southeast's business districts and adjacent residential areas as eligible for low powered alternate vehicles, like Golf Carts, as provided by the California Vehicle Code, would slow traffic and provide a safer cleaner alternative to gasoline vehicles.</p> <p>3. IMMEDIATE IMPROVEMENT TO CONGESTION RELIEF AND ECONOMIC DEVELOPMENT IN COUNCIL D 4 AND D9: Please fund the long-awaited reconnection of Home Avenue and Market Street. Extension of the Home Avenue Route to Market Street for Pedestrians, Bicycles, and Vehicles. The Home / Market connection would provide significant economic development stimulus to the Mt. Hope and City Heights areas. It would assist in congestion relief by providing an alternate to freeway traffic on the SR 94 - Martin Luther King Freeway.</p>	<p>SANDAG consider stormwater, or urban runoff during the project development process and partners with regional transportation infrastructure owners and operators to manage stormwater from roads and highways in the region. For more information on stormwater, please see Appendix R of the 2021 Regional Plan. In addition, the crossings referenced in the comment fall within the City of San Diego's jurisdiction.</p> <p>While Home Avenue is not on the Adopted Regional Bike Network, the 2021 Regional Plan includes the nearby and parallel Chollas Creek Bikeways: North Fork - Bayshore Bikeway to University Bikeway and South Fork - Petway Park to Market Creek Plaza which will improve the connections described in this comment. The project alignment and details can specifically be found in the updated data viewer and Appendix A. The City of San Diego and Metropolitan Transit System are the implementing agencies for these improvements. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is in development and provides another opportunity to provide input on transportation solutions for this area. Establishing special districts is under the purview of the City of San Diego.</p> <p>Your comment was forwarded to the City of San Diego.</p>
E102	John Wotzka	N/A	<p>Don't forget the Offshore Wind projects planned by the Biden Adm. The West Coast needs to find ports that will be able to build and launch components for the Offshore wind project coming in the future.</p>	<p>The Port of San Diego would be the local lead agency for the Offshore Wind project. SANDAG will work with the Port of San Diego to discuss the Offshore Wind project and other future transportation needs.</p> <p>Your comment was forwarded to the Port of San Diego.</p>
E103	Johnny Tran	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>



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E104	Jon Salunga		I am a local educator in Southeast San Diego. My students deserve access to high-quality transportation and economic mobility. I urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated. Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery. No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego. Please contribute to the efforts to make this return to the new school year DIFFERENT, in a good way, so our students know we are supporting them inside and outside the classroom to be their best.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
E105	Jordan Krueger		As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E106	Jose Marie Zambrano	N/A	Very helpful.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E107	Josephine Thompson		There must be free transit for YOUTH, especially!  So many places have free transit for everyone and hopefully someday that is how it will be soon. At least give the YOUTH the break now for FREE TRANSIT.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
E108	Joshua Piedra	SanDiego350	While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.  Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E109	Josie Caballero	SanDiego350	While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.  Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including

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				frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E110	Josie Hamada	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E111	Juan Estrada	Molina Healthcare of California/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>Very good presentation and I'm very excited about all the new options that will help low income communities to move around in a better, safer and more effective way all over our beautiful cities. It is also rewarding to see that the new system will be more environment friendly and will help to reduce global warming in general.</p>	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E112	Judith Schlebecker	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>California is experiencing the worst of climate change with the wildfires and water issues which will only get worse with time unless greenhouse gas emissions are decreased substantially.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E113	Justin Yurasek		<p>Hello-</p> <p>I have a few ideas to help with commutes to and from north county and the main employment centers down south. I commuted to and from Vista to UTC for several years and had the following ideas. I no longer commute these days as I've changed jobs, but I cringe for those who still do. Right now, there are many bottlenecks that prevent traffic from flowing smoothly.</p> <ol style="list-style-type: none"> <li>1) Connect Cannon road from Vista to Carlsbad.</li> <li>2) Connect Citracado parkway from the 78 to the 15 and make sure it has 2-3 lanes in both directions.</li> <li>3) Provide express lanes from UTC La Jolla Village Drive down Miramar road all the way to I-15. Basically, allow people to connect from UTC to I-15 without getting stuck in all the lights on Miramar.</li> <li>4) Provide a main parkway type of surface street from the 56 to the 78. Right now many of the surface streets are two lane roads with lots of stop signs. A 2-3 lane road connecting all the way would alleviate traffic on the freeways.</li> </ol> <p>Some of the above are big efforts, however, I don't see any other way around it.</p>	<p>The Regional Plan includes improvements for arterial roadways, such as these, so that they can benefit from management approaches and technology enhancements to increase efficiency and reduce delays.</p> <p>Your comment was forwarded to agencies that oversee these facilities.</p>



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			Let me know!	
E114	Justino and Angela Martinez		<p>I write to you in opposition to the plan to Charge Per Mile or VMT of the 2021 Regional Plan! I've been watching your executive director since we briefly lived in Los Angeles. He's untrustworthy and it baffled us why San Diego Board of Supervisors would hire Hasan with a pay increase. He's been trying to implement LA/NY style transportation policies in our historically more fiscally conservative county. Now your co-chair Alejandra Sotelo-Solis has been quoted saying "We can't we be more like New York" on KUSI &amp; other sources. Enough!</p> <p>We expect that your "outreach events" will be mostly attended by lobbyists and will be a really uncomfortable &amp; biased environment for any opposition. Lobbyists are organized and paid very well. These operatives are connected to many members within your organization.</p> <p>It's time for a 'No Confidence Vote' for Hasan! (to start)</p> <p>We Love San Diego,</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
E115	Karen Anderson	SD350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>Either we go BIG, or we fall far short of meeting future needs. Now is the time to do everything possible to mitigate the climate crisis. Please make the largest investments possible.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E116	Karina Gonzalez	Hammond Climate Solutions	<p>Hammond Climate Solutions is a local, mission-based social enterprise working to stop the climate crisis and ensure a just, livable future. We are pleased to see SANDAG's new direction and want to ensure that the 2021 Regional Transportation Plan is setting bold climate targets while remaining strong on family-sustaining jobs and environmental justice. This letter highlights recommendations that we feel are necessary in order to address the climate crisis, address inequities in our transportation infrastructure and ensure that equity is centered in every decision moving forward. Our first recommendation is to include no-cost Youth Opportunity Passes. Local community-based organizations in communities of concern, which understand how no-cost passes for youth would positively impact their community, have been advocating for this for over a decade. Studies show that youth transit riders have a higher probability of becoming adult transit riders. Our youth should be a priority group when allocating transit subsidies. We also recommend tailored subsidies for people in communities of concern. Transit subsidies colleaguine to community members who require them, whether that be through using targeted zip codes or census tracts, residents who are on SDG&amp;E's CARE or Ferrates or medical baseline customers. It is important to acknowledge that these communities have experienced historic under investment and moving forward should be prioritized first when determining the distribution of subsidies. While we are pleased to see SANDAG's data evaluating access to basic needs and opportunities via transit, we believe the timeline for improving access to employment centers, higher education and medical centers needs to be significantly shortened. Our communities cannot afford to wait another 30 years for only a marginal increase in accessibility. We urge SANDAG direct immediate funding for infrastructure improvement to communities of concern and low income communities of color in order to drastically improve transit accessibility and ensure our transit systems are working for everyone. As</p>	<p>SANDAG will be applying a social equity planning framework throughout the implementation of the Regional Plan. Through this framework, we recognize the urgent need for reduction of GHG emissions, especially in our most marginalized communities, as a key aspect in an equitable and sustainable future for the region. I would like to direct you to Attachment 3 of Appendix H: Social Equity: Engagement and Analysis, where you will find a list of transportation projects aimed to reduce pollution exposure in our region's disadvantaged communities in accordance to AB805 and CalEnviroScreen 3.0. More detail on phasing and funding allocations to these projects can be found in Appendix B: Implementation Actions.</p> <p>Another one of the near-term Implementation Actions listed in Appendix B will be a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth. SANDAG also is currently working with the Social Equity Working Group to develop near-term solutions to address transit service improvements, amenities, and subsidized transit fares.</p> <p>In Appendix U: Cost Estimation Methodology, Table U.2 captures the transit fare subsidies to riders throughout FY2026-FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U.</p>

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			the worst effects of climate change begin to emerge throughout the county and evacuation events as a result of wildfires and flooding are becoming more frequent, it is imperative that our transit system is emergency-ready. Our environmental justice communities are on the frontlines of these climate change emergencies and deserve adequate transportation to safe hubs in the case of an emergency or evacuation event. Lastly, we urge SANDAG to exceed state mandated targets for emission reduction as climate science says is necessary to prevent the worst effects of climate change. Our region should be a leader and exceeding state mandated targets by one percent is simply not enough in a climate emergency. We appreciate the opportunity to provide feedback on such an important plan.	MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.  Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E117	Kasey Clark	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for GHG emissions reduction, biking infrastructure projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E118	Katharine Harrison	SanDiego350	I truly appreciate the shift SANDAG has taken toward public transit goals, but I think the GHG reduction goals are too low and the transit project timelines too slow for the speed and gravity of the current climate emergency. There is still too much emphasis on roads for private vehicles. Climate change is manifesting itself quickly all around us so our response needs to be big, bold, and fast. A way to cut car emissions, which are about half of the county's total emissions, is with attractive, enhanced public transport that provides easy, efficient mobility for all of us. I taught many years at a small public high school on the campus of City College where students come from surrounding low-income neighborhoods. The school district provides free or discounted youth passes for MTS, depending on their family circumstances, and this has made a huge difference for our students, allowing them to flourish and take college classes early. I've seen the problems that occur when they can't get those passes in a timely manner or the trolleys don't run efficiently enough to help them juggle their time commitments to school, work, and family. The Regional Plan should include free transit passes for all school-age youth and young adults much sooner than 2027, to help them in every way possible join our vibrant economy and citizenry. Furthermore, no-cost passes will encourage significant participation in public transportation and shift expectations for how San Diegans use transit, allowing us to meet more accelerated targets for GHG reductions. We can do better than 40% by 2030 if we act quickly on public transit goals.	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E119	Kathleen Roth	N/A	<p>Reference: Project 644885 Coastal Rail Trail SDP</p> <p>As an avid road bike cyclist (non-E-bike) who rides over 5,000 miles per year including a weekly ride on Gilman Drive between the new Rose Canyon Bike Path (thank you!) and UCSD, I would like to offer the following comments on the Coastal Rail Trail project:</p> <ol style="list-style-type: none"> <li>1. The sidewalk continuation appears to be a good feature.</li> <li>2. Uphill/northbound cycle track between I-5 off ramp and Via Alicante is probably okay.</li> <li>3. There are too many crossing conflicts north of Via Alicante and entire length downhill/southbound to trap cyclists in bikeway with no escape route, especially considering typical relatively high speed of cyclists (20-30+ mph) on downhill portion. E-bike speeds uphill are a concern, too.</li> <li>4. If cycle track project goes ahead, please include sharrow and "Bikes May Use Full Lane" signs so motorists know cyclists riding in the travel lane are not doing anything illegal.</li> <li>5. The barriers themselves are crash hazards to cyclists and the restart of barriers after each driveway is especially dangerous.</li> </ol> <p>Thank you for allowing me to comment on the project.</p>	<p>While the Gilman Drive alignment is on the Adopted Regional Bike Network included in this Regional Transportation Plan, the specific project you're referring to is on the City's CIP list to begin construction in 2022. Your comments might best be noted and addressed by the implementing agency - the City of San Diego, please see webpage here for contact information: <a href="https://cipapp.sandiego.gov/CIPDetail.aspx?ID=S00951">https://cipapp.sandiego.gov/CIPDetail.aspx?ID=S00951</a>.</p> <p>Your comment was forwarded to the City of San Diego.</p>

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E120	Kathy Rudie	N/A	<p>SANDAG's road tax must be stopped. It would be double taxation and an invasion of our privacy. We (Californians) already pay high gas and DMV taxes to maintain our roads. How about taxing just the electric car owners? They do not pay the gas taxes at the pump and are using our roads. We do not need to be tracked by the government, we are already spied on enough.</p> <p>Are our all our current taxes (DMV and gas) actually going to maintain our roads? If they are not, maybe those loopholes need to be closed and get our money going to where it s intended. ( Same for the lottery money- but only going directly to our schools)</p>	<p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.</p> <p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>We understand there are concerns around the privacy and implementation of a road usage charge. There are several ways to implement a road usage charge without the use of tracking devices in personal vehicles. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public's privacy.</p>
E121	Kathy S	N/A	Need bathrooms.	The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.
E122	Katie Meyer	SanDiego350	<p>While I want to thank the staff at SANDAG for their progress in addressing climate and equity in this Regional Transportation Plan draft and for drafting the boldest plan that SANDAG has ever proposed. However, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>As a lifelong transit rider, 24-hour service and increased transit frequency are especially important to me. When I was in school, I would often spend 4-5 hours a day on busses and trollies to get to Grossmont and then work in Pacific Beach. When I had late classes or late meetings, not having frequent busses and trollies would mean I would add 30 minutes to an hour to my daily trip, often waiting by myself in the dark for the next bus or trolley. Many people in San Diego have similar experiences with transit making it especially unpractical for those with night classes and those that work nights.</p> <p>We must make the transit system fast, frequent, reliable, and accessible by increasing passenger capacity, hours of service, and frequency on popular lines. This means 24-hour service and 10-</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p>

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E123	Katie Trist	A Better Life Together/El Cajon Collaborative	<p>minute frequency on many popular bus and trolley routes to connect people to jobs, school, and more.</p> <p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>You mentioned people under 24 getting free or cheaper rides I think is a wasted resource. Colleges often have their own transportation and many people under 24 still live with parents instead, I think cheaper/free rides for people who use CalFresh or MediCal would be a much better way to use resources to provide free rides.</p> <p>It was a nice presentation.</p> <p>Also VA has lanes that can go either way and often it did not help with traffic. Has there been review of other cities that have HOV lanes in both directions?</p>	<p>Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio asegurará que las partes interesadas públicas tengan la oportunidad de expresar su opinión sobre las alternativas. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los jóvenes menores de 19 años.</p> <p>***</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>The proposed managed lanes system includes reversible lane concepts to accommodate peak directional traffic on specific corridors. This concept is similar to the Interstate 15 Express Lanes which includes other policy (example: HOV 2+) and pricing requirements. The lanes are dynamically managed through the use of technology to provide faster travel times for transit and other priority access vehicles. More information on Complete Corridors can be found on <a href="http://SDForward.com">SDForward.com</a>.</p>
E124	Kelli Dumas	N/A	<p>I am against the proposed “miles driven tax”! This tax will negatively affect the hard working families of San Diego County.</p> <p>Getting back to work post pandemic is already challenging enough for most families. These proposed taxes are not fair nor are they necessary.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues.</p>
E125	Kelly A Lyndo	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>In particular, it is critical accelerate GHG reduction goals: Meet the required greenhouse gas emission targets, and ensure measures get us to those goals using federal and state funds available to create high-quality union jobs. Climate change is accelerating, and we are currently seeing the results, which are especially devastating to environmental justice communities. We can’t wait any longer to take the actions needed, so our families and our children have a livable future. The emissions reduction goal in the plan of 40% by 2030 is inadequate in addressing the climate crisis.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
E126	Kelly Nytes		<p>I urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under and seniors 55 and older receive priority when Transit Fare Subsidies are allocated.</p> <p>Youth are often dependent on public transit to access school, enrichment opportunities such as museums, internships, and jobs. Economically challenged families are more likely to be able to take their children to medical or other appointments and to access opportunities in San Diego.</p> <p>In addition, early positive experiences with public transit increases the likelihood that individuals will choose this environmentally friendly option as adults, reducing traffic congestion and emissions.</p> <p>Seniors, too, may become dependent on public transit if they lose the ability to drive safely or face</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>



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			<p>financial challenges on fixed incomes. Having their fare covered would increase the freedom of seniors to be able to access shopping, medical offices, and cultural opportunities.</p> <p>Please amend Appendix A for youth and seniors, supporting their access to transportation while encouraging environmentally friendly options.</p>	
E127	Kelsey Pickert	Surf Rider Foundation	<p>Hi, I am with the San Diego Surfrider Foundation. I am writing because I wanted to thank the staff at SANDAG for their progress around transportation in this RTP. However, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>Additionally, create and fund an anti-displacement strategy to protect vulnerable communities living near transit corridors by preserving existing affordable housing, encouraging community ownership, and protecting tenant rights as well as developing new affordable housing.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
E128	Kieanna Huerta	N/A	More transportation.	Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.
E129	Kim Heinle (on behalf of various commentors)	Bayside Community Center	<p><b>**Comments from Bayside Community Center Senior Luncheon (July 9, 2021) with 3 attendees/commentors. Comments submitted to SANDAG via Bayside Community Center**</b></p> <p>[Comments pertaining to South Bay to Sorrento Comprehensive Multimodal Corridor Plan] Free Passes / Low cost day trips are needed. There should be lower costs for kids or free for children under 5 years old. The bus line was cut in out neighborhood (Linda Vista) and we would like it back! Low emission busses are a great idea. They're better for the environment and better for people with respiratory problems. This project is good for people to reach their destinations. There should be more small busses to transport people to main streets for transferring. Where will the stops be along the project corridor?</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>Specific transit stops along corridors will be defined in project level planning and analysis.</p> <p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a>.</p>
E130	Kim Heinle (on behalf of various commentors)	Bayside Community Center	<p><b>**Comments from Bayside Community Center Senior Lunch Program (July 27, 2021) with 21 attendees/commentors. Comments submitted to SANDAG via Bayside Community Center**</b></p> <p>What they like about transportation: 5-minute regular bus frequency; connection and transfer to Downtown SD from Linda Vista; making Linda Vista walkable; direct bus to the airport</p> <p>What they dislike about transit/transportation: traffic congestion on the freeway; potholes; disobedient drivers</p> <p>What they suggest as improvements needed in the Draft Plan: -Rides for seniors who can't drive - Build homeless shelters / Housing near transit stations - Add more bus lines. Give more attention to busses and less to trolleys - Ensure there are earlier bus times and more options for weekend riders - Add more share at bus stops. Its too hot! -Make an express bus route from Linda Vista directly to Downtown San Diego.</p>	<p>SANDAG acknowledges that action is needed now to provide fast, frequent, reliable, and accessible transit, especially seniors and aging populations. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities such as Linda Vista. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights. Additional information on increased frequencies and spans of service for the transit system has been added to Appendix A.</p> <p>SANDAG will also be conducting pilot programs for the implementation of Flexible Fleets and other micro-mobility options to help connect people connect to the transit network. Information regarding Flexible Fleets can be found in Appendix A and N. Addition materials can be found at: <a href="https://sdforward.com/docs/default-source/2021-regional-plan/5039-sdfrpvisionfivebigmovesonesheets-flexible-fleets-june2019_final.pdf?sfvrsn=79d3f865_2">https://sdforward.com/docs/default-source/2021-regional-plan/5039-sdfrpvisionfivebigmovesonesheets-flexible-fleets-june2019_final.pdf?sfvrsn=79d3f865_2</a></p> <p>SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will</p>

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			<p>-Add a Linda Vista “mini-bus” community transport                      - Limit housing right on trolley lines (Its too loud).</p>	<p>include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
E131	Kim Heinle (on behalf of various commentors)	Bayside Community Center	<p><b>**Comments from Linda Vista Collaborative meeting (July 21, 2021) with 13 attendees/commentors. Comments submitted to SANDAG via Bayside Community Center**</b></p> <p>Regarding hours of operations, public transit must be operational throughout the night to accommodate workers, students at collage, SD’s growing workforce, etc. The duration of the services must be extended.</p> <p>I’m excited that these projects are happening. They’ll help our families connect to greater resources, including recreational activities.</p> <p>-This looks really cool. Regarding hubs, how many will there be? Regarding cost, will there be an added gas tax or how will this funded? Make sure this is properly designed.</p> <p>- Regarding incentives, encourage people to ride public transportation, like in the County of SD does w/ 100% reimbursement</p> <p>-Regarding hubs, let’s use the open space as a place to bring health resources to the people, things like farmers markets, farm stands w/ EBT access, COVID vaccines, health screenings, and public health measures. Collaborate as agencies. Bring the resources TO the community at these mobility hubs. Meet them where they’re at.</p> <p>- Connect SDMTS passes with public benefits. So if they qualify at a certain percentage of FPL, subsidize the ridership pass.</p> <p>- I’m excited that these projects are happening. They’ll help our families connect to greater resources, including recreational activities.</p> <p>- Make sure this is accessible for youth (Youth Opportunity Pass) so kids can move freely and parents don’t have to worry. Connect youth with places of recreation.</p> <p>- Invest more in bus lines. Slow down traffic and give it to the busses. Dedicated bus lanes are worthwhile investments. Invest in the speed of the bus to make it more attractive while disincentivizing private vehicle travel.</p> <p>- Concern re: hours of operation: public transit must be operational throughout the night to accommodate workers, students at college, SD’s growing workforce, etc. The duration of the services must be extended.</p> <p>- Re: purple line: Why are we designing 10-30-mile distance commutes instead of housing people where they work, go to school? We need to add density and to add it where people work.</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, has been added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>Thank you for the comment. Each regional mobility hub coverage area was identified based on a variety of factors including existing and projected population and job growth along with information on where and how people travel. Funding mobility hubs is a truly collaborative effort between SANDAG, local jurisdictions, transit agencies, private developers and employers, and more. Given the large number of mobility hub stakeholders, innovative public-private partnerships can be forged to fund, design, and implement various aspects of mobility hubs including stations, complete corridors improvements, and other mobility hub amenities.</p> <p>The Mid-City Trolley Line (Purple Line) is included as the first major new rail project in the Plan and will serve the north-south travel needs in Sorrento Mesa, National City, Kearny Mesa, and University Heights. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is completing a more detailed ridership analysis of this route. The analysis is studying an alignment that would include stations in City Heights and at San Diego State University (west campus).</p> <p>Additionally, Rapid services are planned that can use dedicated roadway space to increase speeds and avoid congestion. The vast majority of these Rapids also are planned in near-term phases of the Plan.</p>
E132	Kim Heinle (on behalf of various commentors)	Bayside Community Center	<p><b>**Comments from Bayside Community Center Senior Luncheon (July 9, 2021) with 4 attendees/commentors. Comments submitted to SANDAG via Bayside Community Center**</b></p> <p>[Comments pertaining to South Bay to Sorrento Comprehensive Multimodal Corridor Plan]                      All four answered in the affirmative (“good” or “agree”) to the four questions below:                      1) Do you agree with the plan of zero emission vehicles? Why?                      2) Do you feel safe when walking on the sidewalk or crossing the street? If not how can we improve it for you?                      3) Do you agree with creating more bus routes? Do you agree with creating rapid bus lanes?                      4) What do you think about the street quality in the city that you are living in?                      One of the seniors elaborated on Q#1, saying that zero emission vehicles are “good for health and the environment.” He and one other ...                      ... senior also responded “Safe” to Q#2.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E133	Kimberlyn Caywood	SanDiego350	<p>I’d like to take the time to thank SANDAG for the progressive new actions it has taken to ensure that more San Diegans have access to public transportation. However, I would like to encourage</p>	<p>SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s housing incentive program will</p>



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			<p>you all to implement anti-displacement strategies to keep communities intact as much as possible. Prioritizing existing affordable housing, creating new affordable housing, and protecting the rights of tenants are all crucial in maintaining current communities. Additionally, creating a public transportation system that is available 24-hours is necessary as well. A bus at 10-minute increments makes public transportation just as fast and a convenient option as a car, and therefore would increase usage of it.</p>	<p>include development of a regional anti-displacement strategy, consider climate change and resiliency, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p> <p>The 2021 Regional Plan includes increased service spans (longer hours of service) for the trolley and buses up to twenty hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24 hours.</p>
E134	Kip Lund	Sunrise Movement	<p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery.</p> <p>No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego.</p> <p>No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities.</p> <p>Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.</p> <p>I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E135	Kristin MacLeod	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E136	Kyle Bright	SanDiego350	<p>SANDAG staff deserve every thanks for the work they do and for drafting a Regional Transportation Plan that bucks failed policies and reorients our county towards combating inequity and climate change. That being said, this plan still doesn't meet the severity of the crisis we face and still leaves a viable future in San Diego out of reach for people like me.</p> <p>I live in eastern Oceanside and unfortunately can not drive. My home is about 20 minutes walk away from a Sprinter station and 7 minutes walk away from a Breeze Route 318 station that runs</p>	<p>Thanks for your comments!</p>

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			<p>every hour. I know that this is better access to transit than most Oceansiders and San Diegans in general can count on, but that didn't mean much for me this past year as an essential worker on night shift as I was forced by limited transit to spend nearly 1/3rd of my monthly income on rideshare services. And I'm not the only coworker and neighbor facing this dilemma. Transit does not run 24 hours a day or provide frequency of service that aligns with working two jobs, attending school, or childcare.</p> <p>So please reevaluate the RTP to move faster in meeting targets for emissions reduction, increase funding to transit projects, and expand the hours of service and frequency of transit. We can not miss this opportunity for change and aggressively building a better more livable county. Current and future San Diegans like me are counting on it.</p>	
E137	Lanny M	N/A	<p>What an absurd money grab. We already pay plenty of taxes to pay for under used public transit. Trolleys and busses that are nearly empty running to destinations that avoid housing areas. It's just unconscionable that you plan to rob San Diegans again.</p>	<p>Thank you for your comment.</p>
E138	Laura Cunningham	SanDiego350	<p>Immediate changes to halt the climate crisis should be the priority. An emphasis on good, frequent, cheap public transportation is imperative. Get away from individual cars!                      Making public transportation free for low income, disabled, seniors and students.                      More frequent public transportation between North County and San Diego.                      More options from train stations to major business and office areas.                      TRULY affordable housing near transportation centers, and centers near high density housing areas.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resiliency, consistency with the transportation improvements included in the Regional Plan, and alignment with other SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
E139	Laura Gonzalez	N/A	<p>A mobility hub in our community (So. East San Diego) preferably located at our current Orange Line Trolley station. Youth passes given to youth under 24.</p> <p>Fiber optics underground to ensure we are ready for state of the art transportation system that is in the design stage, (iOS systems/smart phones) and to more appropriately address the digital divide in our "Redlined communities".</p> <p>Covering our MTS bus stops. (Structures/bus shelters.)</p> <p>Consider 24 Hour service on the lines that are taking our residents to work.</p> <p>Focus on transforming to an all electric bus fleet in the first 2-3 years of implementation. Improve the frequency and reliability of our bus routes.</p> <p>Ensure all our streets are designed with the "Complete Streets" designs.</p> <p>Increased maintenance of the trolleys and buses proportionate to the heavy usage in our areas (Southeast area of the City of San Diego.)</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E140	Laurel Smith	SESD	<p>As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E141	Leah Schaperow	BikeSD	<p>Comments regarding RTP                      I moved to San Diego a few years ago and left my car behind, replacing it with an electric bike. San Diego is the perfect place to ride because of the wonderful weather year round. I have seen</p>	<p>The bike network shown in the plan is the Adopted Regional Bike Network, which was adopted in 2010. As an early action out of the Regional Plan, SANDAG will develop a new Active Transportation Plan. Although the original plan considered topography, we will</p>

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			<p>positive changes in more protected infrastructure for bikes, but it hasn't been enough and it has been too slow. I still hear in the news, from friends &amp; family about deaths of people on bikes and pedestrians. I own a small business in Liberty Station which I commute to daily from Hillcrest by bike. My bike keeps me healthy and keeps my transportation costs low. I tried to take public transportation for my commute, but the public transportation to and from Liberty Station is sadly lacking. I support Vision Zero, and hope that more people will feel comfortable and safe choosing to ride a bike for transportation. Safety, physical health, and mental health must be the priority over getting somewhere faster.</p> <p>Everyday I continue to choose to ride my bike because of the benefits to myself and my society in the beautiful city of San Diego.</p>	<p>take a fresh look in the new one. With the ever increasing popularity of e-bikes, we do feel it is important to build bike network in both flat and steep areas so provide as many network connections as possible. Additionally the prioritization will include more recently completed and near-term transit projects to facilitate connections like those you mention.</p>
E142	Leah Schaperow	SD350	<p>I ride my bike to commute to Liberty Station. I ride my bike to get groceries, wherever I go I ride my bike. I do not own a car and public transportation does not always go where I need to go when I need to be there. Please move faster to keep me safe on the road.</p> <p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>SANDAG follows national and international best practices in bikeway design to create safe facilities for users of all ages and abilities. Every project goes through a detailed and context sensitive design process which results in decisions regarding the best facility, which may include protected bikeways, buffered bikeways, shared use paths, or shared streets with significant traffic calming elements. The Regional Plan also includes funding for upgrading existing bikeways that may not meet current best practices in maintenance or bikeway design.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
E143	Leeya Appleby	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT.</p> <p>The 5 Big Moves will enhance connectivity and result in people having more travel options and operating solutions, reducing per capita VMT. Local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan. Appendix B includes the near-term actions that SANDAG will work towards achieving these goals. Many of which are anticipated to begin work immediately after the Plan adoption.</p>
E144	Leslie Bridges		<p>As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E145	linda redenbaugh	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005</p>

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			<p>the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>I took the bus everywhere I needed to go. I spent most of my free time waiting for the bus. And if it didn't go where I needed to go, I wouldn't go. You try taking three buses to a colonoscopy and home again afterwards. There wasn't even a bench to sit on. I had to sit on the curb in Kearney Mesa.</p>	<p>levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E146	Linnea Dayton	N/A	<p>As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse gas emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of the San Diego region. I support timely rapid transportation for all San Diego County community members, so they can conveniently access jobs, businesses and community services.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E147	Lori Mendez	San Diego 350, Sierra Club, The Climate Reality Project	<p>I am with San Diego 350, Sierra Club, and The Climate Reality Project. I drive a Nissan Leaf and power it with solar panels (during the sunlight hours). I am also an avid walker, hiker, cyclist, and outdoor enthusiast.</p> <p>I am writing because I want to thank the staff at SANDAG for their progress around transportation in this RTP.</p> <p>As you know, we are in a race against time. Accordingly, this plan must move more quickly and efficiently to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>Accelerate GHG reduction goals: Meet the required greenhouse gas emission targets, and ensure measures get us to those goals using federal and state funds available to create high-quality union jobs. Climate change is accelerating, and we are currently seeing the results, which are especially devastating to environmental justice communities. We can't wait any longer to take the actions needed, so our families and our children have a livable future. The emissions reduction goal in the plan of 40% by 2030 is inadequate in addressing the climate crisis.</p> <p>1. Accelerate transit improvements: Accelerate the timeline for all transit (trollies, buses, rail) and biking infrastructure improvements and prioritize the Environmental Justice communities that need transit solutions the most. Environmental Justice communities, who disproportionately suffer from the effects of climate change, cannot afford to wait; they need immediate improvements while the long-term infrastructure projects are being planned. This means no new roads and specifically accelerating the purple line and collaborating with MTS to improve the blue line that serves these communities. This also means transitioning transit to zero-emission vehicles.</p> <p>2. 24-hour service and increased transit frequency: Make the transit system fast, frequent, reliable, safe, and accessible by increasing passenger capacity, hours of service, and frequency on popular lines. This means 24-hour service and 10-minute frequency on many popular bus and trolley routes to connect people to jobs, school, and more.</p> <p>3.Improve transit amenities: Make immediate improvements to amenities at transit stops, including benches, shade from the elements, and bathrooms that are accessible according to ADA regulations. Improving transit amenities and ensuring safety of riders increases ridership and is crucial to providing our disabled community access to public transportation in an equitable way.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS is working to provide shelters throughout the region. Bus shelters are provided wherever there is sufficient right of way to locate them. Any new infrastructure build would include shelters. Complete Streets designs are an important component of SANDAG's planning today and will be included on projects in the future. As part of larger infrastructure projects like Next Generation Rapid, Trolley and Commuter Rail, all stations will have shelters. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>The transit network that has been developed for the Regional Plan includes faster access to the beach. There are Rapid and Commuter Rail routes that will operate between Mid-City and the proposed Central Mobility Hub. From that location you can seamlessly transfer to routes that will take you to Ocean Beach, Pacific Beach and La Jolla.</p>



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			<p>4. No-cost passes: Provide no-cost transit passes to ALL beginning in 2023, not 2027. No-cost transit passes encourage significant participation in public transportation and help shift expectations for how San Diegans use transit. Additionally there will be less demand for roads and parking, more mobility for people, giving them more range to find employment, leading to more taxable income, Social justice: roads favor only those who can afford cars, but transit is equitable, increased ridership, leading to more and better transit, increased and cheaper commerce since freight delivery has less traffic, GHG reduction, fewer stressed drivers on the road, less road rage, fewer cars mean more safety for all other road users, less pollution means better health, less tax money spent on cars, cars, cars; supporting single-occupancy vehicles is shameful for resource efficiency.</p> <p>5. Equitable service: It shouldn't take hours to get to the beach from City Heights! We can do MUCH better! Source: <a href="https://www.kpbs.org/news/2019/aug/26/city-heights-kids-take-two-hour-public-transit-jou/">https://www.kpbs.org/news/2019/aug/26/city-heights-kids-take-two-hour-public-transit-jou/</a></p> <p>6. Anti-displacement strategies: Create and fund an anti-displacement strategy to protect vulnerable communities living near transit corridors by preserving existing affordable housing, encouraging community ownership, and protecting tenant rights as well as developing new affordable housing.</p> <p>Thank you for your consideration, and more importantly, SANDAG's prompt, effective, efficient, and just action!</p>	<p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
E148	Lorna Delos Santos	Pilipino Workers Center	<p>North city area bus # 306 to and from fall brook needs an additional bus route for the public specially on busy days. Additionally a proper bus stop at many areas in this route is needed specially on hot summer time. To mention one in SR-76 highway corner mission near Daniels market. Submitted by Pilipino Workers Center members who are Caregivers. Priscilla Caringal, Ruby Archean, Nilda Chelonia, Rachel Aquino, Anita Sulangi, April Tellez, Arsenia Fabrigas, Susie Ratana, Cherilyn Apolinario, Carmela Hernandez, Lilia Thomson, and Corazon Canatuan.</p>	<p>NCTD is looking closely at adding service to those areas that are in need, also looking into Flexible Fleet solutions that can bridge the gap in areas that need better service. The Regional Plan includes upgrades to Route 306 in 2029, having buses come every 15-minutes.</p> <p>Your comment was forwarded to North County Transit District (NCTD).</p>
E149	Lorna Delos Santos	Samahan Health Clinic	<p>Temecula should be provided with San Diego Bus Breeze because there are many commuters there who want to get to Escondido to work. Temecula/Murrieta maybe part of Riverside county but most people work In San Diego area. A daily route would help. Submitted by Pilipino Workers Center members/Caregivers : Teresita Vale's, Cecilia Bautista, Bernadette Chaffee, Beth Adonai, Pay Igaya, and Cecilia Jaro.</p>	<p>While the Regional Plan does not currently include new fixed-route transit services north of Escondido on the I-15, there may be some new plans that come out of the North County Comprehensive Multimodal Corridor Plan (CMCP) work currently being considered. Carpool and Vanpool options are provided at the iCommute website.</p> <p>Your comment was shared with the North County CMCP team.</p>
E150	Lorna Delos Santos	Samahan Health Clinic	<p>San Marcos area has a few buses that goes to the next neighboring cities specially in West San Marcos Blvd. area. Bus stops are difficult to locate and would take more than 2 miles to get to the next one. Submitted by Pilipino Workers Center members/Caregivers : Beth Adonai, Joan Gastones, Elvira Corbilla, Nemia , and Elma Movila.</p>	<p>NCTD is looking closely at adding service to those areas that are in need, also looking into Flexible Fleet solutions that can bridge the gap in areas that need better service.</p> <p>Your comment was forwarded to North County Transit District (NCTD).</p>
E151	Lorna Delos Santos	Samahan Health Clinic	<p>San Diego-La Jolla-Carlsbad-Encinitas-National City-Chula Vista. Is there a way an easy access to public transport that traverses in these areas anytime at work weeks? Submitted by Pilipino Workers Center members/Caregivers : Nenita Acson, Mercedita Habagat, Emelita Rigor, June Freeman, Cristina Caracalla, Melanie Patti, Beth Dunn, Nieva Javier, Ronalyn Antic, Richard Soria, Eliseo Bautista Jr., and Emma Cannamasco.</p>	<p>The Regional Plan includes multiple new routes that provide connections between these locations. There is a new commuter rail route that will connect National City, Chula Vista, to La Jolla. Multiple new Next Generation Rapid routes that provide connections through the North County Coastal areas mentioned. All routes are planned to operate every 10 minutes throughout the weekdays.</p>
E152	Lorna Delos Santos	Samahan Health Clinic	<p>Need a clean public restroom at main terminal.            Special curbside for bus to unload/load passengers. Audit the bus stop on Highland Ave and 8th St.            Cover shade for bench.            Avoid putting a bus stop too close to stop light.            Well lit waiting area for night riders for their safety.            Special app to show bus arrival.            Can you color coded the bus?            Install a hand sanitizer dispenser inside the bus.            Some bus stayed longer at bus stop. Waiting for more riders.</p>	<p>SANDAG is working with our transit operators on a bathroom analysis of where to put bathrooms. This will be completed in late 2021. All public transit has shade and seating where it can physically be accommodated. The Next OS system outlined in the plan will work toward developing an app with Next Bus information. The transit operators are in charge of the branding and coloring of the bus, sanitation on the bus, and scheduling.</p>
E153	Louise Potash	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to</p>

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			hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	<p>reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E154	Lyle Pavuk	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E155	Lyn Pratt	Morse High School; Mid-City CAN	<p>I am a volunteer with Mid-City CAN.</p> <p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under, people with disabilities, and seniors. We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>* Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery.</p> <p>* No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego.</p> <p>* No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities.</p> <p>I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E156	Mac Kevin Braza	N/A	<p>I am a UC San Diego student and I usually use my bike, shuttle, and MTS bus to go to school. I will deeply support all Public Transportation projects! This will be very useful for somebody who does not have a car like me.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E157	Madge Torres	SanDiego350	<p>So many of us are unable to afford a car. We rely on Public Transit. Public Transit is inadequate in North County San Diego. Please reduce the cost so we who work for minimum wage, can afford to take transportation to and from work.</p> <p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>Please move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth.</p> <p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation</p>



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				Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E158	Malik Thornton	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E159	Marcelo Ramirez	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E160	Margaret Gelb	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E161	Marguerite Kealey	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including</p>

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				frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E162	Maria Gonzalez	Southern Caregiver Resource Center/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>First of all, I want to say thank you for all those who are behind the scenes making some of the upcoming projects come to reality. Faster and more reliable transportation is a vital change San Diegans need. Bringing greater equity to our transportation system while better serving our lower income communities who rely on public transportation for their everyday needs. I am looking forward to the changes that will happen within the freeway system with more lanes designated specifically for buses. As a community outreach worker, a big number of the clients Southern Caregiver Resource Center do not have the financial capabilities of improving their caregiver situations which are more complicated by the lack of faster and reliable transportation between doctor’s appointments and making it to work on time. I am very excited to see and experience all the changes SANDAG has to offer our communities.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfoward.com">SDFoward.com</a>.</p>
E163	Maria Libia Cabrea	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>Esta bien que haga el transporte gratis paralos jovenes. En la calle Main hacer para bicicletas, y en la calle Madison poner mas stop porque pasan los carros muy fuertes, y tabien hacer lineas para bicicletas y tambien hacer en las calle Broadway poner banquetas mas ampleas. And also, in front of the school Naracanca, poner topes porque pasan los carros muy fuertes y ahi pasas ninos.</p> <p>***</p> <p>Its good that they do free transit for the youth. On Main Street put bike lanes, and on Madison Street put more stops because the faster go very fast, and make lanes, and also on Broadway put wider sidewalks and in front of the school Naranca put cones because the cars past by so fast and that’s where the children cross.</p>	<p>Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio asegurará que las partes interesadas públicas tengan la oportunidad de expresar su opinión sobre las alternativas. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los jóvenes menores de 19 años.</p> <p>Su comentario ha sido compartido con la ciudad de El Cajon.</p> <p>***</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>Your comment has been forwarded to the City of El Cajon.</p>
E164	Maria Navarro	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>Todo el plan que nos dijeron tienen para la ciudad de El Cajon me parecio excelente. Crea eso traira mas trabajo a la ciudad y facilitara el uso de medios de transporte a toda la comunidad</p> <p>***</p> <p>Everything they told us about the City of El Cajon, I think was excellent. I think that it will bring more work to the city, and will facilitate the use of modes of transportation for the whole community.</p>	<p>Gracias por su comentario. Favor de continuar siguiendo el plan regional a: <a href="https://www.sdfoward.com/mobility-planning/2021-regional-plan">https://www.sdfoward.com/mobility-planning/2021-regional-plan</a>.</p> <p>***</p> <p>Thank you for your comment. Please continue to follow that 2021 Regional Plan at: <a href="https://www.sdfoward.com/mobility-planning/2021-regional-plan">https://www.sdfoward.com/mobility-planning/2021-regional-plan</a>.</p>
E165	Marisa Allen	SD350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including</p>

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E166	Mark	N/A	<p>Thank you for all the work that went into this. But I must admit, I'm not a fan of all those managed lanes. That is just crazy! Whoever was developing that part of the proposal wasn't thinking about all the regular people who have to get from point A to B every day - commuters. People in cars, who are most of the tax base here in San Diego, need flexibility. They depend on the government to provide basic services including access to transportation. What if you needed to bring a friend or a special solar cup to access the water easily and swiftly from your tap, unless you want to pay huge fees for every glass? Even if you try to implement this a little at a time I fear it will spark a considerable backlash. I like our elected leaders, but this would give plenty of ammunition for foes. Just don't go there, please!!</p> <p>Many thanks, Mark</p>	<p>The intent of the managed lanes is to create a flexible system that can be managed in real time. This is similar to how the I-15 corridor is currently managed in North County today. Solo drivers will have options to use the lanes but at a price and transit services can travel congestion free. The result is better optimization of the system that encourages higher occupancy travel but with real alternatives that are competitive with driving.</p>
E167	Mark and Cathy Steele		<p>To say we have grave concerns regarding the proposed 2021 Regional Plan is an understatement. Establishing "incentives" to coerce the public to give up their right to use their vehicles is abhorrent; VMT fees, reduced parking, parking and curb pricing, diverting funding from the highway expansion and improvement programs to build multi billion dollar mass transit projects, etc.</p> <p>With your forecast in growth in commuting by mass transit from 3 percent to a very optimistic and very unlikely and measly 12.6 percent? This makes no sense whatsoever. We are already dealing with outrageously high gas taxes and roads that desperately need help. Trying to establish these goals will cause a voter revolt.</p>	<p>Thank you for your comment.</p>
E168	Marquelia Villarreal	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>Hola, soy Marquelia a mi me encanta la junta que tuvimos con munidan del la plan sobre todo por la informacion acerca del transporte publico lo que piasan aser en el futuro en El Cajon todos los proyecto a mi en lo personal me gustaria que nos sigan informando y que siga viendo juntas para saber lo que esta pasando perso tambien me gustaria que si pudiera en a ayudar a la comunidad me lo informara gusto ayudar.</p> <p><b>***</b></p> <p>Hello. I'm Marquelia. I like loved the meeting we had with munidan about the Plan, for all the information about the public transportation and what they plan to do in the future in EL Cajon, all the projects to me personally, I liked that they continue informing and that they continue having meetings about everything that's happening, but also I would like to help the community. I like to provide information to help.</p>	<p>Gracias por su comentario. Favor de continuar siguiendo el plan regional a: <a href="https://www.sdforward.com/mobility-planning/2021-regional-plan">https://www.sdforward.com/mobility-planning/2021-regional-plan</a>.</p> <p><b>***</b></p> <p>Thank you for your comment. Please continue to follow that 2021 Regional Plan at: <a href="https://www.sdforward.com/mobility-planning/2021-regional-plan">https://www.sdforward.com/mobility-planning/2021-regional-plan</a>.</p>
E169	Mary Ann Horton		<p>Thank you for providing this plan and seeking community input.</p> <p>I think the community will be extremely reluctant to sign a blank check for twelve figures. We need proof of what works, with a laser focus on how to most economically solve the problem. You can provide evidence using pilot projects and emulation.</p> <p>You suggest several different solutions, bikes, scooters, high speed trains, ride sharing, managed lanes, etc. The public is very skeptical of many of them, believing the bikes, scooters, and trains will be under-utilized. I share that skepticism. A typical driver needs the flexibility to make stops for errands, picking up kids, etc. They need to carry groceries and stay out of the rain. We're already seeing that bikes are not a solution to transportation, they are a form of exercise and recreation. I'm pretty sure scooters are as well.</p> <p>Here's what I suggest: for each of your several solutions, create a pilot project. Emulate the service with a low-cost, quick-to-create service that will move commuters. Run it for some period (6 months or a year) and see if people will use it. Then you'll have a solid case to build the real equivalent service.</p> <p>High speed trains can be emulated with rapid buses running the same routes and schedules at the projected fares. You might be able to address traffic issues by repainting lanes on existing roads to</p>	<p>The 2021 Regional Plan proposes funding for deploying a wide range of Flexible Fleet services, including microtransit and on-demand rideshare services, to provide greater mobility options. SANDAG will begin launching pilots in 2022 to test different opportunities and applications for Flexible Fleets in addition to infrastructure and technology improvements that support the success of these services.</p>

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			<p>create mini-managed lanes.</p> <p>Microtransit in automated electric shuttles can be emulated with gas-powered human-driven shuttles at the projected fare. You could also subsidize pooled Lyft/Uber rides if they book the rides using your app. You already have data on managed lanes (I-15) and bike lanes (downtown San Diego).</p> <p>I personally believe that microtransit combined with shared rides would be a low-cost high-acceptance alternative to owning a car. It has to get you there in a competitive time with driving, at a fare low enough to compete with driving (56 cents/mile, per the IRS). The “Expanded trip options” graphic on page 29 illustrates this very nicely. This is also the type of service you can quickly and inexpensively emulate for a pilot.</p> <p>Thanks,</p> <p>Poway</p> <p>P.S. Before I retired, I commuted to SDG&amp;E in Mission Valley. That’s impossible by current transit.</p>	
E170	Mary Storm	McGraw Hill	<p>I am writing to let you know my opposition to the Raised Buffer strip on Gilman. I am a 60-year-old “recreational” cyclist that rides that route several times a week and puts in between 100 – 150 miles a week on my road bike. I have been cycling in San Diego for more than 25 years.</p> <p>My issue with the raised barrier is that it is adding a crash hazard. Gilman is wide enough that I have never felt unsafe on either the North Bound or Southbound side from or to UCSD from the Bike path. I have commuted on that stretch on weekdays, as well as weekends. Once the curb is installed there is no way for cyclists to safely pass each other. Also, the bike lane becomes a collecting point for debris because it can no longer be swept away. Glass bottles find their way into bike lanes, and with that curb can’t find their way out. That’s a long stretch with a flat tire, and no place to pull off to fix..</p> <p>I would prefer to see just a painted barrier lane to give cyclists a bit more space.</p> <p>Is it possible for you to pull accident reports from the stretch of the Coast Highway in Cardiff where the barrier has been added and see if more or fewer accidents have been reported before proceeding ? The lane on the Coast Hwy is now a jumble of bikes, walkers, strollers and is so dangerous I prefer to take my chances with the cars. I know that wasn’t your intent, but if you were to go observe that lane at various times of the day you would see the outcome.</p> <p>I feel like there are many other better ways to use these funds.</p> <p>One thing that does need to be added is some sort of indication to motorists coming off Northbound 5 at Gilman to watch for cyclists crossing onto the bike path. Cars frequently blow past limit line, blocking the access to the entrance to the bike path. Or they plan on turning right on red and directly into our path. Their line of sight up the hill is blocked as we come out from under the 5, and we are moving fast due to the downhill. Perhaps make that a “no right on red”?</p> <p>Thanks for your time, I do appreciate what you are trying to do – make San Diego a first-class city for cycling !</p>	<p>While the Gilman Drive alignment is on the Adopted Regional Bike Network included in this Regional Plan, the specific project you’re referring to (or specific extents / intersections) is within the project limits of the City’s CIP project estimated to begin construction in 2022. Your comments might best be noted and addressed by the implementing department within the City of San Diego, please see webpage here specifically for the Project Manager’s contact information at: <a href="https://cipapp.sandiego.gov/CIPDetail.aspx?ID=S00951">https://cipapp.sandiego.gov/CIPDetail.aspx?ID=S00951</a>.</p>
E171	Maureen Hartin	Volunteers in Medicine/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>Reviewed the plan and think it will work well for the East region.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E172	Maya Enciso	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to</p>

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				increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E173	Melodee Tuskagie	Jamul First Methodist Food Pantry/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>You don't detail plans for straightening roads. What roads are you talking about? Those of us in rural areas pay the taxes, but we don't get the benefits.</p> <p>What are you doing to make our roads safer? Look at Camp Road in Rancho San Diego area: the lanes go away right where they are needed to be available - specifically between the intersection of Camp Rd/Jamacha Blvd and Avocado Ave.</p> <p>Also, we need passing lanes on Hwy 94 from Campo Rd down to Otay Lakes Rd. There are reports of multiple incidents of cars passing other vehicles using the right shoulder, crossing the double yellow line into oncoming traffic.</p> <p>Quit putting in bike lanes, especially where they are not needed or wanted. The back country roads are not meant for multiple bike riders - especially if they can't follow the laws about riding in single formation - 4-5 bike across a well-travelled road is pure idiocy.</p>	<p>Lane straightening improvements are included on the following corridors: State Route (SR) 76 from Rice Canyon Road to Pala Reservation and Harolds Road to Pauma Rancho. SR 94 from Jamul Reservation to Tecate Road, And SR 67 from Mapleview to Dye Road.</p> <p>SANDAG will continue to work with our partners to identify projects that improve safety along our region's roadways.</p>
E174	Michael Petrivelli	SanDiego350	<p>Your proposed plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>I ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. Thank you.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E175	Michael Verdu	Resident (Encinitas)	<p>Following up on my email from June 6 (below). I wanted to offer a constructive suggestion for how to move forward:</p> <p>Rather than ask for an up-or-down vote on funding the entire 2021 Regional Plan, why not unbundle the largest and most controversial part of the 2021 Regional Plan - the new commuter rail system and its stations - and ask the voters to fund that separately?</p> <p>There are a lot of projects needing funding that will likely get much broader community support, such as moving the railroad tracks off the bluff in Del Mar (to the degree that SANDAG contributes funding for that project), building and maintaining the Central Mobility Hub (providing connectivity from the existing rail infrastructure to the airport), improving roads and bridges, and building new trails. It would be great to increase Coaster and Sprinter frequency and improve bus service to existing train stations. Roll up all of these projects and put them on the ballot as "Phase I", funded by a simple increase to the sales tax. Then make a separate ask of the voters for the commuter rail system and network of stations, as "Phase II", which would also include the specifics of the per-mile fees (how they're assessed and collected) as well as the additional increase in sales tax needed to fund the projects.</p> <p>By breaking up the vote and funding, you'll increase the odds that many critical projects get the money they need sooner, while also getting a clean read on how your community feels about the big new vision for commuter rail and the future of regional transportation behavior. If San Diego</p>	<p>Once the proposed final Regional Plan is adopted, implementing the components in the plan will require many phases that will likely result in going to the voters multiple times to fund different components of the plan. Regarding a road usage charge, SANDAG staff will initiate a study in the next year to work with Board Members, stakeholders, and community members to develop implementation strategies, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. Your comments will be considered as SANDAG considers how to bundle different projects and initiatives as we work towards implementing the plan.</p>



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			<p>wants to bet on commuter rail and a multi-modal hub-and-spoke system as the heart of the region's transportation future, then great. And if not, then you don't lose all the other good stuff if and when the voters reject that bigger vision.</p> <p>It would be tragic if the badly needed projects that had the potential to garner more community support were held hostage to the hugely ambitious commuter rail system.</p> <p>Sincerely,</p> <p>Resident, Cardiff-by-the-Sea</p>	
E176	Mike B		<p>I just would like to ask why would anyone with any intelligence ask for more taxes based on how much you drive?</p> <p>The tax on 1 gallon of gas for the amount of vehicles on the road should be an ample amount to take care of business. The people in charge of the money obviously don't know what they are doing already. Why would we give more money to be mismanaged?</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p>
E177	Milena LaBarbiera	SanDiego350	<p>I am a current resident of San Diego. While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, we are asking that certain changes be made and that we accelerate this plan to more effectively meet the goals of achieving climate justice.</p> <p>As a young working professional living in San Diego, I rely on proper public transportation to get me to my job and to perform other tasks, such as grocery shopping. We ask that this plan includes 24 hour service and more frequent service so that those who rely on public transportation, like myself, are able to get to their jobs quickly, safely, and without needed added stress.</p> <p>Additionally, we must accelerate this transportation plan because we must combat environmental injustices in our community. Communities of color are the hardest hit by the effects of climate change, and we all deserve to live in a clean, safe, and healthy environment. It is imperative that we take faster action against climate change to protect all people, especially the communities that are the most vulnerable.</p> <p>Thank you for reading my statement. I hope that my words, and those of the other people who have submitted comments, will resonate you, and you will take action to incorporate our asks.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the draft 2021 Regional Plan Appendix H. This list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p>
E178	Molly Boyd	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to</p>



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			hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	<p>reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E179	Monica Leyva	Health Net, Covered CA/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>I am very excited to see the future plans coming to San Diego in the next few years. The current projects to help with technology and transportation look great. I approved of the great strategies they will implement to help the county.</p>	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E180	Myeshia Williams	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E181	N/A	N/A	If you are taxing cars for usage of road, you need to tax bicycles...they use roads and have lanes. Tax them too!!!!	The road usage charge is intended to replace the revenue losses from gas taxes in recent years due to more fuel efficient vehicle technology and electric vehicles. Gas taxes are implemented to fund the maintenance and operations of our current transportation system resulting from wear and tear from regular vehicle use, as well as unrealized costs of carbon emissions on the environment. Roadway wear and tear by bicycles is negligible and zero carbon emissions. Currently, gas taxes do not apply to cyclists and the proposed road usage charge would be expected to continue that practice.
E182	Nanci Kelly	SanDiego350	<p>I am submitting this comment on behalf of all the individuals who would like to utilize public transit in San Diego but require improved services and prioritization of the needs of the public, particularly young people. Many years ago I tried to take the bus to work (fortunately, OB still has good bus line access, at least to begin or end ones journey) in the Mission Valley area however a 15-minute drive became a 2-3 hour bus trip (each way!). This is untenable for people who have multiple life/schedule commitments. San Diego has made very little progress in the 50+ years I have lived here and now we have the additional knowledge of the need for public transit to meet the climate crisis. While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
E183	Naomi Raffel	Crawford High School	Our students deserve an equitable education. They have to be able to get to school for this education. I urge you to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for ages 24 and under receive priority when transit fare subsidies are allocated.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies

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				for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
E184	Nastassia Patin	SD350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>Particularly in light of the recent tragic cyclist deaths, San Diego is long overdue for streets that are designed for people, not cars. Expanding freeways and encouraging single occupancy car travel directly conflict with the urgent need to expand and encourage alternative transit. Please treat the need for transit with the urgency it deserves when we consider the climate and safety goals of San Diego.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E185	Natalie Mladenov	N/A	<p>I have watched the videos about the new 2021 Regional Transportation Plan. As a North County resident, I support this plan. In particular, there is a tremendous need to invest in safe ways for kids, families, everyone to use alternate transportation like bicycles and rapid transit systems, to get around, and especially in low income parts of San Diego where we have NOT yet invested with safe bike lanes and other measures. It is also important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E186	Nicholas Norcross	SD350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E187	Nicole Burgess	BikeSD	<p>Comments regarding RTP</p> <p>For background, I am an active commuter and travel daily by bike. I am a board member of BikeSD and a participating member of QOL. I appreciate the time and opportunity to comment on the 2021 RTP and the dialogue with staff on a regular basis. I applaud the new leadership that has brought new direction to the agency and the overall approach to transportation with more transit.</p> <p>These are my personal comments, however, I will often say we, which identifies the greater number of people that bike and the organizations that support a healthy active transportation network. I support the goal of Safety and am grateful that Vision Zero is part of the RTP framework. Safety must be the priority for every project that is initiated and implemented. I support an equitable plan that prioritizes transportation justice, therefore support the SD Transportation Equity Working Group Transit Line recommendations. I would like to include and stress an important 11th bullet point; the implementation of safe access to transit and ensuring the first and last mile to transit is part of the Mobility Hubs and RTP. With safe active transportation access to transit stations, research has shown that transit ridership can increase 7-12x.</p> <p>"It is often hard to advocate for something if you have no idea about it" This is how I feel with folks from disadvantaged communities, the general public, and even much of the SANDAG staff. As an active commuter that travels daily by bike, I have a full understanding of the benefits and joys of commuting by bike. I know the challenges and I know that San Diego has the potential to be an</p>	<p>The 2021 Regional Plan includes a number of investments in active transportation including the regional bike network, local bike projects through local streets and road funding as well as complete street investments in mobility hubs, mobility hub amenities (including secure bike parking and e-bike charging), e-bike incentive program, and Vision Zero programs. In addition, Appendix B describes implementation actions for the Regional Plan, which includes a Regional Active Transportation Plan (including updated Regional Bike Plan), Comprehensive Multimodal Corridor Plans, Regional Vision Zero Action Plan (including Regional Safety Policy), updating SANDAG grant programs, quick build program for complete streets, and transportation demand management grants and incentives.</p> <p>In developing the mobility hubs, SANDAG ensured each military base is immediately adjacent to a mobility hub area. The proposed final 2021 Regional Plan includes bathrooms at new rail stations and a bathroom access study as a near-term implementation action. The 2021 Regional Plan includes a tunnel for the tracks to be moved from the Del Mar Bluffs.</p> <p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from</p>

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			<p>amazing bike mecca where ridership exceeds all expectations. Unfortunately this RTP fails to capture the true value of bikes in such a beautiful city with perfect weather all year round. San Diego has large amounts of street space that can be reallocated to active commuters and we have a large amount of residents that are interested in commuting by bike, especially with the innovation of ebikes. This RTP fails to integrate bikes with transit and capture the true value and synergy of biking. It is unfortunate that this RTP is focused primarily on transit, EV's and shuttles that will one day be autonomous. This RTP fails to have a vision for a large number of folks choosing to go by bike since it lacks an updated bike plan that captures the ridership needed to meet the City of San Diego's Climate Action Plan. It is extremely important for SANDAG and the City of San Diego to update their bike plans so that we can maximize the opportunities and increase ridership. There needs to be grand vision for safe and secure bike parking throughout the region as this is an important component of supporting people who bike.</p> <p>It is hard to see what has been changed for active transportation from previous RTP's. Funding has not changed, projects have not changed with the exception of the addition of the Chollas Creek Regional Park and bikeway. We appreciate this addition as we believe this is the most equitable active transportation project in the region and will drastically improve mobility and outdoor access for the communities that need it most. They deserve a separated and connected bikeway and the 7 miles from La Mesa/Lemon Grove to Downtown would be an amazing asset to our region.</p> <p>I do oppose highway widening for any purpose and am not in favor of the new transit station to Camp Pendleton. I would like to see the ridership numbers and modeling for this station. I personally believe that a safe connected bikeway to this area would be far more beneficial for all. The military is a huge base of commuters in San Diego, approximately 30%, and I believe this plan fails to support this demographic of commuters. With a close partnership, the military can be the leaders of changing the way we move in San Diego. These are the men and women that can protect our homeland while staying physically fit and strong, to meet their goal of Military Readiness. Please discontinue using the word "Faster". Speed kills and is not supporting Vision Zero.</p> <p>I do believe the strategies and programs will be a critical component to change cultural car centric habits in San Diego. I encourage a Healthy Commuter Incentive Program to provide incentives for residents to change the way they move. Charging for parking and congestion pricing will also be extremely effective in changing behaviors. Let's start with 163 as it goes right through our beautiful Balboa Park. This corridor should have BRT with adjacent walking and biking trails. Charging for all curb space and keeping vehicles out of city centers will be critical for vibrant transit friendly communities.</p> <p>Mobility Hubs everywhere with connected bikeways for safe healthy access is so critical. These mobility hubs do not need to be grand; consider a basic stop with shade and seating provided by a structure that has solar power, lighting and electric bikes available as part of the transit system. If the station is well used then a bathroom would be recommended. Health and maintenance of our residents and roadways needs to be considered. When one person uses a bike in lieu of a vehicle (ICE or electric) the benefits are grand and it is unfortunate your modeling is not capturing the positive outcomes of active transportation.</p> <p>Improved health, very little air or noise pollution, streets stay in better condition, people have an opportunity to engage and be social, and our residents and city become safer, healthier, cleaner, and more resilient city.</p> <p>EV's are Not the answer. Electric Bikes Are! As far as Grand Central Station, it can help transform the Midway District, but it is a big expense that does not have a great ROI. I personally believe the station should be closer to the proposed Laurel location with a people mover connecting to the Airport and beyond to Liberty Station, military bases in PL, and the beach area. Above ground air trams, people movers, would be a great addition in San Diego. Tourists and residents would love it. Our scenery and viewpoints around the waterfront are amazing and we should be capitalizing on the beauty. An air tram to and around Balboa Park would be fantastic. I personally am not a fan of an underground subway however I would highly recommend the boring technique to be used for creating safe bikeways across/under our most difficult crossings at highways and waterways. This should be a primary use of underground technology.</p> <p>At this point I would not support a tax measure to fund this plan as it does not properly address the</p>	<p>passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>

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			<p>immediate climate crisis and needs of community members that are suffering the most. The current bike plan is only 3% of the total cost of the entire regional plan. With the low cost to fund and implement a complete connected bike network, these projects should be a priority and be implemented as soon as possible and should be completed by 2035.</p> <p>I support the Coastal Rail Trail and appreciate separated facilities away from the noise and pollution of vehicle traffic. When the tracks are moved from the Del Mar Bluffs and the tunnel is created under Miramar, we recommend that the old tracks be converted into a Rails to Trails project. These are by far, some of the best corridors to ride in the US.</p> <p>I appreciate that the new RTP is a better approach than previous RTP's, however there will be much work to do to actually implement the needed infrastructure to change the car culture of San Diego. I do believe with a new bold bike vision and the prioritization for healthy active transportation, our city can achieve, and even exceed, the desired mode share goals of 18% by 2030. I would like to suggest that SANDAG evaluate the most difficult and dangerous areas to ride a bike. As I have experienced, most of the dangerous locations are around and through highway interchanges. Perhaps a new approach to our bike improvements is for SANDAG to address these hot spots specifically, working with Caltrans and Cities to make these areas safe to help connect our communities. As SANDAG focuses directly on these dangerous intersections with Caltrans, the City can support "quick build" protected bikeways that approach these areas. For example, rather than have SANDAG address the entire 2.5 mile corridor of Nimitz, I would prefer they focus on the most dangerous area near the I-8 and efficiently implement a grade separated facility for connecting at this hot spot, while allowing the City of SD to add flex posts and barriers along the rest of the corridor to provide the safer facility in a more reasonable timeframe. With a Vision Zero priority at SANDAG, money cities receive from SANDAG should be dedicated to complete streets using Vision Zero Strategic Solutions for Safety.</p> <p>The collaboration between cities, Caltrans and other agencies is extremely valuable to being successful and commend staff for working on all fronts to address the transportation issues in the region. We have amazing new leaders throughout San Diego County. For them to continue to be great leaders and ensure a holistic transportation system is created, these leaders need to experience all modes of transportation. The Board of Directors, Transportation Team and SANDAG staff should all be using the current transit system and bikeways to truly understand the benefits and challenges of each. If they only drive a car, they will only know how to advocate for such. SANDAG can help facilitate this and it is important that our leaders ride the Coaster, Sprinter, BRT, Blue Line and the bus to understand what we have and don't have in San Diego. Leaders need to actively ride a bike to understand and feel why there is such a demand for separated and protected facilities. This is the best way for our leaders to be advocates for an inclusive and healthy transportation system.</p> <p>I truly appreciate the opportunity and continued dialogue for a safe, healthy, and efficient transportation plan for our region. The Climate Crisis is real and we have limited time. The best ROI is to prioritize people centric communities with bikeways connecting these people, businesses, and amenities in our City. Be inspired by Mayor Anne Hidalgo in Paris and watch how she has changed her city in the last two years. This is possible here in San Diego and we too can act quickly to be successful to get people out of their cars. San Diego is shining and people want to ride for transportation. It is time to provide the safe network for them to do so.</p> <p>May our commutes become the best part of our day.</p>	
E188	Nicole Mu??oz-Proulx	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>1. Accelerate GHG reduction goals: Meet the required greenhouse gas emission targets, and ensure measures get us to those goals using federal and state funds available to create high-quality union jobs. Climate change is accelerating, and we are currently seeing the results, which are especially devastating to environmental justice communities. We can't wait any longer to take the actions needed, so our families and our children have a livable future. The emissions reduction goal in the plan of 40% by 2030 is inadequate in addressing the climate crisis.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>



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E189	Nicole Mu??oz-Proulx	SanDiego350	<p>2. Accelerate transit improvements: Accelerate the timeline for all transit (trolleys, buses, rail) and biking infrastructure improvements and prioritize the Environmental Justice communities that need transit solutions the most. Environmental Justice communities, who disproportionately suffer from the effects of climate change, cannot afford to wait; they need immediate improvements while the long-term infrastructure projects are being planned. This means no new roads and specifically accelerating the purple line and collaborating with MTS to improve the blue line that serves these communities. This also means transitioning transit to zero-emission vehicles. 24-hour service and increased transit frequency: Make the transit system fast, frequent, reliable, and accessible by increasing passenger capacity, hours of service, and frequency on popular lines. This means 24-hour service and 10-minute frequency on many popular bus and trolley routes to connect people to jobs, school, and more.</p> <p>Improve transit amenities: Make immediate improvements to amenities at transit stops, including benches, shade from the elements, and bathrooms that are accessible according to ADA regulations. Improving transit amenities increases ridership and is crucial to providing our disabled community access to public transportation in an equitable way.</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 through 2050 of \$657 million for zero-emission buses and infrastructure, which is to support accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p>
E190	Nicole Mu??oz-Proulx	SanDiego350	<p>3. No-cost youth passes: Provide no-cost transit passes for youth 24 years old and younger beginning in 2023, not 2027. No-cost transit passes encourage significant participation in public transportation and help shift expectations for how San Diegans use transit.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E191	Nicole Mu??oz-Proulx	SanDiego350	<p>4. Anti-displacement strategies: Create and fund an anti-displacement strategy to protect vulnerable communities living near transit corridors by preserving existing affordable housing, encouraging community ownership, and protecting tenant rights as well as developing new affordable housing.</p>	<p>Land use authority is reserved to local jurisdictions –the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
E192	Pablo Corona	HICAP/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>Great presentation! I found it very interesting because the new improvements focus on mobility for</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>

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			all ages and I really hope that this plan really helps reduce the affects of global warming. Thank you Carol!	
E193	Patricia Murrin	N/A	<p>SANDAG members and staff,</p> <p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>Patricia Murrin</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E194	Patricia Valiton	N/A	<p>With so much attention to San Diego County's future transportation, what is SANDAG doing right now to ensure the health and safety of current passengers?</p> <p>This PBS article (<a href="https://www.pbs.org/newshour/nation/public-transit-post-pandemic">https://www.pbs.org/newshour/nation/public-transit-post-pandemic</a>) describes improvements other cities are currently making to their public transportation protocols -- additional cleaning, better air circulation, increased distances between passengers. I understand that even with the new California COVID plans going into effect tomorrow, all public transportation will continue to require that passengers wear facial coverings (which in my very limited experience riding on San Diego busses lately is not universally applied or enforced). So what is SANDAG doing to ensure that current as well as future passengers are assured rides without health risks?</p>	<p>Public transportation vehicles and facilities receive regular maintenance. As part of the COVID-19 protocols, vehicles are wiped and cleaned at the end of each run throughout the day. Additionally, all riders are required by federal mandate to wear a face covering or mask while on public transit.</p>
E195	Paula Holland	N/A	<p>I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially overcrowded ones. Therefore, I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system.</p> <p>I call for increased funding for electric bus/trolley system.... better for less green house gas emissions.</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p>
E196	Paula Jewell	N/A	<p>I am a resident of Cardiff and I live just off the Birmingham Drive exit. I took a deep dive into Appendix A of the 2021 Regional Plan, and I wanted to share my questions and comments with you that I also submitted to the SD Forward website. I am very pro active transportation and love to use Class IV protected bike lanes and Class 1 multi-use facilities and would like to see more of these in San Diego County. The multiple transportation projects near my home have piqued my interest in the transportation projects in San Diego. I have been following the projects in North County since I</p>	<p>Yes, we have worked with our project partners at Caltrans to include the North Coast Bike Trail projects in our Final 2021 Regional Transportation Plan as part of the Adopted Regional Bike Network. Caltrans will be the implementing agency working along with the individual jurisdictions to complete their segments of North Coast Bike Trail as per the NCC PWP/TREP.</p>



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			<p>will be using them much more than others. I have been enjoying the Coastal Rail Trail for local trips in Encinitas and I am really looking forward to the completion of the North Coast Bike Trail that will be a Class I multi-use path between Birmingham Drive and Solana Beach.</p> <p>Below are my comments and questions that I also submitted to the SD Forward website:</p> <p>North Coast Bike Trail: It seems like the North Coast Bike Trail is a regional active transportation project that should be included in the 2021 Regional Plan. Why isn't the North Coast Bike Trail included on the list of active transportation projects in the 2021 Regional Plan?</p>	
E197	Paula Jewell	N/A	<p>I-5 Widening: I am a 4th generation Californian. I can remember my parents and relatives talking about freeway widening projects since I was a small child. They would always lament that the widening was not enough for future use. Why don't the transportation planners account for future use, not just 2 years after completion they would complain. We now know that widening freeways just induces demand to drive more and does not reduce congestion. I am not clear on whether the future SANDAG projects will widen the I-5 in North County beyond the Phase 1 portion of the Coast Corridor Public Works Plan / Transportation &amp; Resource Enhancement Program (NCC PWP/TREP). I don't think the 2021 Regional Plan should include the widening of the I-5 corridor. From multiple past projects, we know this will not reduce traffic congestion in the long run. Additional freeway size will just increase the noise we hear or air pollution my family breathes in.</p> <p>The 2021 Regional Plan should not include the widening of the I-5 freeway. This project will not reduce traffic congestion in the long run. Is the Phase 2 portion of the I-5 freeway widening proposed in the 2021 Regional Plan? If so, what projects are proposed?</p> <p>I-5 Bike, Pedestrian and Safety Enhancements: If the Phase 2 portion of the I-5 Widening is not proposed in the 2021 Regional Plan, will the other community enhancements still be proposed? SANDAG should not remove the pedestrian, bike and safety related community in the 2021 Regional Plan that were proposed in original EIR for the NCC PWP/TREP. Below are a few specific community enhancements in Encinitas that should be proposed.</p> <p>In the 2015 SANDAG Regional Plan, the Birmingham Drive bridge was scheduled for replacement in a future phase of I-5 construction (estimated 2035 per the 2015 SANDAG Regional Plan). During this time, there were plans to widen the westbound sidewalk from 5 to 12 feet and add a new 12-foot eastbound sidewalk. Roundabouts were also proposed at northbound and southbound intersections at Birmingham Drive. However, these are scheduled to be completed along with the replacement of the Birmingham Drive overpass replacement and future improvements. There were also plans for portions of the North Coast Bike Trail to become a Class 1 facility.</p>	<p>We have worked with our project partners at Caltrans to include the North Coast Bike Trail projects in our Final 2021 Regional Transportation Plan as part of the Adopted Regional Bike Network. Caltrans will be the implementing agency working along with the individual jurisdictions to complete their segments of North Coast Bike Trail as per the North Coast Corridor Public Works Plan/ Transportation and Resource Enhancement Program</p>
E198	Paula Jewell	N/A	<p>Are any improvements to the Birmingham Drive overpass or the other bike and pedestrian community enhancements that were proposed in the NCC PWP/TREP included in the 2021 Regional Plan? Many of these projects will create safe off-street paths that will complete the network for people on bikes and walking and should be included in future transportation planning.</p>	<p>Yes, we have worked with our project partners at Caltrans to include the North Coast Bike Trail projects in our Final 2021 Regional Transportation Plan as part of the Adopted Regional Bike Network. Caltrans will be the implementing agency working along with the individual jurisdictions to complete their segments of North Coast Bike Trail as per the NCC PWP/TREP.</p>
E199	Paula Jewell	N/A	<p>Coastal Rail Trail (CRT): According to Figure A.12 in Appendix A of the 2021 Regional Plan, there are small gaps in the CRT that are not scheduled for completion until 2050. The CRT will be a major bike and ped corridor that will greatly improve the quality of life and allow people to access the beach without using a car.</p>	<p>Each city can prioritize improvements through their active transportation or sustainable mobility plans for segments like these and complete improvements there sooner. SANDAG is committing to make these smaller spot improvements by the 2050 phase year but there are a number of projects that we are working on sooner that constrain the amount of time and budget we can commit to projects throughout the region. As you may well know we recently completed a new segment of the Coastal Rail Trail in Encinitas and will be extending it further north in coming years. Please sign up for updates and learn more here: <a href="https://www.keepsandiegomoving.com/RegionalBikeProjects/Introduction.aspx">https://www.keepsandiegomoving.com/RegionalBikeProjects/Introduction.aspx</a>.</p>
E200	Paula Jewell	N/A	<p>Small gaps in regional bike projects (AT073, AT074 and AT122) should be moved to the year built in 2035 to accelerate safety and access for all users. Additionally, any advancement to complete the network of bike/ped projects should be prioritized in the 2021 Regional Plan.</p>	<p>The bike network shown in the plan is the Adopted Regional Bike Network, which was adopted in 2010. As an early action out of the 2021 Regional Plan, SANDAG will develop a new Active Transportation Plan which will look at adding in a number of new connections like these. SANDAG prioritizes community engagement and will develop</p>

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				these connections in partnership with the community so that we can make sure the routes take people where they want to go.
E201	Paula Jewell		I will not have access to the internet on Tuesday June 15 and will be unable to attend the North County Coastal virtual Informational open house on zoom. Will the meeting be recorded? If so, where will this be located online? Will the other open houses be recorded and available online?	All public hearings and informational open houses held during the public comment period were recorded and can be viewed in both English and Spanish at: <a href="http://www.sdforward.com/about-san-diego-forward/calendar">www.sdforward.com/about-san-diego-forward/calendar</a> .
E202	Peggy Griffith	N/A	<p>This proposal is going to punish those who can afford it least. People who cannot afford to live inside the city of San Diego already &amp; have to commute from out of town will suffer the most. Folks who have more money &amp; live nearby will never have to pay as much tax. This will be the tipping point for many young people to move from San Diego. The service industry will suffer even more, except those workers who come from Mexico. How fair is that?</p> <p>You say this tax will eventually replace the existing gas taxes. There is nothing more permanent than a temporary tax. Stop the current tax, then I'll consider thinking about a possible new tax.</p> <p>We just passed a gas tax for \$.12 a gallon a few months ago. For roads. What the heck happened to all that money?</p> <p>This is insane. I'll be protesting more gas tax on the steps of your offices if this idea continues.</p> <p>-Overtaxed tax payer</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as rural residents, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system. For example, drivers of fuel-powered vehicles in the state of Oregon receive a credit for fuel tax and remote emissions testing through their road usage charge program called OReGO.</p>
E203	Phil Birkhahn	SanDiego350	<p>ENHANCED BLUE LINE INSTEAD OF 3RD TRACK EXPRESS  p. A-14, Projects TL13, TL57 p. A-15, Project TL12  Phil Birkhahn, Member of SD350 Transportation Committee philbirkhahn@gmail.com</p> <p>We need a stronger Blue Line to serve its many passengers and get ready to work in partnership with the new Purple Line in 2035. Fortunately, the 2021 RTP Appendix A already shows \$1.02 billion for Blue Line improvements, not counting \$200 million for the San Ysidro Mobility Hub. Blue Line needs a clear path for evolution leading to faster service on a Blue Line Express (BLE). However, BLE did not get fresh analysis for the draft 2021 RP. What follows is a reconnaissance through the factors that need careful consideration before proceeding.</p> <p>I do not believe 3rd Track Express is the right approach other than to frame the issue. Trolleys on a 3rd track could save time by enabling trolleys to bypass a station without slowing down or stopping. Other than that, it would be subject to the same conditions along the route that limit trolley speed today. Station skipping does not even need a 3rd track. Surfliner runs through the Encinitas station at 50 to 60 mph and the two LOSSAN tracks carry diverse traffic.</p> <p>3rd track is probably not a must for freight service either. The 2am to 4am window for freight should be compatible with 30- to 60-minute BLE frequency. Freight would run on the east track and BLE on the west. Both express service and freight on the Blue Line can run separately on the existing two tracks. Since 30-minute frequency on Blue Line starts at 11:30pm, the freight window might even be expanded.</p> <p>Through evolution, I believe Enhanced Blue Line can reduce travel time as much as 3rd Track Express. Instead, enhancements called "channelization" of the existing double tracks would enable full use of the 55-mph cruising speed and 3 mph/second acceleration of the S700 trolley cars. Elevated viaducts, i.e., long bridges, are one example. Track beds elevated on 5 to 10 feet of soil contained within vertical retaining walls on both sides is another. Even fencing has a role.</p> <p>The existing travel time of 34 minutes could be reduced about 8 minutes. I think 26-minute travel time qualifies as a better Blue Line Express than 3rd Track, which skips stations. Skipping could be a difficult public process that might be good to avoid.</p> <p>For now, everyone's Blue Line choices are speculative, including mine seen here. We need a process like the Blue Line Express Service Analysis identified at a recent meeting of the SANDAG</p>	<p>The 2021 Regional Plan includes increased service spans (longer hours of service) for the trolley and buses up to twenty hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24 hours. The Regional Plan also prioritizes early implementation of increased frequency on existing transit lines and upgrading many routes to Next Generation Rapid routes which increased frequency and spans of service. Also, SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (to be included in Appendix B).</p>

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			<p>Transportation Committee. Except on steroids with broad reach into alternative evolutionary paths. That process demands full sharing of information with the public, for example, several years of train movement records for the freight operation in the middle of the night.</p> <p>SANDAG and MTS must collaborate on upgrades to Blue Line. First step is a joint comprehensive technical report arriving at the best combination of vehicles, new construction and specific operating plan that would enhance service. Rigorous modeling of each train movement in proposed alternates is necessary to keep hopeful goals from becoming unrealistic and expensive expectations.</p> <p>Please answer the following questions, offer information, and comment where you like:</p> <ol style="list-style-type: none"> <li>1. Will SANDAG and MTS commit to a joint comprehensive report to the public in SANDAG's Blue Line Express Service Analysis?</li> <li>2. Will the above report provide full and complete analysis to the public about alternative evolutionary paths for Blue Line?</li> <li>3. Will the above report recommend the best combination of vehicles, new construction, and specific operating plan?</li> <li>4. Will SANDAG research and provide a list of LRT systems that use bypass or run-through tracks to skip stations to reduce travel time?</li> <li>5. Will SANDAG support the above work with rigorous modeling of each train movement in proposed alternates that is necessary to keep hopeful goals from becoming unrealistic and expensive expectations?</li> </ol>	
E204	Phil Birkhahn	SanDiego350	<p><b>BUILD THE WHOLE PURPLE LINE BY 2035</b>  p. A-12, Project TL02; p. A-14, Project TL03  Phil Birkhahn &amp; SD350 Transportation Committee, Bee Mittermiller, Chair philbirkhahn@gmail.com</p> <p>We need the whole Purple Line Fast Commuter Rail by 2035 instead of splitting it into two projects, which delays completion to 2050. Building just part of the line by 2035 will isolate it from half its commuter market, leading to low early ridership for 15 years that invites criticism of the project and its technology. The second part might get canceled. Luckily, it is a bargain at less than 20% of the total cost.</p> <p>The SANDAG proposal for Purple Line is fast service from Sorrento Mesa to the border in modern commuter trains like the Siemens Mireo or Desiro City powered by electricity.</p> <p>The social purpose of Purple Line is to connect Environmental &amp; Economic Justice Communities south of I-8 to Tijuana, to job and education centers at I-8 and north to Sorrento Mesa. The technical transit purpose is to bring practical travel times to large numbers of inland and southerly commuters.</p> <p>The transit equity purpose is to provide north-south transit to inland San Diego for the first time. Coastal service (Blue Line and Coaster) and east-west service (Orange and Green Lines) has been in place for decades, while inland towns and neighborhoods have close to zero north-south connection by transit. Their travel demand is met by freeways alone.</p> <p>The global warming purpose is Purple Line's ability to serve two to six times as many riders as trolley technology at three times the speed using 100% renewable energy. The trains have a single interior space and all amenities a passenger could want. It's a powerful builder of transit mode-share.</p> <p>Purple Line will likely have a dozen stations over its 30 miles: Sorrento Mesa, UTC, Kearny Mesa, Linda Vista, SDSU West, City Heights, Orange Line &amp; Euclid, National City, Chula Vista Downtown, Palomar &amp; 4th or Chula Vista East at I-805, Iris or Palm, and San Ysidro.</p> <p>It will provide 30-minute travel times from the border to Sorrento Mesa. South Bay commuters headed that far north will choose it instead of a trolley ride of an hour or more. Blue Line will primarily serve Downtown residents working in UTC and Sorrento, and South Bay residents working Downtown.</p> <p>Purple Line is divided into two projects at National City:  National City to Sorrento Mesa TL02 p. A-12 \$12.660 billion 2035 Completion  National City to the Border TL03 p. A-14 \$ 2.977 billion 2050 Completion</p> <p>The SANDAG proposal for Purple Line Commuter Rail is \$15.637 billion for Sorrento Mesa to the border, about 30 miles. That is a lot of money but is less than the alternative of roughly \$25 billion in new lanes needed to fix commuter-rush freeway congestion and keep traffic flowing at 60 mph</p>	<p>A station at I-805 and Palomar is difficult to do. There are high frequency power lines overhead and a significant water line underground. The majority of the ridership for the purple line comes from the denser community areas which are mostly located west of I-805. Station sites will be identified during the advanced phase of the project. At that point, communities will be engaged in the planning effort. SANDAG will pursue all available opportunities to expedite the full Purple Line.</p>

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			<p>until 2050.                      Most freeways would need two or three new lanes each way, which means taking a butcher knife to adjacent neighborhoods. That leaves permanent damage that never heals. Purple Line Fast Commuter Rail is 80 percent in deep tunnels. Purple Line is a great way to preserve and serve neighborhoods instead of destroying them.                      The ridership value of those last four stations, Chula Vista Downtown to San Ysidro, is about half the accessible travel market. They are a bargain at \$2.977 billion, just 19% of the total cost of the Purple Line.                      That \$3 billion should come from recapitalizing the Del Mar Tunnel. Tunnel funds should come from a new budget category under Capital Projects called Climate Change Adaptation and funded independently of any source of transit funds.                      Please answer the following questions, offer information, and comment where you like:                      1. Have you considered a station in Chula Vista East at I-805 &amp; Palomar or similar site? If not please evaluate it.                      2. When will SANDAG have recommendations on station sites and when should communities start working on it.                      3. Will SANDAG undertake a special study to find a strategy leading to the whole Purple Line by 2035.</p>	
E205	Phil Birkhahn	SanDiego350	<p>ENHANCMENT PROGRAM LEADING TO A BLUE LINE EXPRESS                      p. A-14, Projects TL13, TL57 p. A-15, Project TL12</p> <p>I assume overcrowding reports are correct. MTS should post station ridership and entry-exit tables like those provided by BART so anyone can deduce the situation with a little work.                      Early Action to 2025                      A. Quickly establish a pilot program of bus service from 1 to 4am to complete 24-hour service. The pilot should be free to passengers to draw out the market and include some free rides to the station for passengers with problematic routes to the station. Use the pilot data to study an upgrade from bus to trolley in the Blue Line Express Service Analysis.                      B. Increase passenger capacity by adding a fourth S700US LRT car to Blue Line trains. This solves the immediate overcrowding problem but will be quickly outgrown unless train frequency eventually can be boosted to at least 12 per hour. If not, go to a Strategic Solution of changing to S700 full-length cars. Is there room to park longer trains at the rail yard south of Imperial?                      C. For now, accept the 25-mph travel speed of the existing Blue Line to Downtown. It already meets SANDAG's 30-minute access criterion to a Tier 1 Job Center for passengers as far south as Iris station if they live nearby. Beyer and San Ysidro are just a few minutes more.                      For 2025 to 2030 Completion                      D. Go ahead with the 5 grade separations funded in the draft 2021 RP for 2035 completion but recognize that the effect at those locations will be to speed up car traffic, not the trolley. As such, the grade crossings should be funded by road funds not Transit Leap.                      E. The Transit Leap funds for the Blue Line already in the 2021 RP should instead be spent on five bilevel stations integrated into their adjacent rail overpass. The track will already be elevated because the grade separation abuts the station. Maybe 1 minute saved.                      F. The stations should be state-of-the-art, including bathrooms on both levels. The upper level would be restricted to passengers holding valid tickets to ride, as is done at the Grantville station. A fence between the tracks would keep people off, like in the SDSU station.                      ALTERNATIVE: Alstom's Citadis Dualis, Metropolis, or X'Trapolis cars can have restrooms on board and have wide connections between cars creating a single interior space. Restrooms would not be needed at the upper boarding level of stations.                      G. Determine the potential for bilevel stations to enable skipping a station at higher speed found in Encinitas on LOSSAN. Bypass tracks may not be needed. Note that Surfliner trains go through Encinitas station and nearby crossings at 50 to 60 mph.                      Consider for 2050 Completion                      H. Elevate or otherwise isolate the trolley tracks from "H" Street to 12th &amp; Imperial. This section is the slowest part of the Blue Line south of Downtown, 22 mph. Saves about 5 minutes, putting San Ysidro within 30 minutes of Downtown.                      The above measures would lower travel time to about 29 minutes from the current 34 minutes, no</p>	<p>The 2021 Regional Plan includes increased service spans (longer hours of service) for the trolley and buses up to twenty hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24 hours. The Regional Plan also prioritizes early implementation of increased frequency on existing transit lines and upgrading many routes to Next Generation Rapid routes which increased frequency and spans of service. Also, SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (to be included in Appendix B).</p>



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			<p>stations would be skipped, and travel speed would be 29.4 mph. Isolating tracks on from San Ysidro to “H” Street could save 3 or 4 more minutes.                      Please answer the following questions, offer information, and comment where you like:                      1. Will SANDAG and MTS commit to a joint comprehensive report to the public in SANDAG’s Blue Line Express Service Analysis that includes a specific phased program leading to steady progress toward a Blue Line Express?                      2. Will SANDAG support the above work with rigorous modeling of each train movement in proposed alternates that is necessary to keep hopeful goals from becoming unrealistic and expensive expectations?                      3. Will SANDAG determine if the achievable travel time reduction is sufficient for Blue Line to be a strong partner for the Purple Line?                      4. Will SANDAG consider conversion to faster vehicles with more amenities like those offered by Alstrom?</p>	
E206	Phil Birkhahn	SanDiego350	<p>DEL MAR TUNNEL IS CLIMATE CHANGE ADAPTATION NOT TRANSIT                      p. A-26, Project TL06                      Phil Birkhahn, Member of SD350 Transportation Committee philbirkhahn@gmail.com</p> <p>Del Mar Tunnel is an expensive, \$3-billion project required for adaptation to sea-level rise caused by climate change. Sea level had held steady for two- or three-thousand years before erosion of the coastal bluffs was initiated by global warming. Goods movement and transit needs could have been met by double tracking the existing route. We need a new budget category called, “Climate Change Adaptation” to recognize reality, bring visibility to the cause of the spending, and seek special funding sources not related to goods movement or transit. Budget presentations in Appendix A and throughout the Regional Plan necessarily group projects leading to wide interpretive differences. Case in point is TRANSIT LEAP, \$51.637 billion. This breaks down as follows:                      CATEGORY COST, billions COMMENT                      New Commuter Rail Routes \$33.680 Mostly in deep tunnels                      Improve Existing Heavy Rail \$6.949 LOSSAN: Freight, Surfliner, Coaster                      Climate Change Adaptation \$2.630 Move tracks from Del Mar coastal bluffs                      Improve Existing Light Rail \$3.088 Trolley and Sprinter                      New Tram Loop \$1.175 Downtown-Hillcrest-North Park-Golden Hill                      Rapid Bus \$2.717 35 New and Existing Route Improvements                      Airport People Mover \$1.398 San Diego International Airport                      The real cost of Transit Leap will be lowered to \$49.007 billion by properly moving Del Mar Tunnel to the new budget category of Climate Change Adaptation.                      Note that new commuter rail routes are only \$33.680 billion, far lower than reported by news media. That is for the Purple Line from Sorrento Mesa to the border, the east-west line from Central Mobility Hub to Hillcrest to El Cajon, and the line from Downtown to Hillcrest to Linda Vista. Maps in the Regional Plan are not drawn to reflect distinctions between category of project, such as New Commuter Rail versus Existing Heavy Rail. And projects not in the Regional Plan at all are shown on some figures without differentiation, for example California High Speed Rail.                      Please answer the following questions, offer information, and comment where you like:                      1. Will SANDAG create a new budget category for Climate Change Adaptation and take such projects out of Transit Leap?                      2. Will the estimated cost of Transit Leap be \$49.007 billion?                      3. Will the estimated cost of the three new Commuter Rail lines be \$33.680 billion?                      4. Will SANDAG enhance existing maps and figures in the Regional Plan to highlight the above differences in project type and cost allocation?</p>	<p>1) No. Moving projects out of the transit category could compromise the ability to successfully obtain grant funding.                      2) No, see #1.                      3) No.                      4) No.</p>
E207	Phil Birkhahn & Bee Mittermiller	SanDiego350	<p>CITY HEIGHTS ON PURPLE LINE FAST COMMUTER RAIL                      p. A-12, Project TL02; p. A-14, Project TL03; p. A-29, Project TL01                      SANDAG’s commuter rail network in its draft Vision for the 2021 Regional Plan Network Development Summary Report, released August 7, 2020, had a big surprise: City Heights was off the</p>	<p>The revisions to the Purple Line were adopted in the SB2S CMCP. Unfortunately, the network modeling and EIR were developed prior to this change being included in the network. The Regional Plan mentions the change to the Purple Line in Appendix A, but the network maps and figures will not be updated.</p>

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			<p>Purple Line, North Park and University Heights were on. Purple Line has always included City Heights on its run to Kearny Mesa, UTC and Sorrento Mesa from Environmental &amp; Economic Justice Communities south of I-8 to Tijuana. The other surprise was that North Park was not included in the east-west line from University Heights on its way to City Heights.</p> <p>By September I was working with San Diego Transportation Equity Group to get City Heights back on the Purple Line. Equity is prime, but my original objection to the change was its decreased capacity relative to large-scale traffic flows on I-15, I-805, SR-163 and I-5. It adds up to 700,000 cars per day through the zone between SR-52 and SR-94</p> <p>Moreover, the Purple Line route proposed by SANDAG merged with the other north-south route coming from Downtown to Hillcrest, Kearny Mesa, and Sorrento. I objected to that network design because eventually two north-south routes are needed from SR-52 to SR-94. North and south of that zone, just one route is needed to match the market.</p> <p>SANDAG's configuration to the south is great, bringing routes together at National City to head south to the border. The SANDAG configuration to the north is problematic. Bringing them together at University Heights to continue north as one route to Mission Valley and points north deprived the area from I-8 to SR-52 of the additional route it needs. It gives up a large chunk of the potential market.</p> <p>I define need as offering congestion reduction on the four north-south freeways and having potential for high mode shift from cars to Fast Commuter Rail. Purple Line is an opportunity to provide travel time less than 30 minutes from the border to Sorrento Mesa. Even during the height of the commuter rush. No freeway will ever be able to do that.</p> <p>When we got SANDAG to commit to putting City Heights back on Purple Line, they proposed a good route through a station at SDSU West and then to Linda Vista, and Kearny Mesa. SDSU West may need an above ground site because an underground station would face poor subsurface conditions could have a cost impact.</p> <p>My last point is that North Park deserves a Fast Commuter Rail station. Luckily, SANDAG already plans and budgets for a tunnel from University Heights to City Heights. It will pass just half-a-mile north of North Park. Please modify that project by slightly diverting the tunnel to a North Park Station. I believe direct connection to City Heights, SDSU and points east will be better for North Park than direct connection to points south.</p> <p>Please answer the following questions, offer information, and comment where you like:</p> <ol style="list-style-type: none"> <li>1. For project TL02, will you delete "University" and add "City" in its description?</li> <li>2. Will the figures in the final RP be updated?</li> <li>3. Does SANDAG agree that the zone for heaviest north-south traffic stretches from SR-52 to SR-94?</li> <li>4. Has SANDAG estimated the cost and consequences of trying to solve traffic jams with enough added lanes to eliminate commuter-rush congestion and keep traffic moving at greater than 60 mph until 2050? Should Caltrans perform such a project?</li> <li>5. Has SANDAG conferred with SDSU West about modifying their plans to include a fast commuter rail station?</li> <li>6. When will SANDAG model the rail operations to pin down travel time between each station pair and end-to end?</li> <li>7. Will SANDAG publish estimated ridership contributed by each station for 2035 and 2050?</li> <li>8. Will you add a Fast Commuter Rail connection at North Park using funds in already in Project TL01 for the tunnels and Project TL02 for the station?</li> </ol>	<ol style="list-style-type: none"> <li>3) There are several "zones" in the region with significant traffic – SR 52 to SR 94 are high on the list of most congested but it is not the most congested.</li> <li>4) No, SANDAG has not done that analysis. The RP does not included additional freeway lanes that would warrant that analysis.</li> <li>5) SANDAG is working with SDSU on a potential station site. The exact location of that station will be developed during the advanced planning stage.</li> <li>6) SANDAG will conduct the analysis of travel time between stations during advanced planning. Modeling has been completed that results in a total travel time.</li> <li>7) SANDAG does not generally publish station ridership at the Regional Plan stage because the exact locations of stations has not been defined, just the area's a station would be placed.</li> <li>8) No.</li> </ol>
E208	Priscilla Lane	SanDiego350	<p>I am close to a bus line but it takes a very long time to get where I'm going by bus. We should strive to make transit competitive with driving. While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, give priority to transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. This is essential especially for those who rely on transit as their only means to get around.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including</p>



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				frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E209	Rachel Tisnado	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>According to the EPA our current era of global warming is directly attributed to the burning of fossil fuels. 14% of global greenhouse emissions comes primarily from fossil fuels burned for transportation. This means that there is a big opportunity for SANDAG to make an impact on our global crisis by making public transportation a priority. We can all feel the impacts of global warming already and to wait till 2050 to help will be too late.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E210	Rami Ibrahim	Majdal Center, SD350	<p>Hi, my name is Rami with the Majdal Center, I am writing because I wanted to thank the staff at SANDAG for their progress around transportation in this RTP. However, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
E211	Rami Ibrahim	Majdal Center, SD350	<p>Many community members in East County are walking communities with no access to transportation. Many walk in 100 degree heat, and vulnerable community members face health risks when merely engaging in movement. First, we need to Accelerate transit improvements: Accelerate the timeline for all transit (trolleys, buses, rail) and biking infrastructure improvements and prioritize the Environmental Justice communities that need transit solutions the most. Environmental Justice communities, who disproportionately suffer from the effects of climate change, cannot afford to wait; they need immediate improvements while the long-term infrastructure projects are being planned. This means no new roads and specifically accelerating the purple line and collaborating with MTS to improve the blue line that serves these communities. This also means transitioning transit to zero-emission vehicles.</p>	<p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p>
E212	Rami Ibrahim	Majdal Center, SD350	<p>As a UC San Diego student, I was frequently taking the bus home from work at odd times in the night. Waiting for over 25 minutes at a bus stop made me uncomfortable and made me feel unsafe. We need 24-hour service and increased transit frequency: Make the transit system fast, frequent, reliable, and accessible by increasing passenger capacity, hours of service, and frequency on</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights,</p>

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			popular lines. This means 24-hour service and 10-minute frequency on many popular bus and trolley routes to connect people to jobs, school, and more.	<p>and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements. SANDAG will be working hard with the help of all of our passengers and representatives to ensure that this plan gets implemented.</p>
E213	Rami Ibrahim	Majdal Center, SD350	Many community members have accessibility needs that need to be met when taking public transportation. Public transportation must be accessible to ALL. Please Improve transit amenities: Make immediate improvements to amenities at transit stops, including benches, shade from the elements, and bathrooms that are accessible according to ADA regulations. Improving transit amenities increases ridership and is crucial to providing our disabled community access to public transportation in an equitable way.	SANDAG agrees that amenities are important on public transportation. That is why all of the new services planned in the regional plan will include shade structures and benches. Bathrooms are being evaluated in a study to determine where they can be placed or upgraded to meet ADA requirements.
E214	Rami Ibrahim	Majdal Center, SD350	Next, we need No-cost youth passes: Provide no-cost transit passes for youth 24 years old and younger beginning in 2023, not 2027. No-cost transit passes encourage significant participation in public transportation and help shift expectations for how San Diegans use transit. At UC San Diego, bus and transit passes were provided with our tuition. However, many students and youth are not enrolled or have the funds to be at a higher education institution. These youth need to be able to move freely, get a job, and enjoy public transit without barriers.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
E215	Rami Ibrahim	Majdal Center, SD350	<p>Lastly, we need Anti-displacement strategies: Create and fund an anti-displacement strategy to protect vulnerable communities living near transit corridors by preserving existing affordable housing, encouraging community ownership, and protecting tenant rights as well as developing new affordable housing.</p> <p>Thank you. I look forward to seeing these improvements implemented.</p>	Land use authority is reserved to local jurisdictions –the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.
E216	Randall Thill		While I appreciate the amount of effort that has gone into this proposal, I think it will not work out very well for the county. By the time the high-speed rail is completed most cars will be self driving and/or there will be cars that you can summon to your home and take you anywhere in the county for a small fee. Also, with the advent of smart cruise control more cars will be able to drive on existing freeways with less gaps between cars, which will help eliminate traffic congestion.	<p>The Regional Plan envisions a transportation system that provides sustainable mobility choices in the region. Fast and reliable transit remains the most efficient way to move the largest number of people; traffic congestion on our urban corridors will be remedied by fast commuter rail services that serve longer distance regional trips. Transit services will also be complemented by Flexible Fleets, which include shared, electric, and eventually autonomous vehicles. Flexible Fleets provide greater travel choices for connections to transit or areas where transit may not work well.</p> <p>However, there is great uncertainty about when shared fleets of fully autonomous and connected vehicles will be capable of operating in the manner you've indicated. Though small, automated pilots have been launched in many parts of the country, including San Francisco, widespread deployment of truly autonomous services is not likely until much later.</p>
E217	Randall Thill		I think the prospects for increased ridership on trains will be similar to what we have seen with the Coaster and Sprinter programs, which is minimal usage. I think part of the reason for programs like the Sprinter was to decrease air pollution but if you notice, every time the Sprinter crosses an	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The 2021 Regional Plan will add tremendous capacity to the transportation system and offer people compelling alternatives to driving

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			intersection there are many cars sitting there idling until the Sprinter passes. Has anyone done an analysis as to whether this creates more or less air pollution?	alone. Infrastructure improvements at congested crossings are considered when designing and improving such intersections. The model tool that is used to measure GHG emissions and delay for the 2021 Regional Plan does include delay times at rail crossings.
E218	Ravi Gopinathan	SanDiego350	<p>First, I'd like to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft.</p> <p>However, we at San Diego 350 feel this plan still prioritizes private cars more than we need to be doing in order meet the urgency of the climate crisis through improving public transit. Instead of further freeway expansions, I support expanding our trolley network such as by building the purple line trolley from Chula Vista to Sorrento valley east of the existing blue line, and increasing density of housing along transit corridors.</p> <p>We ask that you move faster in meeting targets for emissions reduction, and improving the hours and frequency of transit so that our public transit system can be a meaningful alternative to cars. Lastly, I would like the agency to prioritize reducing car dependence, increasing walkability and housing construction nearby the Grand Central station planned to connect to the airport as well as to Escondido.</p>	SANDAG shares the goals cited in this comment. All of the projects developed in the Regional Plan are intended to provide multimodal options that will help to reduce greenhouse gases and vehicle miles traveled.
E219	Rebecca Paule	n/a	Always using MTS bus going to Samahan Clinic, waiting time is fair enough.	Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E220	Regina Agarma	n/a	To reduce health risk, what's possibility of providing electric bus. Consider offering a free fare to seniors or 65 plus with low income and underserved communities.	The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a> .
E221	Richard Bentley	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E222	Rita Clement		<p>I live in Chula Vista. Thank you to the SANDAG staff for researching and designing the Regional Transportation Plan.</p> <p>No cost transit passes are an essential element to ensure the future success of the Regional Transportation Plan. People ages 24 and under are more likely to use transit to attend school, colleges and universities. They are the most likely to work in low paying jobs making \$15 an hour or less. If transit has no cost for them, they will probably not buy a car which pollutes the atmosphere. If they are used to taking transit, they will continue to use transit after age 24. Please support no cost transit for people age 24 and younger.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
E223	Rita Clement	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>I encourage you to accelerate faster and more frequent buses to take us to the trolley stations. It</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation</p>

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			took me 1 hour to go to the H ST trolley station from my home in Eastlake in Chula Vista. I used transit for 12 years.	<p>Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>In addition to increased bus frequency, as part of the 5 Big Moves SANDAG is working to implement Flexible Fleets that would offer additional mobility options for community members to get to and from transit stations. These mobility options would include electric scooters and bikes, rideshare, and microtransit shuttle systems.</p>
E224	Rob Fox		I'd like to know who the point of contact is regarding the proposed tax on miles driven by hard working San Diegans. I represent a group that is adamantly opposed to this proposal and would like to know who we can deliver petitions to and who the members of my group can contact so that they may make known their objections as well.	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues.
E225	Robert Gonzalez	N/A	<p>If SANDAG tries to implement the mileage Tax, I will sue SANDAG and keep you in court for years, seek an injunction preventing you from collecting and ensure that all drivers in San Diego are protected.</p> <p>Stop trying to charge motorists for everything we already paid for, implement what we paid for, and go after all those bicyclist that haven't paid for ANY of the roads or trails they use.</p> <p>It is unfair of you to try to charge only a motorist, yet Bicycles require special lane adaptations, maintenance and additional road upgrades that are not recovered.</p> <p>Your making improvements to roads to accommodate these individuals and charging motorists for those "improvements", which take away lanes, increase traffic, pollution and make our roads more dangerous.</p> <p>Until you tax bicyclists, any additional taxes you impose on motorists are nothing more than taxation without merit. Our roads and maintenance were already included in existing taxes.</p> <p>This is yet another reason that SANDAG needs to be closed down. Your nothing more than a waste of tax payer dollars and overhead. All of your proposals for regional transit, transportation and infrastructure upgrades have built in addition taxes and costs that benefit SANDAG and your programs directly.</p> <p>Your employee benefits and costs are absurd and the overhead for SANDAG is unnecessary, given that your Director's vision for San Diego is absurd, and San Diego needs to run him out of town just like they did in LA.</p> <p>You people are self-serving idiots. None of your proposals represent the ideas nor desires of the people of San Diego. I sincerely think that the Citizens of San Diego need to vote to close SANDAG down, just as the agency you replaced was closed down.</p> <p>Your never going to get anyone in San Diego to approve your tax increases. People already pay way too much for practically nothing. Your recognizing a cost savings that isn't passed on to the tax payer for several of your programs, and using that savings for overhead purposes. In other areas, your way over budget, late on delivery and in some projects, your years away from even getting started. In most cases, you already spent the money, and now you want more.</p> <p>Your expanding the trolley to north county, but in the mean time, who is going to rise the trolley? More homeless? That's going to go over well with people in North County, I am sure. You were supposed to buy newer updated Trolley cars, yet frequent breakdowns on these older cars are still allowed to continue. Homeless have invaded the trolley and it's generally unsafe to ride at most hours. Even if you consider it safe, transit police are mentally unstable and incredibly aggressive.</p> <p>Now your replacing the compass car system, because the old system was constantly down or not working correctly. Another waste of tax payer dollars for a broken system that you and MTA are not capable of administering or operating.</p> <p>You "purchased" the toll road, and conditions on the road have become substantially worse, and it's seldom traveled road anyway. It's dangerous, unmonitored and the toll booths are constantly broken. Machine coin counters rip you off, and there is never anyone manning the booths. An incredible waste of tax payer money. You didn't buy it, you don't own anything. The tax payers own</p>	Thank you for your comments.



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			<p>that road.                      SANDAG is property of the citizens of San Diego. Your administration clearly seems to dismiss and forget that. Your not actually a real agency, you were created from the old center city development corporation and your a waste of tax payer dollars.                      It's unfortunate that more people don't care or get involved. Nobody should have to write an email to an organization that's just going to toss it in the trash. I have been to your closed door meetings and heard what you have said about the public and how you and the public safety committee really feel about public input. It's just too bad that I didn't have hidden video of such conversations at the time.                      We both know what you guys say about the public and what you will say about this email behind closed doors. Your Executive Directors office isn't private and neither are his conversations. Maybe someday, those will get exposed and the public will learn the truth. You never know what people inside your organization are leaking.</p>	
E226	Robert Luliucci	N/A	<p>A mobility hub in our community (So. East San Diego) preferably located at our current Orange Line Trolley station. Youth passes given to youth under 24.</p> <p>Fiber optics underground to ensure we are ready for state of the art transportation system that is in the design stage, (iOS systems/smart phones) and to more appropriately address the digital divide in our "Redlined communities".</p> <p>Covering our MTS bus stops. (Structures/bus shelters.)</p> <p>Consider 24 Hour service on the lines that are taking our residents to work.</p> <p>Focus on transforming to an all electric bus fleet in the first 2-3 years of implementation. Improve the frequency and reliability of our bus routes.</p> <p>Ensure all our streets are designed with the "Complete Streets" designs.</p> <p>Increased maintenance of the trolleys and buses proportionate to the heavy usage in our areas (Southeast area of the City of San Diego.)</p>	<p>All of the elements identified in your comment are under consideration in the Regional Plan. Fare subsidies are included in the plan and as part of implementation strategies it will be determined who will receive those subsidies. Next OS includes fiber connections throughout the region. MTS is working to provide shelters throughout the region. Any new infrastructure build would include shelters. 24 hour service is also included on several routes in the plan. Electrification is required by the State and is included in the plan. Complete Streets designs are an important component of SANDAG's planning today and will be included on projects int he future.</p>
E227	Roberto Velasco	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.                      We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E228	Robin Edwards	N/A	<p>To the SANDAG Transportation Committee:</p> <p>As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
E229	Roger Agarma	n/a	<p>Pls add restroom in main bus stations.</p>	<p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p>

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E230	Roger Moyers	N/A	<p>Dear Sandag,</p> <p>I tried to submit this via your website but it would not accept it. So emailing:</p> <p>Your report is well-formatted and looks beautiful. Good thing it looks so great because from a reality point of view it smells like the landfill in Miramar. In simple words, it stinks. A waste of taxpayer money.</p> <p>Before deciding how to grab more of our hard-earned dollars and waste it on pie in the sky dreams of getting people to change their transportation habits you should examine what is working today and what has failed. Start first by looking at how MTS resources are used now. Huge sums of money were wasted putting express bus lines in along the I-15 corridor. So the very citizens whose tax dollars were used to build these unused bus lanes go zero value from this wasted money. Examine the most used bus lines in the MTS, they go from the US border to urban or industrial areas in the county. Yet your study wants to waste more money putting in bus lanes and more busses. Busses that nobody rides. I'd advise Sandag members to get out and ride the busses. Find out for yourselves that nobody, yes nobody, rides these things.</p>	Thank you for your comments
E231	Roger Moyers	N/A	A better use of money would be to offer anyone that wants to use a bus an Uber or taxi ride to where they want to go. All that wasted gas/energy plus a bus driver's salary to move around 1 person is a total waste. Yet you use climate change as the driver in your decisions. Either you are lying or you are ignoring the data.	The 2021 Regional Plan proposes a variety of transit services based on trip demand between major origins and destinations. For areas of less demand, services like Uber or taxi could offer an on-demand accessible mobility option.
E232	Roger Moyers	N/A	It is incredibly ironic how you throw out the word Smart in your beautiful document. When Smart is the farthest thing from what you will create. If the city can't even own up to the fact that the MTS wastes billions of dollars every year how can you honestly say that you are capable of carrying out such lofty goals as Smart Infrastructure, Smart Corridors, Smart Borders or Smart Mobility. Get the data from MTS. Show us that you are going to use our money wisely and not throw it away trying to get people to change their transportation methods. It won't happen.	The term "Smart" refers to technology solutions that will allow transportation operators to manage roads and transportation services so they operate smoothly and serve people better. The 2021 Regional Plan proposes technology solutions that will reduce traffic congestion, make public transit faster and more frequent, and provide people with better tools for trip planning.
E233	Roger Moyers	N/A	It appears your goal is to tax our citizens to death, drive up the cost of fuel and driving and expect these overtaxed, over charged individuals to toe the line you have put forth. California is already losing residents faster than any other state in the nation. Your new plan will continue this trend as you drive jobs and workers out of our state. Do you want to responsible for this continued downturn of great state. It's continue government overreach with no oversight that is killing this state. Your refusal to examine the actual data from your the implementation of your past transportation plans. Get out ride the trolley, ride the busses, drive our freeways during high use times. Admit that you cannot change the habits of people with your plan to overtax, over charge them for their preferred methods of transportation.	Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently fund different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge, including potential policies, fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure a fair system. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
E234	Roger Moyers	N/A	By the way, your statement that the seas are going to rise 2.5 feet by 2050 is so far off track. I will personally bet any one of you your annual salary that this prediction is so far from reality. If this were true then the seas should have already risen 3 inches. Of course they haven't.	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT.</p> <p>The 2021 Regional Plan is founded on the best available science and data as of the date written.</p>
E235	Roger Moyers	N/A	While prior to Covid the trend was for young families to move to high-density cities, which has been the goal of transportation agencies in California, and eliminate suburbs. But that trend has been reversed with Covid as people realize that the ability to avoid a highly communicable disease is	The 2021 Regional Plan was developed through a data driven planning process. The forecasted development pattern for the 2021 Regional Plan Sustainable Communities Strategy (SCS) is driven by regional goals for sustainability, mobility, housing affordability,



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			much more likely in suburbs. Unfortunately lawmakers in our state continue to see the suburbs as a racist divide that does not meet their mandated “equity” solution. Once again the SANDAG members ignore that data that shows that suburbs are the most racially diverse areas of our county. It just continues the mismatch between government bureaucracies and the reality of how people live their lives in our county. Instead, it uses misguided state mandates such as those mentioned in your document to drive our transportation solutions. Stand up and let these Sacramento state government people know that they don’t understand the San Diego population and that we will find solutions that actually help our citizens. Empty busses, empty trolleys, do nothing to help our community.	and economic prosperity. The SCS land use pattern uses areas in the region known as Mobility Hubs to concentrate future development. Mobility Hubs are communities with a high concentration of people, destinations, and travel choices. The SCS land use pattern represents a continuing trend in the San Diego region to provide more housing and job opportunities in the existing urbanized areas of the region.
E236	Roger Moyers	N/A	<p>There are commercial companies that can and already do manage transportation so much more efficiently than any government entity will ever be able to. Why is this true, because they operate their businesses efficiently. Efficiency is the bane of solutions put forth by government agencies. In your own words in your own document, it’s all about equity. But how is it equitable when the solution overburdens certain parts of the county with high taxes yet punishes those very citizens with solutions that they won’t use. Trying to take solutions that work well in one area and foist them on other areas will never work. To make matters worse the attempt by your taxation policies to force people into further poverty so they become dependent on your proposals is not the role of government agencies.</p> <p>Get out your office, ride the busses, ride the trolleys. This plan does not meet the needs of the people of San Diego, it meets the needs of the politicians that occupy our state government. Be strong, stand up. We need solutions that work, not put more people in poverty and drive them out of our state.</p>	A critical component of reviewing the impacts of the 2021 Regional Plan is evaluating the effects on historically underserved and systemically marginalized groups. This evaluation is known as a social equity analysis and focuses on communities of color, residents with low incomes, and seniors. While the 2021 Regional Plan delivers improvements to the entire region, this review ensures that the benefits are shared by everyone and that the burdens of the 2021 Regional Plan’s changes are not disproportionately shouldered by any social equity focus population.
E237	Roxana Morris	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E238	Ryan McCarty	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need. We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>Before I got my drivers license a few years ago, I relied entirely on public transit and got pretty good at navigating the routes. I would feel more encouraged to use it if there were more routes available but it be buses or trolley routes. I still use one of the trolley routes to get into downtown for easier parking at another station, yet a major bus terminal requires a parking permit since it is in Miramar College.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E239	Ryan Okeefe	N/A	ABSOLUTELY NOT!!!!	Thank you for your comment.

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E240	Sadie Sullivan-Greiner		<p>How do you do? I have read the plan, and have a few thoughts. I was not able to find supporting appendices, so some of these questions may have been answered, and if so, I apologize. I will organize my comments by page number, from the downloadable version. I hope they will be of some value.</p> <p>Pg 6:                      “Transit Leap”: In getting people from where they live to where they want to go, work is doubtless the most significant destination. In my own area, there are a lot of people who must commute to Sorrento Valley &amp; North County. There is no good way to do that by transit. What kind of data gathering has SANDAG done to identify and quantify the numbers, locations, and necessary timing to get 80% of those people to and from work in under an hour on a daily basis?                      Additionally, I would suggest that the following be regarded as primary destinations: the neighborhood ‘downtown’ area, the regional courthouses, the DMV offices, universities &amp; colleges, hospitals, grocery stores, and retail areas.</p>	<p>SANDAG developed the Regional Plan and the proposed transportation network based on a data-driven process— analyzing where people live and work, how they get around, what transportation infrastructure exists, what is needed to serve future growth, and more. This data included census data and cellphone based data. SANDAG did not build it on data alone: The Regional Plan reflects the views of real residents from around the region, the professional judgments of a number of planning professionals at the agency, and extensive knowledge of diverse communities across our region. Appendix T includes the detailed methodology for network development and performance of the plan related to improved access to basic needs (retail, parks, and medical), employment centers, and higher education.</p>
E241	Sadie Sullivan-Greiner		<p>Pg 19:                      “Sustainable Communities Strategy”: Accommodating the Regional Housing Needs Assessment Determination. While we are still in the throes of a pandemic, it will end. When it does end, there is likely to be a surge in homelessness, as people are evicted from rentals. It seems to me that SANDAG could prepare the cities and county for that surge by getting a cooperative group going that would pre-plan for emergency shelter for those who will need it, with the understanding that such shelter needs to have access to sanitary facilities, access to medical care, and assistance for ensuring that affected children remain in school, and that parents who require child care to work or look for new jobs can find that child care. Additional needed services need to be accessible on site.</p>	<p>Indeed, it is hoped that the pandemic will end, and we know that the housing crisis will get worse. There are a number of federal, state, and local initiatives to support affordable housing and wraparound services. SANDAG’s role is to support the jurisdictions in the development of affordable housing throughout the region. We are in the process of administering a new state grant program to support access to affordable housing.</p> <p>For more details please review: Appendix K - The Regional Housing Needs Assessment Plan.</p>
E242	Sadie Sullivan-Greiner		<p>Pg 21:                      “Complete Corridors...give buses and other transit vehicles dedicated space on roadways that is uncongested by cars and trucks.” (Just visualize the old lady doing the happy dance! I’ve been wanting that for years.)                      “Safe and convenient places to park....” Yes. These could also be used as safe overnight parking for those who are forced to live in their cars. Jewish Family Services runs a similar program here in San Diego; their experience could be useful in expanding the concept.                      Not incidentally, consider safe and convenient places to park one’s bike! Very few places have bike racks that can be used to put a lock on while one is in a shop or at an appointment, most places aren’t happy having bikes wheeled into their premises, and yet finishing one’s business &amp; discovering that one’s bike has been stolen doesn’t inspire confidence in the bike as a reliable mode of transport.</p>	<p>Initially adopted in 2010, the Regional Bike Network includes regionally significant active transportation facilities implemented through multifaceted street retrofits including bikeway, walking, drainage, lighting, signal, transit, and landscaping improvements.</p> <p>Regarding bike parking, we work to include visible and convenient bike parking in every one of our active transportation and transit stations projects. That said, SANDAG-led active transportation projects are limited to the regional bike network (see paragraph above) or transit network. For local discussions with individual cities, we recommend working with city staff. We are happy to help connect you to the right people if we can, although we do not have control over the process of local jurisdictions. Not to say there haven’t been successes, for example, we at SANDAG have provided grant funding for the City of Oceanside to set up a secure bike parking area near their City Hall. We will continue to work with local agency jurisdictions through our Smart Growth and Active Transportation Grant programs to increase the number of secure parking areas for bikes and personal micromobility devices. Thank you for your comments.</p>
E243	Sadie Sullivan-Greiner		<p>Pg 24:                      “2050 Transit Network (map)” I see Downtown and San Ysidro Mobility Hubs...but none for East or North County. As you know, East County is not, generally, a high income area; functional transit would be a great boon, economically and otherwise. North County is developing a high-tech jobs base, which needs workers, and one only needs to think of the traffic on I5 or I805 during rush hour...</p>	<p>The 2021 Regional Plan includes Mobility Hubs and Transit Leap services for East County and North County. These projects can be found in Appendix A: Transportation Projects, Programs, and Phasing. Mobility Hubs are communities with a high concentration of people, destinations, and travel choices. They offer on-demand travel options and supporting infrastructure to enhance connections to high-quality Transit Leap services while helping people make short trips around the community on Flexible Fleets.</p>
E244	Sadie Sullivan-Greiner		<p>Pg 25:                      “Better Integration...” An anecdote for you: My niece had a 0800 doctor’s appointment in La Jolla; she lives in Lakeside. She called me in tears to beg a ride because there was no way she could get to the appointment by transit. It was literally not possible.</p>	<p>SANDAG agrees that our region needs to provide fast, frequent, reliable, and accessible transit.</p> <p>In addition to the transit projects proposed in the 2021 Regional Plan, SANDAG will be conducting pilot programs for the implementation of Flexible Fleets and other micro-mobility options to help connect people in less dense regions into the greater transit network. Information regarding Flexible Fleets can be found in Appendix A and N. Addition materials can be found at:  <a href="https://sdforward.com/docs/default-source/2021-regional-plan/5039-sdfrpvisionfivebigmovesonesheets-flexible-fleets-june2019_final.pdf?sfvrsn=79d3f865_2">https://sdforward.com/docs/default-source/2021-regional-plan/5039-sdfrpvisionfivebigmovesonesheets-flexible-fleets-june2019_final.pdf?sfvrsn=79d3f865_2</a>.</p>

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E245	Sadie Sullivan-Greiner		Pg 26: “Safe Streets...wider walkways...” I’m sure you have engineers who can give you a measurement, but (roughly) if people can’t walk two abreast, they won’t walk. That’s bad for traffic, and for public health.	SANDAG follows national and international best practices in bikeway design to create safe facilities for users of all ages and abilities, which includes recommended path widths for estimated users by mode. That said, our plan is a plan for the whole region, and our efforts are regional. For local discussions with individual cities regarding existing infrastructure, we recommend working with city staff. We are happy to help connect you to the right people if we can, although we do not have control over the process of local jurisdictions.
E246	Sadie Sullivan-Greiner		Pg 32: “San Diego Region in 2050” chart” Your chart shows 16% of new jobs outside of mobility hubs. The goal must be to have the increase in transit and the increase in housing, match the locations of the increase in jobs. If we don’t achieve that, we’re just replicating the current issues. If it isn’t possible to increase housing in an area, then transit options must be increased to connect the available housing with the locations of jobs.	The proposed land use pattern of the 2021 Regional Plan focused jobs and housing primarily in existing communities and near transit. Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG will work closely with local jurisdictions to implement the land use pattern proposed in the 2021 Regional Plan.
E247	Sadie Sullivan-Greiner		Pg 33: “Regionally, government agencies are considering how to better align housing policies with transportation initiatives.” Forgive me, but haven’t we seen this material before? We require developers to provide minimum parking spaces for their buildings. We can require them to work with transit authorities to plan for bike lanes, wider sidewalks, bus stops, and transit centers, while requiring the transit authorities to cooperate in planning for the construction of those things.	The 6th Cycle Regional Housing Needs Assessment (RHNA) Plan sets a strategy for sustainability that focuses housing and job growth in urban areas where there is existing and planned transportation infrastructure, protects the environment and helps ensure the success of smart growth land use policies by preserving sensitive habitat and open space, and addresses the housing needs of all economic segments of the population. In the long term, housing located near transit and jobs should provide opportunities for residents to take more trips by bus or train and live closer to where they work, reducing vehicle miles traveled (VMT) and greenhouse gas emissions.
E248	Sadie Sullivan-Greiner		Pg 34: Figure 2.7: “Sea-Level Rise”... Put this on a detail map, and make it available on your website. People will understand what 2.5 feet by 2050 means better if they see the tide line coming over the street they live on.	SANDAG has prepared a Regional Transportation Infrastructure Sea Level Rise Assessment and Adaptation Guidance in May 2020. This project analyzes potential sea level rise impacts to transportation facilities such as highways, bikeways, trails, and light and heavy rail that cross jurisdictional lines and includes maps that show the impact of sea level rise on the San Diego region. The Adaptation Guidance was recommended by the SANDAG Regional Planning Committee and accepted by the SANDAG Board of Directors as a regional resource. The document is available on SANDAG’s website at: <a href="https://www.sandag.org/uploads/projectid/projectid_510_28075.pdf">https://www.sandag.org/uploads/projectid/projectid_510_28075.pdf</a> .
E249	Sadie Sullivan-Greiner		Pg 35: “...local CAP implementation through regional initiatives, such as carbon sequestration.” How? And where? Every one of those plans I’ve seen calls for a specific geology, and I don’t recall seeing it in our region. We’ll have better chance at carbon sequestration by planting trees down the greenway of every street, and requiring all new construction to produce 50% of its anticipated power needs via on-site solar or wind.	The 2021 Regional Plan proposes a Nature-Based Climate Solutions Program that will promote natural infrastructure that uses or mimics natural processes to benefit people and wildlife. SANDAG will prioritize resilience and innovative solutions in transportation infrastructure, Comprehensive Multimodal Corridor Plans, and consistent regional planning and implementation of the Sustainable Communities Strategy actions, emphasizing both nature-based and technological climate solutions. There are also further opportunities to expand upon ongoing efforts to assess the amount of carbon storage and sequestration potential of open space lands and the co-benefits from preserved open space, land management, and restoration activities.
E250	Sadie Sullivan-Greiner		Pg 41: “...mobility hubs to Tier 1 employment centers...” What is the definition of “Tier 1” employment?	SANDAG defines “Tier 1 employment centers” as those communities with the highest densities of employment in the San Diego region. Three employment centers comprise the Tier 1 category – Sorrento Valley, Kearny Mesa, and Downtown San Diego. These are the communities with more than 75,000 employees. More information and analysis on these and other employment centers in the region is available at: <a href="http://www.sandag.org/employmentcenters">www.sandag.org/employmentcenters</a> .
E251	Sadie Sullivan-Greiner		Pg 47: “Road User Charges” Unless you want to try and institute a county-level gasoline tax, how are you planning to track and calculate this? I can hear the outraged screams now. Any sort of tracking is going to fuel paranoia over ‘government interference’.	We understand there are concerns around the privacy and implementation of a road usage charge. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan, including the road usage charge. At a minimum this plan is updated every four years with the latest in planning ideas and concepts. Further research will, and is currently, being conducted at the regional, state, and federal level on how to effectively implement these new funding options while safeguarding the public’s privacy.  SANDAG will launch a study in the next year to further study the potential of usage-based

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				<p>fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
E252	Sadie Sullivan-Greiner		Pg 49: “Flexible Fleets will be primarily accessible through mobile apps ....” The issue I see here is that not everyone has a smartphone. This might be a place where the old pay-phone model could be useful: An access point into the system placed at bus stops or train stations, accepting debit cards or coins.	Ensuring there are options for all people to access Flexible Fleets is an important component of the 2021 Regional Plan. This includes designing services that enable all people to easily reserve a ride such as a call center, cash payment options, or trip planning kiosks in mobility hubs. As Flexible Fleet pilots are launched in the region, services will be designed to be inclusive and equitable for all.
E253	Sadie Sullivan-Greiner		Pg 51: IRT Military Working Group: We’re retired Navy. Cut a deal with the Navy to run buses from each housing area to the bases & you’ll cut a lot of traffic. Move from there to other parts of the plan	SANDAG is actively working with our partners, including the military, to plan and test new mobility services that improve transportation for commuters. This includes providing new transit and Flexible Fleets options such as e-bikes, shuttles, or ridesharing that can provide a convenient alternative to driving. SANDAG will continue to work closely with stakeholders to explore innovative solutions to improve mobility options.
E254	Saed Hagi	N/A	When will they start developing the grand central station and where? What’s the expectancy time or projection of The Big Five moves to completed? Are we really having faster rail than the current trolley we use in the future?	<p>Preliminary environmental work is on the Central Mobility Hub is currently underway. Information about this project can be found on: <a href="https://sandag.mysocialpinpoint.com/centralmobilityhub">https://sandag.mysocialpinpoint.com/centralmobilityhub</a>.</p> <p>The Central Mobility Hub will be designed to accommodate both existing Bus, Trolley, COASTER trains, and Pacific Surfliner trains as well as new higher-speed commuter rail services envisioned in the 2021 Regional Plan.</p>
E255	Salvador Bernal	SanDiego350	In a rich country, the rich take public transport. Prioritize public transport.	The 2021 Regional Plan seeks to offer fast, safe and reliable transportation options for the San Diego region that make public transit a competitive alternative to personal vehicles.
E256	Samar Alyas	El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative**</b></p> <p>We are so thankful for these lovely projects up coming to our state. #1 As a parent for a high school student I would like this project to find a way to make it easy for high schoolers to get to the schools because they are away more than 3 miles. #2 We would like to support the idea to make it affordable to students who are less than 25 years so they could get to school ASAP.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
E257	Sandra Buehner	N/A	Until you can lower the cost of housing in San Diego County, this gas tax per mile hits those who can least afford it. People who live in Tijuana and those who live in Temecula and each work in various locations throughout San Diego County.	The 2021 Regional Plan is a long-range planning document and is required by federal law to provide a reasonably feasible funding plan. Significant additional work, including public involvement, pilot testing, legislation and much more will be necessary to inform implementation of elements of this plan. At a minimum, this plan is updated every four years with the latest in planning ideas and concepts. There will be two additional regional plans developed prior to the 2030 planned timing of the roadway usage fee.
E258	Sandra Candler	Cajon Valley Union School District/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>After viewing the Draft 2021 Regional Plan at the El Cajon Collaborative meeting on 7/6/21, I was amazed at how well thought out the plan seems to be. I appreciate the city listening to the</p>	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .



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			community and taking their comments in consideration of what is being prepared for the future. As a school district employee and working with the families that will really benefit from a centralized hub, it opens possibilities for opportunities in learning, training, and employment for needy and low-income families. It is exciting to see this work moving forward.	
E259	Sebastian Frias	SanDiego350	<p>First of all, I want to thank the staff at SANDAG for taking seriously our climate emergency and addressing it in this Regional Transportation Plan draft.</p> <p>However, I believe because of the urgency of the issue we must speed up some of those goals. We have an ecosystem and some members of our city who do not have all that time to linger without progress.</p> <p>I want to ask specifically that you reduce your Green House Gases output more than the proposed 40%. There are estimates that put San Diego's transportation at half of it's emissions, that with the airport in Downtown and with the overwhelming majority of people driving to work makes some of the air in San Diego very unhealthy. I request that you up your reduction and speed up the process for this decrease.</p> <p>When I was in college, I got to travel to Madrid to study abroad. I did not have the means to buy a car, and to get to the university I had to take the metro and then a train. This college experience would have been slightly different had there not been such a good public transportation system, and a 20 euros monthly passes for people under 25 years of age. Talking to the international students in San Diego, many feel like their only alternative is to rent a car or use rideshare apps, both which dramatically increase their study abroad costs. Not only for that small portion of the population would it be important, but for our local students, the thousands of them like my sister who use the bus at Liberty Station to go to High School from Chula Vista. This and to increase the frequency and times for transportation would be a great benefit to our beautiful city of San Diego.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E260	Sheri and Art Armendariz		<p>Thank you for the wonderful emails and communication of goals. However, the huge website is time consuming for average citizens to search. A better search feature is needed from our mobile phones.</p> <p>There is no need for an expensive walkover/ bike over bridge in Encinitas, proposed to connect the Union Streets over I-5.</p> <p>There are two already within a mile. One at Encinitas Blvd. and one at Leucadia Blvd.</p> <p>Our small Union Street already has an apt. complex coming and the amount of traffic will be dangerous to bikes and pedestrians.</p>	<p>We have worked with our project partners at Caltrans to include the North Coast Bike Trail projects in our Final 2021 Regional Transportation Plan as part of the Adopted Regional Bike Network. Caltrans will be the implementing agency working along with the individual jurisdictions to complete their segments of North Coast Bike Trail as per the NCC PWP/TREP, which includes the Union Street connection.</p> <p>Your comment was forwarded to Caltrans.</p>
E261	Sophia Waker	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>Making these changes will increase the amount of people on public transit systems!</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E262	Stacey Singh	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG</p>

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			hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	<p>looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E263	Stephanie	N/A	Patients at Samahan Health center in Granger location were affected by the removal of the bus stop at Granger. The next bus stop is not until 1 mile down from the clinic. Patients at Samahan are mostly elderly and is not very convenient to have a bus stop so far away from their pcp's office.	MTS is responsible for the placement of local bus stops. We have forwarded your comment to them.
E264	STEVEN GELB	N/A	<p>Every day the news brings us more evidence of looming ecological collapse.</p> <p>This morning it is the deterioration of the Gulf Stream which will have devastating effects on civilization world wide as it progresses. SANDAG must revise the RTP to prioritize transit infrastructure now, rather than committing to road projects.</p> <p>I take transit as much as I can to avoid contributing to global warming in my car. But I've had to use my car when I'd prefer not to because the system is so limited and slow. For example, I had a weekly meeting that ended at 9:00pm in Rancho Penasquitos. The number 20 bus I would have taken to come home did not run that late, so I had to drive.</p> <p>Please create a quality transit system in San Diego as quickly as possible.</p>	The Regional Plan includes a variety of new transit options that will make transit a more optimal choice for many riders.
E265	Steven Koch	MTGL, Inc. - Senior Vice President	My company provides a daily service needed for construction. Testing & Inspection services are included with the general contractors bid however we are a non-union firm which excludes us from working on most projects. Is there an effort for SANDAG to sponsor a Project Labor Agreement that would allow non-union firms to work with union signatory contractors for up and coming projects? MTGL testing labs is a certified DBE and Caltrans certified firm.	<p>On July 23, 2021, the SANDAG Board authorized SANDAG staff to begin negotiations with the San Diego County Construction Trades Council to execute a Community Benefits Agreement or Project Labor Agreement. However, California Labor Code Section 2500 (2) with regards to Project Labor Agreements, permits all qualified contractors and subcontractors to bid for and be awarded work on the project without regard of whether they are otherwise parties to collective bargaining agreements. Please note, that the Board has only authorized negotiations of a Project Labor Agreement and has not yet approved it. For more information regarding the Community Benefits Agreement and the Board of Directors, please see: <a href="https://www.sandag.org/index.asp?fuseaction=meetings.calendar">https://www.sandag.org/index.asp?fuseaction=meetings.calendar</a>.</p>
E266	Susan delos. Santos	N/A	How do I avail of the bus schedule?	The 2021 Regional Plan includes increased service spans for the trolley and bus service up to twenty hours per day. The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24 hours.
E267	Susan Duerksen	SanDiego350	<p>Thank you for doing better, but we are out of time. By still putting highways first, the draft Regional Transportation Plan doesn't match the urgency of the climate crisis.</p> <p>We need reliable, accessible public transit now! That means 24-hour service and 10-minute frequency, at least on major bus and trolley routes.</p> <p>We have to get out of our cars. San Diego sorely needs decent public transit. Stop wasting time, please.</p>	<p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on</p>



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				planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E268	Susan Pedersen	N/A	<p>SANDAG officials , San Diegans are Not in favor Of this tax ! it's is Not acceptable .</p> <p>If you persist in trying to add this to</p> <p>Over burdened tax payers .</p> <p>We will see if we can remove this board</p> <p>from our County .</p> <p>Time to Stop this unlawful burden to working People of San Diego .☹️</p>	Thank you for your comments.
E269	Susan Wilding	N/A	<p>I would like to know what are the specific community plans for the Pacific Beach and Mission Beach communities. I see you have slated bus-lines every 10 minutes, and a Last Mile Delivery and Ride Hauling services. It appears that you have quite a number of vehicles on the road, and none of them as actual community members. Additionally, I would like to see what you have slated for housing and parking.</p> <p>Also, can you mail me a copy of your plan to read.</p>	<p>The Regional Plan outlines the following projects in the Pacific Beach/Mission Beach areas. These proposed projects can be viewed in more detail using the data viewer on <a href="https://sdforward.com/envision">SDForward.com/envision</a>.</p> <p>Pacific Beach Mobility Hub Complete Corridor Arterial improvements on Ingraham Street, Mission Boulevard, and Grand Avenue. On-street and off-street bike and pedestrian facilities from Pacific Beach to East Mission Bay. On-street bike and pedestrian facilities on from Mission Boulevard to Pacific Beach Drive. <i>Rapid 292</i> – Pacific Beach to Kearny Mesa via Balboa Avenue to Grand Avenue. On-street bike facilities from Pacific Beach to Mission Beach via Cass Street. Next Gen <i>Rapid</i> service on Route 30 to the Balboa Station.</p> <p>Specific community plans and decisions regarding land use will remain under the authority of local jurisdictions and will require future collaboration with community members and the City of San Diego.</p> <p>A SANDAG staff member will be in contact with you regarding how to obtain a printed copy of the requested documentation. The full draft 2021 Regional Plan can be viewed on our website at: <a href="https://www.sdforward.com/mobility-planning/2021-regional-plan-draft">https://www.sdforward.com/mobility-planning/2021-regional-plan-draft</a>.</p>
E270	susana arnold	N/A	As a North County resident, I support the 2021 Regional Transportation Plan. It is important to me that we reduce greenhouse emissions for a cleaner environment and provide clean rapid transit for people of all ages connecting ALL of San Diego. I support timely rapid transportation for all San Diego County community members who support San Diego's business community.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://sdforward.com">SDForward.com</a> .
E271	Tarik Abdennabi	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>I also think that the growth of public transit is necessary for any legitimate city to grow as a city. Southern California is severely lacking in that department when compared any big city in the U.S..</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E272	Theresa Lane	Sunrise Movement	<p>I'm a volunteer with the Sunrise Movement.</p> <p>Every San Diegan deserves access to high-quality transportation and economic mobility, especially young people ages 24 and under and seniors.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway,

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			<p>We urge SANDAG to amend Appendix A of the 2021 Regional Plan to declare that no-cost transit passes for youth ages 24 and under receive priority when Transit Fare Subsidies are allocated.</p> <p>Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. No-cost transit passes is a key investment necessary for our region's equitable economic recovery.</p> <p>No-cost transit passes for all youth ages 24 and under ensures generations of lifelong transit riders are part of our long-term strategy to build a greener and equitable San Diego.</p> <p>No-cost transit passes will connect youth to school, work, medical care, internships, and other early-career opportunities.</p> <p>Programs like these exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles.</p> <p>I urge the board to take bold action to build a greener, healthier, prosperous, and just future in San Diego. Please amend the Plan to include Youth Opportunity passes as a priority.</p>	<p>staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E273	Tiffany Maple	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>As a native San Diegan and East county resident, I've had to drive everywhere as public transit hasn't been a relief or accessible option. That contributes to traffic and pollution as I would love the option of a better designed transit system.</p> <p>I ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. I so ask that you make it very affordable so low income communities can use it.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E274	Tina Tran	SanDiego350	<p>Hello, I am with SanDiego350. First, I want to thank the staff at SANDAG for their efforts in addressing climate and equity in this draft for the Regional Transportation plan. However, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>I want to ask you to move faster to accelerate greenhouse gas emission reduction goals. As a youth, I fear for my future on this planet because of climate change, and I live not far from those wildfires every year.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E275	Tom Abram	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. There are still many barriers to expand the amount of people taking public transit on a regular basis. We need to make it more convenient and affordable for all people to take benefit of transit.</p> <p>The climate crisis is already here and affecting us. We have to take a leadership position to reduce our own regional emissions and serve as a model for others.</p>	<p>SANDAG recognizes the urgent need for reduction of GHG emissions, especially in our most marginalized communities, as a key aspect in an equitable and sustainable future for the region. Please see Attachment 3 of Appendix H: Social Equity: Engagement and Analysis, where you will find a list of transportation projects aimed to reduce pollution exposure in our region's disadvantaged communities in accordance with AB805 and CalEnviroScreen 3.0. More detail on phasing and funding allocations to these projects can be found in Appendix B: Implementation Actions.</p> <p>Additionally, one of the near-term Implementation Actions listed in Appendix B will be a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth. SANDAG</p>

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			<p>While managing the sustainability efforts at SDSU, I encouraged students, faculty, and staff to take transit. Even with an incredible transit station on campus, only a small portion of the community took transit to campus. Barriers included frequency and cost, especially for low income students. I'd encourage you to work with SDSU and other large campuses and organizations to develop universal transit passes. We also need programs to normalize and get people comfortable with transit. A lot of hesitancy was from people who never took transit in their lives.</p> <p>I encourage you to emphasize transit rather than single-occupancy vehicles to reduce our emissions and address equity issues here in San Diego.</p>	<p>also is currently working with the Social Equity Working Group to develop near-term solutions to address transit service improvements, amenities, and subsidized transit fares.</p> <p>In Appendix U: Cost Estimation Methodology, Table U.2 captures the transit fare subsidies to riders throughout FY2026-FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U.</p> <p>Lastly, another near-term action of the Regional Plan includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. Through this, SANDAG aims to provide accessible, educational resources on transit are readily available as we advance with our next OS system. More information on the Digital Equity Strategy and Action Plan can also be found in Appendix B.</p>
E276	Tony Ramirez		<p>I looked through your website and its very difficult; next to impossible, to locate where to leave input for the user tax being proposed. Today being the deadline, please note that I oppose the tax.</p> <p>We already pay high taxes on everything: gas, property, vehicle registration, sales, state income. etc.</p> <p>How about stop spending so much money on landscape? This area is arid; look at Nevada.</p> <p>And how about taxing bicyclist for these new bike lanes and restriping.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. While the design of the program has not yet been determined, initial assumptions included in the Regional Plan is that the regional road usage charge would be a user-fee for use of roads in San Diego County. So a San Diego County resident would not be charged a San Diego user fee for miles drive in other counties, and residents of other counties would be charged for miles driven in San Diego county. SANDAG will rely on coordination with other agencies in California along with the State Department of Transportation to integrate the selection of technology, collection methods, and account management to ensure a consistent experience for travelers.</p>
E277	Tore Hultgren		<p>It appears that SANDAG's 2021 Regional Transportation Plan suggests that public transit be expanded and that the driving and parking of cars should be made costly and difficult. Obviously, mass transit can significantly reduce traffic congestion and greenhouse gasses. It is particularly important to provide a public transportation option for commuters. Trams and buses should not only reach major employment areas but must be extended deep into residential areas with stations that provide free and sufficient car and bike parking to accommodate short distance driving from the homes of commuters.</p> <p>The cars will be with us now and in the future when they all become electric, powered by wind, solar, wave and nuclear electricity generation. Free parking will always be needed at local shopping areas, even at regional ones, because there is a limit to what you can carry by foot or bike. Also, parking will be needed at places like Costco and Home Depot where you often purchase heavy items. Likewise, the car will be needed to bring the surfboard and the picnic to the beach. My point is that free - or reasonably priced - parking, must still be provided, and there is no reason to punish the driver for trips that are difficult to make by public transit. Higher fees will not stop the drivers when they need the car.</p>	<p>The 2021 Regional Plan has redefined the transit network to include a 'support system' of regional Mobility Hubs and Flexible Fleets to expand the reach of transit to ensure major destinations are more accessible. Supportive land use combined with high quality transit service and an array of on-demand Flexible Fleets can offer a '15-minute city' experience in and around each of the regional mobility hub coverage areas featured in the Plan. Between now and 2050, it's anticipated that the drive alone mode share will be significantly reduced. Cars will still play a part in the mobility ecosystem, yet effective parking and curb management strategies will be needed as multimodal options within communities increase. The key will be to make the right amount of parking available when it is needed and price it so that alternative commutes are encouraged and accessibility, equity, and economic development are promoted. Tiered pricing will need to be implemented; for example, free and lower priced parking in outlying, more suburban communities including 'gateway' (i.e., end-of-line Transit Leap stations) compared to market-rate pricing in our urban core and other denser communities.</p>
E278	Tore Hultgren	Retired AICP Planner	<p>It appears that SANDAG's 2021 Regional Transportation Plan suggests that public transit be expanded and that the driving and parking of cars should be made costly and difficult. Obviously, mass transit can significantly reduce traffic congestion and greenhouse gasses. It is particularly important to provide a public transportation option for commuters. Trams and buses should not</p>	<p>The draft 2021 Regional Plan's network of mobility hubs includes strategies such as priced parking in commercial areas in combination with the deployment of on-demand Flexible Fleets, including services for seniors. Parking pricing is one of many travel demand management strategies communities can implement while ensuring there is adequate</p>

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			<p>only reach major employment areas but must be extended deep into residential areas with stations that provide free and sufficient car and bike parking to accommodate short distance driving from the homes of commuters.</p> <p>The cars will be with us now and in the future when they all become electric, powered by wind, solar, wave and nuclear electricity generation. Free parking will always be needed at local shopping areas, even at regional ones, because there is a limit to what you can carry by foot or bike. Also, parking will be needed at places like Costco and Home Depot where you often purchase heavy items. Likewise, the car will be needed to bring the surfboard and the picnic to the beach. My point is that free - or reasonably priced - parking, must still be provided, and there is no reason to punish the driver for trips that are difficult to make by public transit. Higher fees will not stop the drivers when they need the car.</p>	<p>curb space for both parking and loading/unloading of passengers and goods. SANDAG intends to use emerging technologies to provide a fast, safe, and reliable transportation system to the San Diego region. Personal vehicles will continue to be part of our transportation system, but we also intend to provide competitive transportation methods to the personal vehicle. By providing alternatives to the personal vehicle, we could actually alleviate highway congestion, make our roads and streets safer, and make our whole transportation system operate more efficiently.</p>
E279	Travis Jeremiah		<p>As a member of our San Diego county community, I look forward to the promise and future we have ahead of us as a society. I understand that the Big 5 moves are a part of that, and that sounds amazing.</p> <p>However, how we fund that should be looked at more intensely. I do not believe that a mileage tax is the right thing to do.</p> <p>While a gas tax is going to become less effective as EV's gain more market share, taxing every citizen on their travel is not the answer.</p> <p>Road trips to see family out of state, camping trips, and other recreational activities that require us to get to a location to start should not be taxed.</p> <p>Taking children to and from school, the jobs that cannot telecommute, and errands like grocery shopping should not cost money just to go do.</p> <p>I understand we need to create the funds to pay for these initiatives. But forcing citizens to pay a tax on their traveled distance in a vehicle is wrong. We created a society where travel is necessary for most of it. Taxing that necessity is advantageous and cruel, especially for those already in low income jobs, that require the commute to their jobs.</p> <p>I hope that as we look to our future, we do it in a way that lets us thrive together, and not punish us for our involvement in it.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
E280	Vaishnavi Kuppa	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E281	Valerie Chereskin	N/A	<p>Climate change is a threat to the planet. While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>



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E282	Veronica Osuna	n/a	Bus need daily maintenance.	Buses currently receive daily maintenance. As part of Covid protocols, buses are wiped and cleaned at the end of each run throughout the day.
E283	Vicky James	SanDiego350	<p>I want to thank the staff at SANDAG for their work in addressing climate and equity in this Regional Transportation Plan draft, but this plan doesn't move quickly enough to meet the URGENCY of the climate crisis, in my honest opinion.</p> <p>I BEG that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p> <p>I live in Ramona, and public transportation up here is a JOKE!! I'm pretty sure if you added more frequent busses, you might get more commuters using public transportation vs. driving up and down the hill on a daily basis.</p> <p>I realize that Ramona isn't a big priority, but it SHOULD be!!</p> <p>The number of cars going down the 67 to jobs in Poway, San Diego, El Cajon and beyond cause serious congestion EVERY weekday, but there are NO good options for those commuters.</p> <p>Adding routes, adding more busses, along with community meetings to get LOCAL input on the needs of those commuters, would go a long way toward decreasing the amount of emissions generated by the hundreds of cars that make that commute on a daily basis.</p> <p>Widening the 67 is just a stop-gap measure that makes it easier for those already commuting, but does nothing to help with the climate crisis we find ourselves facing right NOW!!</p> <p>I've lived in San Diego county since 1956, growing up in Poway and living in various parts of inland N county forever. I've seen 2 of the largest fires in the county firsthand, watched RB burn... BURN!! I was told to evacuate during that fire. Now I live in the Witch Creek area E of Ramona, an area that burned in both the 2003 and 2007 fires, and where the 2007 fire first started. Last summer the temperature at my house hit 121, a temperature I've NEVER experienced in my lifetime, nor EVER thought I'd experience HERE, at my home!!</p> <p>Climate change is happening before my eyes, at a rate BEYOND what scientists predicted, and it's not gonna get any better without BOLD action. But there ARE steps that can be taken to slow it down, if people and governments start working TOGETHER to reduce OUR impact!!</p> <p>We don't have time to wait...</p>	The San Vicente Comprehensive Multimodal Corridor Plan (CMCP) will study ways to improve transportation safety, provide emergency evacuation options, maintain rural community character, and create greater trip reliability and efficiency.
E284	Violet Mooberry	N/A	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
E285	Viona Deconinck	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn't move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>I'm from Belgium and I miss the sense of community which is created through the repeated use of public transport. Also the sense of freedom. Capitalism is the cause for the increased reliance on cars and we are seeing more and more how capitalism is not sustainable.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the</p>	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.

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			hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars.	Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
E286	Virginia C. Hire Damrauer, MLIS, MBA, MFA, EJD		<p>I attended the online meeting tonight (Wednesday, 30 June) for Central San Diego residents to discuss and comment on the SANDAG draft 2021 Regional Plan. I truly appreciate the ability to provide my input as a citizen of San Diego.</p> <p>I was happy to hear one of the other citizens with the screen name “RightCow LeftCoast” ask about transit plans between San Diego and Imperial Valley as one of his multiple questions. I apologize, but I did not hear clearly what the reply was about that part of the transit plan.</p> <p>In support of a regional approach to affordable housing, please consider the creation of a new East-West Transit comprehensive solution (a mix of Commuter Train, Commuter Bus, Trolley, Commuter Airplanes, anything, everything, etc.) from El Centro/Imperial Valley to Central San Diego. Please also include solutions for First, Second, and Third shift workers, and weekend workers (I work 2nd shift and some weekends).</p> <p>The rationale behind this request is that there are open jobs in San Diego and there is still plenty of affordable housing (\$1300 or less per month) in farthest East County, El Centro, and Imperial Valley. The option of reliable transportation between Imperial Valley and San Diego County can quickly and significantly reduce existing homelessness, prevent emerging homelessness in the first place, reduce housing anxiety, and will relieve some of the pressure in the San Diego housing market while encouraging workers like me to fill open jobs.</p> <p>Thank you again for this opportunity to represent San Diego workers like myself, and to voice our concerns.</p>	<p>SANDAG recognizes the need for more affordable housing for people of middle to low incomes households that are near employment centers and a variety of transportation options. SANDAG is currently developing a Regional Housing Incentive Program and will take several factors into consideration to ensure the program meets housing needs and the goals of the 2021 Regional Plan. The housing program will consider climate change, climate resilience, and consistency with the transportation improvements and land use goals included in the 2021 Regional Plan. SANDAG will also coordinate with the Social Equity Working Group and other interested stakeholders to ensure the housing program promotes equity and addresses issues like gentrification and displacement.</p> <p>SANDAG acknowledges that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights.</p>
E287	Wendy Mihalic	SanDiego350	<p>I am a proponent of TOD but its hard to convince others of its benefit when our transit system is still so lacking - even in La Mesa which has five (underutilized) trolley stations! The vision in this RTP is much appreciated but falls short to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>Please move faster in meeting targets for emissions reduction, transit projects, and the hours of service and frequency of transit so that our public transit system can be a meaningful alternative to cars. We are facing a climate emergency. Our actions need to reflect that.</p>	The 2021 Regional Plan meets the region’s required greenhouse gas emission reduction target by 2035 through a combination of both land use and transportation strategies that allow for a meaningful alternative to cars for more trips. The Plan includes investments in both the existing public transit system to improve hours and frequencies of service as well as new Rapid bus, light rail, and commuter rail services.
E288	William Wellhouse	SanDiego350	<p>Thank you for all of the work you have put in to this new transportation plan. I strongly support your efforts to address climate change and climate justice but I would ask that you move more quickly in these two areas:</p> <p>1) Accelerate the reduction in GHG emissions. We need to move quickly to reduce the worst impacts of climate change, many of which we have been witnessing all over the world in the past few months.</p> <p>2) Move forward the plan to offer youth opportunity passes. Before I retired I was a principal of a charter school in City Heights. Many of my students were low income and lived at a distance from the school. The school itself had to purchase bus passes for the students so they could attend. Providing low income students passes should be a high priority and offered as soon as possible.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
E289	Xi Li	SanDiego350	<p>While I want to thank the staff at SANDAG for their strides in addressing climate and equity in this Regional Transportation Plan draft, this plan doesn’t move quickly enough to meet the urgency of the climate crisis and give those reliant on transit the relief they need.</p> <p>We ask that you move faster in meeting targets for emissions reduction, transit projects, and the</p>	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.



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E290	Ynoi	N/A	Provide more secure and safe transportation for all. I took the trolley once and then the bus going to the airport. I noticed how filthy the trolley was at that time, the trash were all over. homeless people came in and out looking for food inside and even sitting in the handicapped reserved seats. You should provide security at all times and made sure that no eating and drinking should be allowed. Cleanliness and safety should always be the priority.	Operational subsidies are included in the Regional Plan. Every trolley includes security cameras and roving transit security officers. The current policy does not allow for drinking or eating on transit services.
E291	Zainab Salih	Barrio Logan College Institute/El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>The plan looks very interesting and promising. I can see it will help the underserved communities in El Cajon. Providing public transportation can help them to go out and engage with other activities outside El Cajon. The plan to provide easy-to-use, easy-to-access public transportation will help them to come over this obstacle. Also, the goal indicating ways access for students and the workforce to reach their location in a timely manner; this is huge for our low-income families. Students usually pick the nearest university or even change to the community college because of transportation issues. I knew about the application on the phone; I would like to see if it will be provided in different languages. We need to communicate with the parent using their native language. Today parents are tomorrow seniors, and the Arabic language will be an essential aspect to avoid confusion and encourage utilizing this facility and the transportation. App, Maps, and messages communicated during the road are necessary to be provided in different languages.</p> <p>Training for families on using the transportation, routes, and app will bean essential step to start establishing the new norms. Starting with school students will plant a person in every household that has the ability and knowledge to advise and help riding the transportation.</p>	<p>We appreciate your support and feedback. One of the Regional Plan’s near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. We have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations (such as for Arabic) and translated educational resources on transit are readily available as we advance with our next OS system and build upon improving our existing transportation systems.</p> <p>Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a>.</p>
E292		El Cajon Collaborative	<p><b>**Comment submitted to SANDAG via El Cajon Collaborative from presentation from El Cajon Collaborative on the Regional Plan on July 6, 2021**</b></p> <p>Enthused to see how transportation is addressing a transformation that is way overdue, that is all inclusive of its community members.</p> <p>I wanted to also hear what SANDAG is doing to address economic barriers the community is experiencing with accessing affordable public transport. Will you be offering equity focused supports such as financial assistance or reduced fares for community members to increase their ridership.</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.

# Appendix G Attachment 7C: Voicemail-Sourced Public Comments and Responses

The table below contains all comments received via phone during the public comment period for the draft 2021 Regional Plan. Comments and corresponding responses are sorted by commentor name in alphabetical order.

Table G7C: Draft 2021 Regional Plan Responses to Comments – Voicemail Sourced

Draft 2021 Regional Plan Responses to Comments – Voicemail Sourced				
ID	Commentor Name	Agency	Comment	Response
V1	Glen Gillies	N/A	<p>***TRANSCRIPTION - VOICEMAIL***</p> <p>I live in the north county of San Diego. I'm calling to leave some information and thoughts about this proposed mileage tax. I read on a local news website that feedback was being collected through the end of today. My two cents worth is that, If mileage is taxed I'm going to cut down the amount of mileage that I actually drive. I'm going to consolidate trips. I'm going to use less gasoline. And that doesn't seem overall like a good way to support the local economy. I'm sure I'm not the only one who will have to rethink running to the store every other day and that kind of thing.</p> <p>I'm a full-time caregiver for my elderly mother. I'm technically unpaid, my small business closed during the pandemic, And I don't feel like taxing.... and we know California and San Diego have high taxes everything....I don't feel like adding a tax, psychologically a good way to go, for San Diego. I'm sure I'm not the only one like I said who will consolidate trips. think twice about going out. and will not actually spend more money on gasoline and so those taxes are collected.</p> <p>So those are my thoughts.</p>	<p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
V2	Lily Feingold	N/A	<p>***TRANSCRIPTION - VOICEMAIL***</p> <p>I'm calling about this proposed mileage, taxation. I'm I thought it was a joke. I thought it was an urban legend and apparently this is real. So I would like to get more information about it, and I'm against it. And so, I'd like to hear what SANDAG is thinking with this kind of madness. So thanks, look forward to hearing from someone. Bye.</p>	<p>Nationwide states and regions are confronting the shortfalls of gas tax revenues to fund maintenance, operations, and construction of their transportation systems. The federal gas tax was the largest source of transportation funding for many decades. However, the federal gas tax per gallon has not changed since 1993, that is when the minimum wage in California was \$4.25. The federal gas tax does not grow with inflation and the purchasing power of that source has diminished over time. States and regions have implemented their own sales and gas tax measures to try and meet the needs of their transportation systems. However, the best tax measures tied to fossil fuel consumption will continue to erode in time as vehicle technologies change.</p>
V3	Rebecca Neary	N/A	<p>***TRANSCRIPTION - VOICEMAIL***</p> <p>I live in Jamul. And I sent an email at public information at SANDAG.org, but I wanted to tell you about a person. I'm going to have him call you too, but he'll be nervous. You are proposing with other government organizations, a potential gas Usage Tax, and people who are low-income like me, or my friend who makes about \$20,000 a year, will be impacted by this.</p> <p>If we lived in town, I used to live in the city of San Diego and used to take buses everywhere. I had a car, but sometimes it'd sit for three or four days. I'd have to go start it, I wasn't driving it enough, I didn't want the battery to run down.</p> <p>My friend, he lives in El Cajon, and if he had one job for eight hours a day he could go on public transit. But as it turns out at 70 he's still working, he goes to nursing homes. He put on entertainment which is psychologically very important. And then he goes from place to place; he's working for about an hour to 4 hours at a time. And he has to travel more than once a day, and sometimes up to North County and so forth.</p>	<p>The San Diego Forward 2021 Regional Plan is a federally required long-range planning document with horizon years of 2035 and 2050. It is a requirement to provide a reasonable and feasible funding plan. The road usage charge may be phased in as gasoline sales continue to be phased out through emerging technologies.</p> <p>SANDAG intends to use emerging technologies to provide a fast, safe, and reliable transportation system to the San Diego region. Personal vehicles will continue to be part of our transportation system, but we also intend to provide competitive transportation methods to the personal vehicle. By providing alternatives to the personal vehicle, we could actually alleviate highway congestion, make our roads and streets safer, and make our whole transportation system operate more efficiently.</p> <p>SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing</p>

## Draft 2021 Regional Plan Responses to Comments – Voicemail Sourced

ID	Commentor Name	Agency	Comment	Response
			<p>He does carpool with his son, they go together, and they have a minivan, and its very good on mileage, but nevertheless its gonna take a big chunk out of what they make. He just can't afford it, he just can't. And neither of us can upgrade to even hybrid cars. We can't afford it. And that's what happened, there are people that care about the environment. I don't drive everyday. My car is parked, still; because I'm retired. I drive about twice a week, only down to El Cajon, and I combine all my errands, get three or four errands in all at once.</p> <p>And if I do go to the beach areas, my friend and I go together, so we carpool. But this new gas cost will be too much. And it's not the right thing to do right now, what you really want to do is give us strong incentives to get electric vehicles if we can.</p> <p>My number is ***-***-****</p> <p>I'll also have him call for himself, but I'm really better at being a shrill nag. He's a really nice man. So I did the shrill nagging, and I did also write you an email about my own situation.</p> <p>No, a gas usage tax, probably not a good idea. Trying to encourage people to have better mileage cars and electric cars, is a very good idea. But you have to help us, because we can't afford them. It just seems like the only way we can do this.</p> <p>When I used to live in Boston, I could go everywhere, I never owned a car. Till like 30 and I moved out here. Owning a car, I still use public transit, but now in this rural area I cannot. And I outlined in my own email reasons a person in these rural areas cannot.</p>	<p>revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>

# Appendix G Attachment 7D: Public-Meeting-Sourced Public Comments and Responses

SANDAG held six virtual open houses and two public hearings on the draft 2021 Regional Plan in June 2021 and July 2021. Comments provided during each meeting were recorded as public comments on the draft 2021 Regional Plan. Public comments were also recorded from the May 28, 2021, Board of Directors meeting when the draft 2021 Regional Plan was released for public review and at the SANDAG Social Equity Working Group meeting held on August 5, 2021. All ten of these meetings and links to available recordings are listed below:

- May 28, 2021 – SANDAG Board of Directors Meeting (full video recordings: English: [youtu.be/2cBPmgFM3vo](https://youtu.be/2cBPmgFM3vo), Español: [youtu.be/V8yqXQSWVtw](https://youtu.be/V8yqXQSWVtw))
- June 15, 2021 – North County Coastal Open House (full video recordings: English: [youtu.be/PsmOMdZgFiQ](https://youtu.be/PsmOMdZgFiQ), Español: [youtu.be/O\\_bqQ916fe4](https://youtu.be/O_bqQ916fe4))
- June 16, 2021 – County Unincorporated Open House (full video recordings: English: [youtu.be/zEaAR3R4m7E](https://youtu.be/zEaAR3R4m7E), Español: [youtu.be/26Nx9W4THaQ](https://youtu.be/26Nx9W4THaQ))
- June 22, 2021 – South County Open House (full video recordings: English: [youtu.be/AAvXOnz0pbY](https://youtu.be/AAvXOnz0pbY), Español: [youtu.be/wvr7VxrjFkg](https://youtu.be/wvr7VxrjFkg))
- June 24, 2021 – East County Open House (full video recordings: English: [youtu.be/vZgErtelF04](https://youtu.be/vZgErtelF04), Español: [youtu.be/TNb-Hh8SsIE](https://youtu.be/TNb-Hh8SsIE))
- June 28, 2021 – North County Inland Open House (full video recordings: English: [youtu.be/zpBpmlwWdmU](https://youtu.be/zpBpmlwWdmU), Español: [youtu.be/IPRnCFiaEZI](https://youtu.be/IPRnCFiaEZI))
- June 30, 2021 – Central San Diego Open House (full video recordings: English: [youtu.be/k9ugRtnMZps](https://youtu.be/k9ugRtnMZps), Español: [youtu.be/KzJjj7ZtqnM](https://youtu.be/KzJjj7ZtqnM))
- July 16, 2021 – SANDAG Transportation Committee Meeting (full video recordings: English: [youtu.be/QcALGIXoBwl](https://youtu.be/QcALGIXoBwl), Español: [youtu.be/X8SNnkvWU58](https://youtu.be/X8SNnkvWU58))
- July 23, 2021 – SANDAG Board of Directors Meeting (full video recordings: English: [youtu.be/v\\_iA8v7Xhzo](https://youtu.be/v_iA8v7Xhzo), Español: [youtu.be/MSu6G\\_I5X3M](https://youtu.be/MSu6G_I5X3M))
- August 5, 2021 – SANDAG 2021 Regional Plan Social Equity Working Group Meeting (full video recordings: English: [youtu.be/xo75XzN56mc](https://youtu.be/xo75XzN56mc), Español: [youtu.be/7f4F-Dk57rk](https://youtu.be/7f4F-Dk57rk))

The table below shows all comments received at the public meetings held during the public comment period for the draft 2021 Regional Plan and the corresponding responses, including responses provided by moderators during the meetings. Comments are separated by meeting then sorted by the commentor's name, in alphabetical order. Comments provided by members of the Social Equity Working Group during the discussion on August 5, 2021, are summarized and responses are provided in Table G7D. In addition, meeting minutes from the August 5, 2021, Social Equity Working Group meeting are included at the end of this attachment.

Table G7D: Draft 2021 Regional Plan Responses to Comments – Public Meeting Sourced

Draft 2021 Regional Plan Responses to Comments – Public Meeting Sourced				
ID	Commentor Name	Agency	Comment	Response
<b>May 28, 2021 – SANDAG Board of Directors Meeting</b>				
M1	Alicia Sanchez		<p>Buenos días mi nombre es Alicia Sánchez vivo en National City y mi testimonio es sobre el Plan Regional de Transporte. Yo uso el transporte público para ir a mi trabajo y mi experiencia es que cuando salgo de mi casa por las mañanas tengo que caminar unas cuadras para tomar el autobús en ese momento siento que vuela el aire limpio pero cuando llego a la parada del autobús ya no es lo mismo puesto que huele mucho a humo. Por eso quisiera pedir un cambio pronto no esperar muchos años para que cambien los autobuses de gas natural a que sean eléctricos ese cambio mejoraría el aire contaminado que tenemos en mi comunidad. Yo tengo mi esposo enfermo y sé que le hace mucho daño y vísperas de la contaminación. Por favor les pedimos un cambio lo mas pronto possible gracias.</p> <p>***</p> <p>Good morning, my name is Alicia Sánchez and I live in National City. I would like to comment about the Regional Transportation Plan. I take public transportation to go to work. When I leave my house in the morning, I have to walk several blocks to take the bus and during my walk the air smells clean; but when I get to the bus stop it smells like smoke. That is why I would like to ask for a change soon, do not wait many years to change natural gas buses into electric buses. This change would improve air</p>	<p>El Plan Regional 2021 propuesto apoya la electrificación de los autobuses del transporte público en la región y la regulación estatal de Transporte Público Limpio e Innovador. Los Anexos A y B incluyen el compromiso de SANDAG de invertir \$657 millones de dólares hasta el 2050 en autobuses e infraestructura cero emisiones que apoyarán los Planes de Implementación de Autobuses Cero Emisiones (ZEB, por sus siglas en inglés) de MTS y NCTD. SANDAG propone una inversión de \$325 millones de dólares entre el 2025-2035. Puede encontrar los Planes de Implementación de los ZEB de las agencias de transporte público en el sitio web de CARB: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>***</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and</p>

## Draft 2021 Regional Plan Responses to Comments – Public Meeting Sourced

ID	Commentor Name	Agency	Comment	Response
			quality in my community. My husband is sick, and I know that pollution is really bad for him. Please, we ask you to make changes as soon as possible. Thanks.	infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a> .
M2	Ariana Federico	Mid-City CAN	I am the lead organizer at Mid-City CAN and also a transit rider of 26 years. I'm actually here to ask the board to support no-cost transit passes for all youth ages 24 and under in our region. We need the RTP to commit to implementing youth opportunity passes as early as 2022 or as soon as funding becomes available. We need the board to avoid any delayed implementation. We've already seen that similar programs that exist here in within California like Alameda County, San Francisco have provided this program, and we know that these programs work. We have young people here today to share the positive environmental and social outcomes of implementing YOP. Youth opportunity passes is an investment San Diego must implement if we want to really have true meaningful conversations about equity and the future of transit in San Diego overall. Please include the immediate implementation of youth opportunity passes in the 2050 Regional Transportation Plan.	One of the Implementation Actions listed in Appendix B will be a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M3	Ava Raymond	Mid-City CAN	I'm here with Mid-City CAN. I'm a student at High Tech High Mesa as well as a transit rider. I ask you to support no-cost transit passes for all youth ages 24 and under in our region. We need the RTP to commit to implementing youth-opportunity passes as early as 2022 or as soon as funding becomes available. We need to avoid a delayed implementation. I am asking you to support this because the youth living in your communities today need youth-opportunity passes to connect with school, work, internships, and other opportunities. From personal experience, I know how much these passes could benefit San Diego's youth. Many of my peers rely on the city bus to get to school because our school has no school bus, and the fees for these services add up quickly. We know the youth-opportunity passes work because similar programs already existed with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles. Please include the immediate implementation of youth-opportunity passes in the 2050 Regional Transportation Plan.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M4	Bee Mittermiller	SanDiego350	I'm with SanDiego350. The release of the 2021 Draft RTP is a remarkable day in the history of SANDAG. The plan's use of emerging technologies, data-driven planning, and community input has the potential to usher in decades of progress in combating climate change, achieving equity for our communities of concern, protecting the environment, and providing connected mobility options for all San Diegans. Staff has put together a thorough and comprehensive report. SANDAG leaders, thank you for your vision and leadership. We look forward to providing comments on aspects of the plan that will ensure its success.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
M5	Bertha Rodriguez	Climate Action Campaign	I am with Climate Action Campaign, which is a member of the San Diego Green New Deal Alliance. We are encouraged by SANDAG's new direction and thank the staff for their work on the draft. For the final plan, we urge support to maximize emission reductions and to center social equity. I ran a youth center in San Ysidro right in front of a bus stop, but few youth would use it and many of my youth would walk down from San Ysidro High School because the bus routes and stops were not accessible and many of them could not afford to use public transportation daily. That is why it is imperative that we have youth opportunity passes, no-cost transit passes for youth 24 years old and under in order for youth to be able to go to school, after-school programs and jobs. And please prioritize investments in the communities of front lines of environmental injustice and climate crisis.	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
M6	Brenda Garcia Mijan		I live in South Bay. As a woman I can tell you, as a woman who relies on public transit I can tell you that transportation is an issue of safety. It's happened to me many times that while I'm waiting for the trolley or the bus, I am harassed by men and instead of getting a more frequent transit all I see is just more police presence in stations. Now we all know that that's not the solution, and I know that for a fact because I have had a chance to live in other cities in the United States and also in Europe, in Mexico, and the reason I felt safer in those places was because of their public transportation system which didn't make, which doesn't make people wait for half an hour for a trolley. That being said, I share this experience because I think that the Regional Plans need to take into consideration safety and just as a final comment, the Regional Plan needs to ensure that we reduce VMT and our greenhouse emissions.	<p>SANDAG, MTS, and NCTD are taking steps to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements. SANDAG will be working hard with the help of all of our passengers and representatives to ensure that this plan gets implemented.</p> <p>Additionally, SANDAG staff is bringing forward an item to the SANDAG Transportation Committee and the Board of Directors to amend the agency budget and act now to increase services on transit lines that have infrequent service in the evenings and late nights. Further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the</p>



## Draft 2021 Regional Plan Responses to Comments – Public Meeting Sourced

ID	Commentor Name	Agency	Comment	Response
				<p>proposed final 2021 Regional Plan.</p> <p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
M7	Brian Puller		<p>I'm going to give a special thanks to staff for putting on such an effective and comprehensive presentation. We also would like to thank SANDAG and their continued outreach efforts to help ensure underserved communities are at the table at this important transportation junction. The decisions that are made at times, new transportation projects have physically divided communities or impacted access to community services resulting in social and economic costs. It is important, critical to understand the impact of transportation and other infrastructure investments on our most vulnerable communities in order to better plan for the future. For these reasons environmental justice principles and social equity goals are an important consideration in the Regional Plan. Transportation projects have a significant affect on the quality of life in our underserved communities. So again, thank you for being to responsive to our needs.</p>	<p>We appreciate your support and feedback representing our environmental justice communities. Please continue to follow along in this process by visiting <a href="https://SDForward.com">SDForward.com</a>.</p>
M8	Carmela Munos	Vista Community Clinic	<p>I work for the Vista community Clinic, one of the cities doing community outreach for SANDAG in North County, San Diego. I have been working for adults in youth of several years, especially underserved communities. Many of these residents rely on public transportation because they cannot afford a car. So many of these families are very excited about the 5 Big Moves, they believe this new plan is more fair and equitable for everyone. The new plan will benefit everyone not only drivers. Thank you SANDAG all the efforts in creating an innovative plan that will provide options for all residents in San Diego. Thank you also for translating important chapters of the Regional Plan, this will help non-English speaking community members be more involved in the decision-making process. Looking forward for the public comment period.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://SDForward.com">SDForward.com</a>.</p>
M9	Carol Kim		<p>We're really excited to see this RTP that's been proposed today. It's got a lot of great things in it, and we're definitely going to be digging into the details as we move forward. I'm really looking forward to seeing some of these really good quality, good paying jobs go to local workers here in San Diego and absolutely on board with all the comments from our partners at the Quality of Life Coalition, as well as the Equity Committee talking about accessibility and the importance of including environmental justice communities and really tackling our transmission - our emissions and being able to lower those along with VMTs. So again, thank you for the work that's gone into this, and we look forward to continuing to partner with you. Oh, and I think Edwin G. is gonna be coming on, and you called on him. He was having issues with his technology.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://SDForward.com">SDForward.com</a>.</p>
M10	Carolina Goldwin	Environmental Coalition	<p>I'm with the Environmental coalition and the San Diego Transportation Equity working group. We know that the transit system doesn't work. It doesn't connect people to jobs and we have the seventh worst ozone pollution in the nation. 41 percent of our greenhouse gas emissions are coming from transportation so we submitted a letter with all our comments. We have short-term solutions that need to be seen in our communities fairly soon so that we could transport us into the future as soon as possible. We ask that the bus system be transformed by 2025, 24/h service, the youth opportunity pass, anti-displacement strategies, bathroom network, emergency ready system. All by 2025 a best electrification full transition by 2030 and long-term solution addressing the blue line. The blue line is the backbone of our transit system it should be our biggest move. We need to ensure the blue line infrastructure is not defunded and left to age without major investments.</p>	<p>The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. Additionally, the transit agencies will continue to electrify their fleets in response to state mandates. SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (to be included in Appendix B).</p>
M11	Christopher Allen		<p>I'm a San Diego native, proud Southwest Union carpenter and have helped build San Diego infrastructure for more than a decade. I have personally seen the relief in congestion and improvement of our communities by rapid transit, elevated rails, heavy rails, bike and walking pathways. We need to build forward-thinking infrastructure like this in America's finest city and build it with a skilled and trained workforce as well. Investment to infrastructure should also go back to the community members that build these projects. I support this Regional Plan and let's build community wealth together.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://SDForward.com">SDForward.com</a>.</p>



## Draft 2021 Regional Plan Responses to Comments – Public Meeting Sourced

ID	Commentor Name	Agency	Comment	Response
M12	Craig Jones	Alliance for Regional Solutions	I'm a representative to the social equity working group for the Alliance for Regional Solutions. The alliance is a robust collaborative of over 75 human serving and community serving organizations we also have representation from the cities of North County and the City of San Diego. Our mission is to provide services and improve the lives of the disadvantaged and there are significant underserved communities in North County. This plan is dramatically important to help them. Speaking of social Equity I want to reference a couple of things in the plan- well my time is wrapping up- I want to refer everybody to chapter 2 figure 2.4. This is a map showing a coverage of flexible fleets into the regional transportation system. Everybody go look at this figure 2.4 it is dramatically important to achieving social equity.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
M13	Daniel Wisma	Ironworkers Local 229	I'm the organizer with Ironworkers Local 229. I've been born and raised in San Diego, and I believe this proposed Regional Transportation Plan would make such a positive impact within our community, including thousands of good paying jobs here in San Diego. We're supportive of the changes being proposed in the 2021 RTP and hope that the board will be too.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
M14	David Johnson	San Diego Union Iron Workers out of Local 229	I'm with the San Diego Union Iron Workers out of Local 229. We're glad to see how much work has been put into this envisioning on how we can improve our transportation system in San Diego County. This is how we can provide the first-time safe, convenient, and realistic alternatives to driving. Will also improve local roads. It's long overdue. San Diego workers everywhere and across all industries will benefit from those options, as well as benefit from the positive climate impact we'll see through reduced carbon emissions. We're looking forward to partnering with SANDAG and the community in transforming San Diego County for better. We would love to be a part of this transportation movement in San Diego.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
M15	Delia Contreras		<p>Buenos Días mi nombre is Delia Contreras. Yo nací en Texas viví toda mi vida en México desde chiquita me llevaron regresé cuando tenía 32 años. En el 2004 sube la custodia de cuatro niños mis nietos y mis mi comentario es este mi experiencia es que cuando tuve esa experiencia de tener cuatro niños conmigo no no podía yo sostenerlos no conocían sistemas tenía y regresé muy joven Estados Unidos. Pero no conocía el sistema a esa edad cuando ya tenía yo cuatro nietos y mi experiencia es que en esta comunidad de City Heights es nosotros tenemos la línea morad. Y pase este no costo para los jóvenes porque yo supe lo que era no no sacar a mis nietos a ningún lado por no tener los recursos para llevarlos a ninguna parte. Ojalá que ustedes comprendan la necesidad que hay en mi comunidad y un minuto no es suficiente para contar una experiencia cuando hay niños con hambre con necesidad que no puede.</p> <p>***</p> <p>Good morning, my name is Delia Contreras. I was born in Texas, but I was taken to Mexico when I was a little girl, and I came back when I was 32 years old. I assumed custody of my four grandchildren in 2004. My comment is about my experience. When I had four children with me, I could not support them. I was not familiar with the system, and I came back to the United States when I was very young. But I did not know the system when I had my four grandchildren with me, and my experience is with the Purple Line that we have in City Heights. Even though children did not have to pay, I know what it means not taking my grandchildren anywhere because I did not have the resources to take them anywhere. I hope you understand the needs of my community. One minute is not enough to share our experience when children are hungry, and we have needs that we cannot satisfy.</p>	<p>Gracias por expresar sus inquietudes. El Plan Regional 2021 fue desarrollado en coordinación y con la colaboración de organizaciones comunitarias (CBO, por sus siglas en inglés) que representan a las comunidades de justicia ambiental. SANDAG realizó una evaluación de las necesidades de la comunidad trabajando con sus aliados de las CBO para evaluar las necesidades y oportunidades de los proyectos del Plan Regional 2021 a través de un significativo y representativo proceso que promovió la participación de la comunidades históricamente desfavorecidas . El propósito de la evaluación de las necesidades fue analizar exhaustivamente los servicios de transporte existentes y evaluar oportunidades para nuevas soluciones de transporte que aborden las necesidades específicas y los diversos contextos de las comunidades de la región. Este trabajo se integró al Anexo H del Plan Regional 2021.</p> <p>***</p> <p>Thank you for expressing your concerns. The 2021 Regional Plan was developed with coordination and collaboration with community based organizations representing environmental justice communities. SANDAG conducted a community based needs assessment working with the CBO partners to evaluate needs and opportunities for 2021 Regional Plan projects in historically underserved communities through a meaningful and representative community engagement process. The needs assessment was intended to provide a comprehensive evaluation of existing transportation services and assess opportunities for new transportation solutions that address the unique needs and diverse backgrounds of communities within the region. This work was integrated into the 2021 Regional Plan, Appendix H.</p>
M16	Elizabeth Lou		I am privileged to present to you today. I want to first thank SANDAG for being so inclusive in our community. I have seen great leadership in SANDAG including us, the refugees, the immigrants, and low-income here in San Diego, to understand the transportation system and services in this great city and county. So Nile Sisters is working with all refugees, immigrants here in San Diego, and we are also serving refugees from a different background in East County in El Cajon city with our wonderful partner Newcomers Support and Development, Mr. Tuama. I believe he's here so I'm here to say.	We appreciate your input and feedback in the Social Equity Working Group. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
M17	Esperanza Gonzalez	Environmental Health Coalition	Mi nombre es Esperanza Gonzalez, residente de City Heights y promotora de la Coalición de Salud Ambiental HC. Muchos residentes en mi comunidad dependemos del servicio de transporte público el mismo servicio que no ha mejorado durante muchos años. Es neciciente, sólo para trasladar de un lugar a otro. Tenemos que esperar bastante tiempo así esté cerca donde te diriges. En la parada de los autobuses es muy comunidad mirar cara de angust y desesperación de coraje y potencia porque no	SANDAG está consciente de que se debe hacer algo ahora para tener un transporte público rápido, frecuente, confiable y accesible, particularmente en la rutas de mayor uso. Nuestro personal llevará este asunto ante el Comité de Transporte y la Mesa Directiva de SANDAG antes de la aprobación del Plan Regional 2021 para modificar el presupuesto de la agencia y tomar medidas ahora para invertir en un transporte público que beneficie a

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			<p>llega el bus porque nos gasto y sabemos que esperar bastante tiempo así esté cerca donde la parada de autobuses e impotencia porque no llega el gas porque se nos pasó y sabemos que va a tardar el próximo y estamos mirando y mirando el reloj. El tiempo que pierdes en las paradas del autobús en el tiempo valioso para estar con tu familia estar en casa ayudándoles a tus hijos hacer la tarea es por eso que existimos en el plan Regional de transporte prioridades descentralizadas en comunidades como City Heights necesitamos mas frecuencia, mas rutas y servcio 24 horas en todos las comunidades. San Deigo tiene las familias trabajadoras merece un servicio mejor con mucho mas frecuencia para tener mas tiempo con la familia. [time expired]</p> <p>***</p> <p>My name is Esperanza Gonzalez, I live in City Heights, and I am a promotora (an advocate) with the Environmental Health Coalition of CH. Many residents in my community depend on public transportation services, the same services that have not been improved in many years. We need to travel from one place to another. We have to wait a long time even if you are going nearby. The faces you see at the bus stop are of anguish, desperation, anger, and helplessness because the bus is not arriving, because of the cost, and because we know we have to wait a long time even if the bus stop is close by. Helplessness because when the bus does arrive, we miss it and we know that the next one is going to take a while and we look at our watches over and over again. The time we waste at the bus stops is valuable and could be used to be home with your family, helping your children with homework. That is why we ask the Regional Transportation Plan to decentralize their priorities in communities like City Heights. We need more frequency, more routes and service 24 hours in all our communities. Working families in San Diego deserve a better service, one that is much more frequent so we can spend more time with our families. [time expired]</p>	<p>las comunidades de justicia ambiental. El objetivo de esta acción es aumentar los servicios en las rutas que tienen un servicio poco frecuente en las noches y madrugadas y/o crear subsidios para las tarifas de los jóvenes usuarios. También se modificará el Anexo A del Plan Regional 2021 final propuesto para aclarar aún más las mejoras propuestas para la red de autobuses, incluyendo mejoras en la frecuencia y el alcance del servicio.</p> <p>***</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
M18	Gary Hewitt		<p>I am a resident of San Diego. It's great work by SANDAG staff on what can really be a truly transformational plan. My question is what if we build all these great new projects and people just keep driving? Driving a car will continue to be a very attractive option, and people will need to be nudged into making the travel decisions which help make this plan work. So I think this plan can be supercharged with a very low cost program called TDM, or Transportation Demand Management, which reduces VMT by working with employers to reduce commute trips. The draft plan has a voluntary TDM program, and what I'm proposing today is instead having a mandatory TDM program, requiring employers with more than 50 employees to reduce trips to their work site by 20% over the first 5 years in the Regional Plan. So for some employers this would be providing incentives for carpooling and van pooling, flexible schedules, and allowing employees to work from home. For others who are not as flexible, it may be providing on-site bike parking or free transit passes for workers. For employees who can't implement these programs or meet the goal...</p>	<p>SANDAG has an existing TDM program, iCommute, which currently offers employers and commuters customized solutions for encouraging alternative transportation options. Some of these programs include offering incentives for carpool, vanpool, and transit; promoting shared mobility; promoting on-site amenities for commuters such as bike lockers and showers; and offering resources for developing telework/flexible work schedule programs. The 2021 Regional Plan proposes a Transportation Demand Management Ordinance that would require employers over a certain size to provide transportation benefits and amenities that encourage sustainable transportation choices. These types of TDM ordinances exist in other regions across the state. A near-term implementation action would be to complete a Transportation Demand Management Ordinance Policy Analysis. This policy analysis would detail the employers that the ordinance would apply to and mechanisms for implementation and enforcement.</p>
M19	Goyo Ortiz	Casa Familiar	<p>I am the community development choreographer at Casa Familiar in San Ysidro. As a community agency we're partnering with as a CBO with SANDAG for this endeavor and I would like to congratulate the SANDAG team for its comprehensive view of equitable regional transportation plan and I would like to ask members of the board to think about our working-class neighborhoods as you analyze this plan. Many of our residents depend on the public transportation not just through the 9 to 5 work week but on a 24/7 schedule, living under polluted air from our regional traffic from the international border. And we would also like to think about the blue line as it's been the backbone for our light rail transportation system for year and we would like for it to be given the priority it and it's communities [time expired]</p>	<p>The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. Additionally, the transit agencies will continue to electrify their fleets in response to state mandates. SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (to be included in Appendix B).</p>
M20	Gretchen Newsom	IBEW Local 569	<p>I am speaking on behalf of over 3,500 members of the IBEW Local 569. Today marks an exciting chapter for transportation in San Diego County. This new 5 Big Moves Regional Transportation Plan represents a milestone opportunity for elected leaders to finally abandon obsolete practices to bring our region into the 21st century, prioritize environmental justice, reduce dangerous climate emissions and create high road jobs for our local workforce. The moment to shape a healthier future where all residents to access safe, affordable and convenient transportation. We will be working with out quality of life coalition partners to review the specifics in greater detail and will be providing feedback on this very comprehensive document. We wish to offer our sincere congratulations to SANDAG staff on this major accomplishment. We look forward to continued collaboration.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>

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M21	Jacob Mandel	San Diego Bicycle Coalition	I'm the advocacy manager for the San Diego Bicycle Coalition. We're excited to enter the next phase of making our region's transportation system more sustainable, equitable, and efficient. The Bicycle Coalition is encouraged by the level of detail in the plan, and we thank SANDAG staff for getting this done. As we work our way through the draft to provide specific feedback, we hope that SANDAG leadership and our elected representatives make the decisions necessary to get San Diegans onto bikes, buses, trains, and out of their cars. San Diego's transportation system is long overdue for fundamental change and the Draft 2021 Regional Plan is just the beginning.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdforward.com">SDForward.com</a> .
M22	Jennifer Olguin	Environmental Health Coalition	I'm from San Ysidro. I've been involved with EHC since 2020. I live closer to a freeway than I do to a bus stop. We are closer to developing health issues than we are to public transportation. I urge you all to push for the blue line express and to improve the bus system now. As a teen I walked to places in the dark with my friends because public transportation was unreliable. I felt my heart racing because I was scared of what could happen. We risked our safety because it was faster to walk home than it was to take public transportation. Now I am older yet more terrified to use public transportation. I'm constantly on the look out for anything that could be a threat while I wait for that trolley or bus that often comes many minutes late. Life is precious and anything could happen within that time. Especially to young women waiting alone. The blue line express and buses must run faster and punctually to guarantee safety for everyone. We all deserve to experience comfort and knowing that we can use public transportation to get home quickly and safely.	SANDAG, MTS, and NCTD are taking steps to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.  The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.
M23	Jessie O'Sullivan	Circulate San Diego	I work with Circulate San Diego. Thanks for the presentation on the Regional Plan. At Circulate we'll be doing an analysis of how this plan compares with the 2015 plan including phasing and projects and we will be sharing our conclusions with staff and board members. We appreciate the help from SANDAG staff for sharing this information with us, prepare this analysis. In our preliminary review we were pleased to see funding for vision zero and several bus projects committed to early phases of the plan. San Diego needs a Regional Plan that prioritizes transit and active transportation. Again we look forward to digging in and we'll let you know what we think.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdforward.com">SDForward.com</a> .
M24	Joe Hood	Green New Deal Alliance	I am with the Green New Deal Alliance. We are enthusiastic and support SANDAG's plan. About half of San Diego greenhouse emissions come from transportation. To reach zero carbon, San Diego must drastically reduce emissions by shifting people out of their fossil fuel cars in to multiple, sustainable, and varied modes of transportation. We also urgently need high-density infill development. For the final plan, we urge you to maximize emissions reductions, prioritize investments communities on the frontlines of environmental injustice and the climate crisis. San Diego can't meet its climate goals without implementing your plan. Thank you to the board and staff who are pushing for a transportation system that centers social equity, create good union jobs, and secures climate safe future for all.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdforward.com">SDForward.com</a> .
M25	Jorge Gonzalez	EAC	I'm a regional community organizer with EAC and currently living in City Heights since 2012. I'm a San Diego, Tijuana border native fronterizo and have been living here most of my life. I'm a father of two and this topic is very important to me as I understand it will impact the quality of life for my kids and future generations and the RTP needs robust, holistic, and immediate investment centered in environmental justice communities. In order to alleviate heavy pollution that stand for multiple sources like buses and cars. If we want to transform the culture and take away the negative connotations of riding public transit we need community-based visionary strategies that stem from public transit riders experiences instead of financial gain formulas. As an organizer, I've heard many of the fares that discourage families to use public transit, even when living next to MTS trolley stations from the high cost of riding public transit to the connectivity that's lacking. All those issues really create situations that normalizes two bedroom households in City Heights to have three or five cars. My parents for instance live in Chula Vista. [timer stopped]	The 2021 Regional Plan includes investments to make public transit more convenient and affordable. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.
M26	Jose Franco Garcia	Environmental Health Coalition	I am with Environmental Health Coalition, part of the Transportation Equity Working Group. Just wanted to echo a lot of things that many people have said today about the need to improve the transit system so that it is more accessible. Getting more people on transit allows for more safety, more you know people use it not just when they have to but because it is convenient and it allows you to get to the places that you need to go to. Also echoing what other folks have said about the importance of this RTP or what we should be looking to do moving forward is making sure that it is connecting people where they live to where they need to go, whether that's work, whether that's getting their families to places. All of that has been echoed, and I want to agree with all that, and lastly what I say is	A better transit system is a fundamental component of this Regional Plan. Revenues to fund the transit projects don't come in all at once but dollars that are available are applied to ensure that the best projects are initiated first and that those projects address social equity considerations.

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			that workers and people in San Diego have been waiting for decades for a better transit system. So hearing that some of these things are not going to happen for another decade is discouraging. We need these improvements to happen now and to get us moving in the right direction as soon as possible. Thank you for this time and please listen to the people who spoke today and talked about the importance of moving this forward soon.	
M27	Katherine Rhodes		Thank you for such a thorough report you have here. I put it all together, and there's 4,175 pages to look through, but one of the comments I just wanted to make on Appendix A, the Transportation Projects, Programs and Phasing. I was wondering if you could add a column to the table for how much greenhouse gas emission reductions or additions that each project will actually provide and so if you could just add a column there so that way you know people could actually see it right next to how much it cost and how much it would reduce greenhouse gases. And then also I'm very much in favor of the free transit for youth. I think that if you get people young, and they're used to the transit, they might actually use it in the future, might not ever actually buy a car so thank you so much.	The overall impact on the transportation system on GHG emissions is shown in Appendix T in the various plan years (2025, 2035, and 2050). SANDAG's modeling tools don't allow for the calculation of contributions from individual projects and, even if possible, that type analysis would not appreciate the interrelationships amongst projects given the benefits of the system as a whole (rather than just a collection of individual projects).
M28	Kelvin Barrios	Laborers Local 89	I am the director of government affairs with Laborers Local 89 representing our business manager Valentine Macedo and our over 3,600 members in San Diego County. We would like to thank the work that the board and staff have put into bringing this new regional plan forward, but we do have some concerns on how exactly this will be funded and questions around what type of ballot measure the board may be already considering or outside efforts already in the works. We have concerns about talks being had around not including a taxpayer oversight committee or project list and stakeholders being left out of process. We do support the comments from our friends at CPI around an early action program, the Purple Line including City Heights, and the building of the Blue Line Express. We look forward to providing more detailed public comments in the future and staying engaged during this process.	<p>The Cost Estimation Methodology and Funding Strategies for the 2021 Regional Plan were presented to the SANDAG Board of Directors on March 12, 2021, Item No. 8B. This report and presentation described the various funding assumptions developed for the draft 2021 Regional Plan. The entire Board meeting can be found at <a href="http://www.sandag.org">www.sandag.org</a>.</p> <p>Appendix A includes specifics on projects such as track work and grade separations on the Blue Line, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582.</p>
M29	Kim Heinle	Bayside Community Center	I am with Bayside Community Center located in Linda Vista. We are a contracted CBO with the Social Equity Working Group, and we've been a part of the Regional Plan for years, and we're extremely grateful for the opportunity this morning to provide public comment and to weigh in on the plan. It's been exciting to see how much more progressive the plan has become over the years and how much more digestible and understandable it is to our common public. We know that this is in large part thanks to the working group, the Social Equity Working Group, that's helping to bridge this gap between regional planning and our community members who are directly impacted. Back in 2015, we got the Quick Reference Guide, and now we're getting the guide and now we're getting the plan translated into Spanish, and that's a huge step forward, and we're grateful for the SANDAG team, the board, my fellow CBOs, and of course our community members who are giving their time and input to help this Regional Plan in both an equitable and a sustainable direction.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
M30	Kira Tina	Center for Policy Initiatives and Transportation Social Equity Working Group	I'm a researcher and policy advocate at the Center for policy initiatives and transportation equity working group. The Regional Transportation Plan is our region's opportunity to create a vision for transportation that will work for everyone. That is why the Transportation Equity Working Group's ten big moves to transportation justice must be included in the RTP. For the final plan we urge the Board to first include a blue line express with frequent trips and 24/hr service. Second, continue serving the purple line serving central city heights and ensuring RTP prioritizes investments in the communities on the front lines of environmental injustice by phasing projects earlier in the implementation timeline. By investing in projects like the blue and purple line we can transform communities by connecting working people to job centers and creating reliable systems for those who need it most. While also making public transit a realistic option for those who currently rely on driving. Also including these transit improvements early in the RTP implementation is paramount to helping low income families, youth, and low wage workers who rely on transit better address their needs and improve quality of life.	The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (to be included in Appendix B). Also, transit subsidies are a component of the proposed Final Plan and implementation of those subsidies would include a consideration of low-income and youth populations.
M31	Magdalena Serda		Buenos días a todos Yo vivo en Imperial Beach desde el 2001 pero en el 2004 mi hija Magdalena entró a la misa aquí entró a la Southwestern College y entonces todo se complicó porque ella tenía que hacer tres horas al día de transporte. Para el 2006 mi hija Entonces ahora Magdalena entró a la universidad estatal de San Diego y esto le significaba ella 3 o 4 horas diarias de transporte para poder	SANDAG está de acuerdo con sus inquietudes y creemos que este Plan Regional transformará cómo nuestros residentes viajan, lo que permitirá liberarnos económicamente de las barreras del transporte. ***



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			<p>solucionar esto si nuestras hijas nuestras hijas querían ir a una universidad y tener una carrera profesional en la mejor vida tuvimos que comprar un carro para cada una haciendo un impacto enorme para nuestra economía el derecho de Educación se ve limitado por economía y el mal transporte. Ojalá que estén tenga mejores soluciones este estos cambios.</p> <p>***</p> <p>Good morning everyone. I have been living in Imperial Beach since 2001, but in 2004 my daughter Magdalena started classes at Southwestern College, and it was all very complicated because it took her three hours every day to travel in public transportation. In 2006 my daughter Magdalena transferred to San Diego State University and that meant spending 3 to 4 hours every day using public transportation. To solve this problem and because my daughters wanted to attend a university and obtain a professional degree, we had to buy each one a car which had a tremendous impact in our economy. The right to education is limited by the economy and poor transportation. I hope that there are better solutions and changes.</p>	<p>SANDAG agrees with your concerns, and we believe that this Regional Plan will transform how our residents travel, allowing for economic freedom from transportation barriers.</p>
M32	Marco Gorjardo		<p>Hola buenas tardes. Mi nombre es Marco Gorjardo, soy residente de North Park y soy nativo de San Diego y de Mexicali. Recientemente me integrado al equipo Regional de acción del EHC. Mi historia que voy a compartir es como joven usuario del sistema Público de camiones y se trata de crecimiento personal que yo tuve a través de las libertades que me dio este transporte público. Creo que es vital que le den prioridad en el plan Regional de transporte a los pases de autobús accesibles para jóvenes y para mejorar las rutas más eficientes dónde está la necesidad. Cuando yo descubrí como joven que podía depender de las rutas de camiones para salir de mi pueblo de Fallbrook y explorar independientemente el resto de San Diego [time expired]</p> <p>***</p> <p>Hi, good afternoon. My name is Marco Gorjardo and I live in North Park. I am from San Diego and Mexicali. I recently joined the Regional Action team of the EHC. I want to share what it means to be a young user of the public bus system. It is about the personal growth I experienced due to the freedom that public transportation gave me. I think it is very important to include in the Regional Transportation Plan youth passes and to improve the routes to make them more efficient where they need to be. As a young man, when I discovered that I could depend on the bus routes to leave my town of Fallbrook and explore the rest of San Diego by myself [time expired]</p>	<p>SANDAG sabe que se deben tomar medidas ahora para ofrecer un transporte público rápido, frecuente, confiable y accesible, particularmente en la rutas de mayor uso. Nuestro personal llevará este asunto ante el Comité de Transporte y la Mesa Directiva de SANDAG antes de la aprobación del Plan Regional 2021 para modificar el presupuesto de la agencia y tomar medidas ahora para invertir en un transporte público que beneficie a las comunidades de justicia ambiental. El objetivo de esta acción es aumentar los servicios en las líneas del transporte público que tienen un servicio poco frecuente en las noches y madrugadas y/o crear subsidios para las tarifas de los jóvenes usuarios. También se modificará el Anexo A del Plan Regional 2021 final propuesto para aclarar aún más las mejoras propuestas para la red de autobuses, incluyendo mejoras en la frecuencia y alcance del servicio. Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio asegurará que las partes interesadas públicas tengan la oportunidad de expresar su opinión sobre las alternativas. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los jóvenes menores de 19 años.</p> <p>***</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
M33	Margarita Moreno		<p>Buenos días mi nombre es Margarita Moreno soy residente de Nacional City. El día de hoy estoy pidiendo que se mejore el sistema de transporte público. Una de las decisiones importantes para mí es el Plan Regional del Transporte y es que los autobuses de MTS tengan un precio más accesible para que la economía impacte tanto a nuestros bolsillos y también queremos pedir que sea más frecuente el servicio entre semana para los que van al trabajo. Otra de las cosas que me gustaría es que el transporte sea también los fines de semanas de igual forma ya que muchas familias es cuando salen con sus hijos y tenemos que esperar mucho tiempo para que podamos tomar el transporte. Queremos</p>	<p>SANDAG está consciente de que se debe hacer algo ahora para tener un transporte público rápido, frecuente, confiable y accesible, particularmente en la rutas de mayor uso. Nuestro personal llevará este asunto ante el Comité de Transporte y la Mesa Directiva de SANDAG antes de la aprobación del Plan Regional 2021 para modificar el presupuesto de la agencia y tomar medidas ahora para invertir en un transporte público que beneficie a las comunidades de justicia ambiental. El objetivo de esta acción es aumentar los servicios en las rutas que tienen un servicio poco frecuente en las noches y madrugadas y/o ofrecer</p>

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			<p>que comen encuentra nuestras recomendaciones. Gracias por escucharnos. ***</p> <p>Good morning. My name is Margarita Moreno and I live in Nacional City. Today I am asking for improvements to the public transportation system. I think that one of the most important decisions of the Regional Transportation Plan is making the price of MTS more affordable since this would benefit our pockets. We also want to request a more frequent service during the week for those that travel to work. I would also like public transportation to be the same on the weekends because when many families go out with their children, they have to wait a long time to use public transportation. We want you to take our recommendations into account. Thank for your listening to us.</p>	<p>subsidios para las tarifas de los jóvenes usuarios. También se modificará el Anexo A del Plan Regional 2021 final propuesto para aclarar aún más las mejoras propuestas para la red de autobuses, incluyendo mejoras en la frecuencia y el alcance del servicio.</p> <p>Una de las Acciones de Implementación enumeradas en el Anexo B es un Estudio del Impacto Regional de las Tarifas. Este estudio asegurará que las partes interesadas públicas tengan la oportunidad de expresar su opinión sobre las alternativas. Se espera que el estudio finalice en el año fiscal (FY) 2024 e incluirá una evaluación de los subsidios para las tarifas de las personas de bajos ingresos, los adultos mayores, los estudiantes y los jóvenes. Mientras tanto, el personal de SANDAG, MTS y NCTD está trabajando con las partes interesadas en un programa piloto de un año que puede ofrecer tarifas gratis a los jóvenes menores de 19 años. ***</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
M34	Maria Cortez	City Heights Development Corporation	<p>I'm a resident here of City Heights, and I also work with the City Heights Development Corporation. Also volunteer with Mid-City CAN. I am proud to say that I am happy to hear about, amen, the Purple Line coming through City Heights. 44 years - no project should take that long. I hope I'm still alive to see this because I want this to happen sooner, if possible, than 2035. I am so happy for SANDAG and the staff here to take on the opportunity to see us to do with the Purple Line, and also Todd knows how long it's been, and the pain and everything we've gone through here in City Heights. All of us deserve the same as everybody else, and also I am supporting the youth-opportunity bus passes for 24 years and under. It's a longtime going, but yes, our students deserve the same as everybody else, and this is for everybody in San Diego.</p>	<p>Commuter Rail Line 582 (Purple Line) is included in the Plan to serve north-south travel needs in Sorrento Mesa, National City, Kearny Mesa, and University Heights. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is completing a more detailed ridership analysis of this route. The analysis is studying an alignment that would include stations in City Heights and at San Diego State University (west campus). Also, transit subsidies are a component of the proposed Final Plan and implementation of those subsidies would include a consideration of low-income and youth populations.</p>
M35	Marisa Garcia		<p>I've been a resident here in Logan Heights my whole life. Although my neighborhood is abundant culture and close community, another thing we have in abundance here that is not so great is the pollution that we have to live in. It is a reality that we cannot escape because it comes from every angle, the port, the industry, the freeways, and all the vehicle traffic associated with them. On the clearest of days you can still see a faint haze of smog in our skies and it breaks my heart to know that many of us living here, especially the children growing up in this like I did, will inevitably suffer from breathing an other health problems. I'm aware that this issue cannot be fixed overnight but we can work every day to change the factors contributing to the problem. There are many bus routes that pass through our neighborhood and each one adds to the pollution we have. By electrifying our bus fleets, you can change the negative factor into a positive one and start reducing the pollution we face daily. I strongly encourage your support and electrifying our bus fleet by 2030 to help us gain a healthier community. Our lives are really at stake and we would really appreciate that.</p>	<p>The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>Also, in 2020, SANDAG entered in a Memorandum of Understanding (MOU) between the San Diego Unified Port District, and the California Department of Transportation to work cooperatively on "improving accessibility, sustainability, and economic vitality" San Diego Portside communities, such as Barrio Logan. The MOU specifically calls for the reductions of greenhouse gases and other pollutants, without compromising the health of local community members. SANDAG will continue to work closely to improve the health and quality of life in Portside communities.</p>
M36	Mike Bullock		<p>I want to thank you again for the redirection of SANDAG compared to the past, and I do support the 5 Big Moves. Now as I heard that presentation, I am concerned about whether we will meet our 2030</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005</p>



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			climate stabilizing target and our other vehicle miles traveled reduction responsibilities. I didn't hear hardly any comments about that. I did notice that Ray Major did talk about behavioral change from pricing, but that's really all I heard and I think there needs to be information about how much we're reducing vehicle miles traveled with these projects, and I just point out that earlier people were talking about one or two cents a mile. Ten cents a mile going 10 miles, that would be 43 miles a month and parking downtown can be worth \$350 a month and at the county building it's free.	levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan. The proposed 2021 Regional Plan would provide travelers with more travel and mobility options in residential and employment centers that can lead to a reduction in vehicle miles travelled (VMT).
M37	Mike Townsend	Mid-City CAN	I'm with Mid-City CAN, and I am a student and transit rider. I ask you to support no-cost transit passes for all youth ages 24 and under in our region. We need the RTP to commit to implementing youth-opportunity passes as early as 2022 or as soon as funding becomes available. Avoid a delayed implementation. This is a crucial part of COVID-19 recovery and youth living in the San Diego community today need youth-opportunity passes to connect with school, work, internships, and other opportunities. As a student who often relied on public transportation to get to school, I understand first-hand the impact that transportation fees have on students. Similar programs exist with great success in Alameda County, Boston, San Francisco, and most recently Sacramento and Los Angeles. We know it works. Please include the immediate implementation of youth-opportunity passes in the 2050 Regional Transportation Plan.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M38	Mohammed Tuama	Newcomers Support and Development	I am with the Newcomers Support and Development. I would like to say that I'm working with newcomers and most newcomers are coming from active transportation countries, active transportation systems, and their voice were included in this plan. I would like to thank Hasan, Coleen, and Jane Clough, and Nile Sisters for making sure that newcomers from various languages were included and were listened to when this plan was made.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
M39	Naomi Sanchez		I'm a resident raised here in Barrio Logan, a medical assistant, a promoter for Barrio Logan with the environmental health coalition and entrepreneur. I believe everyone deserves the dignity of having a clean and safe way to get around. If we compare our bus stops to the ones in other places such as Point Loma and La Jolla there are noticeable differences. Bus stops over there have lighting, they are maintained to meet public cleaning list requirements and over there you even see people using the seating provided. Here people stand because they don't want to sit in a dirty space and honestly who would. Environmental Justice communities are transit dependent. We use it the most and yet we get the least funding. Our community already lives right next to highways and industrial areas which produce high amounts of pollutions that we have to deal with. Please prioritize environmental justice communities in the Regional Transportation Plan.	We currently have a process and methodology for the prioritization of projects located in Appendix A of the proposed final 2021 Regional Plan. However, we also understand the sensitive nature that environmental injustices present to historically underserved communities, and other vulnerable populations. It is for this reason SANDAG is currently allocating funding for an equity focused pilot and other initiative programs.  Appendix H includes the social equity analysis for the 2021 Regional Plan.
M40	Noah Harris	Climate Action Campaign	I am with Climate Action Campaign. Thanks to the staff for today's presentation, we're encouraged by SANDAG's bold vision as outlined through the draft Plan. We urge you to prioritize investments in the communities on the front lines of environmental injustice and the climate crisis and as the plan is finalized to center the voices of transit dependent riders. Transportation accounts for almost half of emissions more than any other sector in the region. This draft Plan will achieve a 20% reduction by 2035 which is a great start, but to achieve zero carbon as climate science says is necessary we urge you to exceed our state mandated emissions reduction targets. Next we want to make sure that the plan will help the city of San Diego Achieve its climate action plan mode share targets for biking walking and transit and we'd like to see specific mode shift projections for the city to be able to track progress our goals. Finally please make sure to include youth opportunity passes at no cost transit passes for youth 24 and under the plan.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The Local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan. SANDAG continues to work closely with all of it's member agencies, including the City of San Diego, to help provide the best available data in support of their individual targets and goals.  Regarding youth opportunity passes: One of the Implementation Actions listed in Appendix B will be a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M41	Phillip Petrie	Interfaith Coalition for Earth Justice	I am the acting coordinator of the interfaith coalition for earth justice. We are a coalition of San Diego Faith leaders concerned bout all aspects of eco-justice . Thank you very much for the time to speak this morning. I am really heartened by the national trend to put equity at the front of all policy decisions, but this must not be just talk. As a Christian, I believe God has a special concern for all the poor, for all those marginalized by society which is summed up in Jesus' statement, the last shall be first and the first last. So I ask to keep the members of SANDAG, those here and those who are not here, to keep the needs of San Diego's frontline community foremost in your minds when moving forward with our Regional Transportation Plan.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .

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M42	Rosina Lisagara		<p>Soy bilingue pero ahora me voy a comentar en en espanol en apoyar la equidad social. Soy Rosina Lisagara residente por mas de 23 anos, activista, lider y embajadora de comunidades saludable, como Cichinista y Coronado y otras lugares en National City. Una comunidad caminable y diversa con cultura, con conitos cruza fronteras que usara la transporte publico...[inaudible]...Pero que hay tanto disparidad para nuestra jente tanto trabajadora. Sigumos lo mismo problemas de salud, contaminacion, por anos a unos datos....[inaudible]... y CDC. Nececitamos rapido ..[inaudible]... y polices locales donde personas viven y trajaben.</p> <p>***</p> <p>I am bilingual, but I would like to comment in Spanish to support social equity. My name is Rosina Lisagara, I have been a resident for more than 23 years and I am an activist, a leader, and an ambassador of healthy communities in “Cichinista”, Coronado and other areas of National City. A walkable and culturally diverse community, with border crossings and that uses public transportation...[inaudible]... but there is so much disparity for our working people. We have the same health issues, pollution for years and data [inaudible] and the CDC. We need quick...[inaudible]... and local policies where people live and work.</p>	<p>Un componente esencial de la evaluación de los impactos del Plan Regional 2021 es analizar sus efectos para los grupos históricamente desfavorecidos y sistémicamente marginados. Esta evaluación se conoce como el análisis de equidad social y se enfoca en las comunidades de color, en los residentes de bajos ingresos y en los adultos mayores. Aunque el Plan Regional 2021 propone mejoras para toda la región, esta evaluación se asegura de que los beneficios sean compartidos por todos y de que la carga generada por los cambios que implemente el Plan Regional 2021 no afecten desproporcionadamente a ninguna de las poblaciones que son el enfoque de la equidad social. El Proyecto de Ley de la Asamblea 805 requiere que SANDAG identifique a las comunidades desfavorecidas descritas en la Sección 39711 del Código de Salud y Seguridad e incluye estrategias de transporte para reducir la exposición a la contaminación de estas comunidades. Una lista detallada de las estrategias de transporte, incluyendo los proyectos, las políticas y los programas que reducen la exposición a la contaminación de estas comunidades, aparece en el Anexo A del Plan Regional 2021 final propuesto.</p> <p>***</p> <p>A critical component of reviewing the impacts of the 2021 Regional Plan is evaluating the effects on historically underserved and systemically marginalized groups. This evaluation is known as a social equity analysis and focuses on communities of color, residents with low incomes, and seniors. While the 2021 Regional Plan delivers improvements to the entire region, this review ensures that the benefits are shared by everyone and that the burdens of the 2021 Regional Plan’s changes are not disproportionately shouldered by any social equity focus population. Assembly Bill 805 requires that SANDAG identify disadvantaged communities as designated pursuant to Section 39711 of the Health and Safety Code and include transportation strategies to reduce pollution exposure in these communities. A detailed list of the transportation strategies, including projects, policies, and programs, that reduce pollution exposure in these communities is included in Appendix A, Attachment 2 of the proposed final 2021 Regional Plan.</p>
M43	Sean-Keoni Ellis	UA Plumbers and Steamfitters Local 230	<p>I represent the members of UA Plumbers and Steamfitters Local 230. Thanks to all of you and the enormous amount of work that’s gone into developing a very promising Regional Transportation Plan. We think it’s past time San Diego has a transportation system that gives some practical, usable and cost-effective alternatives to driving and that’s what this RTP process. It will be a huge benefit to the workers and students making their daily commutes to school and workplaces. It will take cars off the highways, which will reduce greenhouse gas emissions, while also decreasing traffic for the folks that need to still drive their cars. We are also pretty excited about the thousands of good paying jobs that will be created right here in San Diego County. Hopefully jobs that will go to the very San Diegans whose taxpayers are paying for these projects. We’re hoping to get an opportunity to partner with all of you in the building of the transportation system of the future for all of us here in San Diego.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
M44	Stephanie Hernandez	City Heights CDC	<p>I’m a twenty-six-years-old native San Diegan who was born and raised in southeast, a lower-income community located between the four major freeways in central San Diego. For 10 out of 12 school age years I rode the bus and spent approximately 2700 hours on the bus so I could get from southeast to Point Loma to attend school. My parents could not drive me since they worked 15 hour days. I tell you my story because unfortunately my experience is not uncommon. As a staff member at City Heights CDC I hear the same challenges that I went through growing up such as one-way two-hour bus and trolley rides. Therefore, I’m calling you today to say that we’re excited to have worked with SANDAG staff as part of the Social Equity Working Group and now that the 2021 Regional Plan gets us closer to creating an equitable transportation system. However, we must ensure that the plan prioritizes communities like the one I grew up and still live in. Invest in me and in the future generation of transit riders who are hungry for opportunity and are in need of a transformative transportation system.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p>
M45	Sylvia Calzada		<p>I am a resident of National City, a neighborhood to the port of San Diego who has used transportation throughout my lifetime. From a college student to a worker. Customers using the blue line trolley has increasingly grown in the last few years. The demand exceeds supply. Please upgrade the need of the clientele in the blue line, from more services including the 24-hour service for people who work and attend college during night shifts to health and safety measures. I have never forgotten the day I was assaulted in the parking lot of the trolley station coming from a night shift working at Hallmark. I cried</p>	<p>We are deeply sorry to hear what happened to you at the transit station. SANDAG, MTS, and NCTD are taking steps to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.</p>

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			on my way home, feeling anger, ashamed and humiliated. It was a personal attack to my persona and it's not acceptable. Please support these important elements in the Regional Transportation Plan.	
M46	Tom Lemon	San Diego Building and Construction Trades Council	I'm with the San Diego Building and Construction Trades Council representing 35,000 union construction workers that have built San Diego. A big shout out to Hasan and his amazing team for this plan, this Regional Transportation Plan. Equity comes with the opportunity to get good jobs and having transportation that provides folks and opportunity to go to construction sites early in the morning and come home late at night is an amazing vision. We're looking forward to working with SANDAG on the future construction projects and creating opportunity for folks in impacted communities.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdforward.com">SDForward.com</a> .
M47	Toshi Ishihara		I'm a transportation justice advocate from Rancho Penasquito. Today I want to share my personal story about bathroom while taking transit. I'm getting older and I need to go to the bathroom very often. My wife also needs access to a clean bathroom with basic hygiene necessities such as soap and water. When I retired three years ago, I decided to take transit to go meetings such as this like SANDAG and MTS board meetings or baseball games at PETCO Park. However, I found most of the tourist stations and transit hubs in San Diego don't have any restrooms. So I had to drive around and find those restrooms available for the public. SANDAG is envisioning a world-class system of transportation. How can any true reward system of transportation can be complete without easily accessible, clean restrooms. Please make sure restrooms are included in your plan.	The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.
M48	Victor Diaz		I am a proud Southwest Union carpenter, born and raised in the beautiful city west of San Diego. San Diego needs infrastructure. Infrastructure built by skilled and trained workforce. A workforce that builds safety and productivity. I am in strong support of the regional plan.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdforward.com">SDForward.com</a> .
<b>June 15, 2021 – North County Coastal Open House</b>				
M49	Karl Aldinger		Hi, folks. I just wanted to give thanks to everybody that came out tonight to give the presentation. I think a lot of us are gonna take some time to read through the draft so it's too early for me to weigh in on what I've seen in the draft so far, but we really appreciate all the efforts that staff at SANDAG have put together. We are looking forward to these big changes and the 5 Big Moves. We will be giving more comment in the future and thanks again for everyone for putting on this presentation tonight. We appreciate the attention that you're giving to North County. It sometimes does feel a bit more rural and spread out, so we appreciate all the efforts there. Thank you.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdforward.com">SDForward.com</a> .
M50	Miguel Aguirre		Hello, everybody. I didn't realize I had my hand raised. I was listening while I was engaged in another activity, but it sounds great. I look forward to seeing the other presentations, and I would, I guess, take this opportunity. I really wasn't prepared to speak, but take this opportunity to remind everybody that we are part of a binational region, and the economic considerations should be integrated into the planning of our region. When we look at our location in North America, of course we are a strategic Pacific Rim of the border with Mexico, and I think that really presents a lot of wonderful opportunities to highlight our region and to plan a competitive mobility plan that is attractive to visitors and to investors in our region. I would also like to take the opportunity to point out that the World Design Capital Organization is entertaining a San Diego-Tijuana World Design Capital 2024 bid that will highlight design as an element for planning our economy, our social structure, and our development. So there's a lot of great things going on in our region, and I'm excited to be participating in the final draft of the Regional Transportation Plan. I look forward to participating and providing comments. Again, I wasn't prepared to speak. I was going to listen, but I'm looking forward to hearing other people comment. Thank you very much.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdforward.com">SDForward.com</a> .
<b>June 16, 2021 – County Unincorporated Open House</b>				
M51	Ricky Williams		I'm with the County of San Diego. I want to say thank you to you all for all the hard work that went into the creation of this plan. As was shown on the slide, there is a lot of information in this, and it's all excellent stuff. I have three questions I wanted to ask tonight. The first being within the RTP, we identified that there are roadway pricing and fees that are included in some of the future implementation. I wanted to ask a bit more of how these funds raised from these proposed user fees would be allocated amongst the jurisdictions and what types of projects the funds would be used for.	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed

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				program that will ensure that no particular group are disproportionately burdened and exploring mechanisms such as caps and rebates to ensure a fair system.
M52	Ricky Williams		Second is I would like to hear a bit more about flexible fleets. I know there's a variety of mobility options identified for flexible fleets, and I'm curious which options are envisioned for deployment in the unincorporated areas and along these rural corridors.	The 2021 Regional Plan envisions the deployment of Flexible Fleet services to complement investments in transit, mobility hubs, and complete corridors. Flexible Fleets can range from bikes and scooters to autonomous shuttles, increasing the number of mobility choices for residents and visitors to use. In the unincorporated County, Flexible Fleets like shared, electric, and eventually autonomous shuttles would be available on-demand, ready to take you where you need to go. Today, services like on-demand rideshare, microtransit, and vanpool already provide a convenient travel option in areas where traditional fixed transit may not work well.
M53	Ricky Williams		Finally, I'm curious to know what types of investments would be included along the complete corridors. I know you went over a lot of the safety investments, but in terms of technology improvements related to electric vehicles or other, what we would say, GHG-reducing activities are envisioned along these corridors. That is my comment.	The complete corridors assumes technology improvements related to both arterials within cities and within the highway system. Within city roadways, Smart Intersection System enhancements are planned to make those corridors more efficient and to decrease delay. On the highway system, dynamic lane management is anticipated and invested in to ensure that all lanes can be managed effectively and prioritize emergency services and transit on those corridors. The Regional Plan also includes incentives for EV charging stations and EVs.
<b>June 22, 2021 – South County Open House</b>				
M54	Carolina Martinez	Environmental Health Coalition	I'm with the Environmental Health Coalition and the San Diego Transportation Equity Working Group. We thank the staff for the presentation and all the work that has gone to make this happen, especially all the intention to collaborate with us to ensure the environmental justice communities have immediate solutions. I wanted to bring up two points. One of them is that the plan looks very exciting, and we support it. We support a vision to transform the transportation system in the region. We appreciate the naming and recognition that our transit system doesn't work. So because it needs a huge makeover, it's going to take a lot of time and years that have been missed, a lot of opportunities that have been missed. So our communities cannot continue to wait for solutions so we are asking that while the long-term solutions are important, like the Purple Line and we support strongly, that our communities especially in the South Bay, communities like City Heights need immediate solutions. They are hurting right now, and they've been hurting, and they cannot afford to continue to hurt. So how could the Regional Transportation Plan implement solutions like a bus system that provides connectivity immediately and so that they could then wait for the Purple Line? How could the youth opportunity pass happen immediately so our young ones could ride transit for free rather than waiting many more years before they could actually access the system? So what are the solutions that could be implemented right now so that they could connect to jobs now and not 10 years from now? So that is something we are asking and we are urging the Regional Transportation Plan to include. The last thing is that the Blue Line unfortunately as we see it in the Regional Transportation Plan doesn't reflect an investment into the future. The Blue Line is the line that is most used by riders currently. It's the backbone of our transit system. It connects us to the border. However, the Regional Transportation Plan does not demonstrate that it will be taken into the future into the next 30 years. How does the infrastructure improve so that the Blue Line actually creates more connectivity, because right now it is not meeting the needs of our communities? So we are asking that a consideration for Blue Line Express be included as part of the Regional Transportation Plan.	The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (to be included in Appendix B). One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M55	Flavio Olivieri		I am a Chula Vista resident. My perspective is that the whole plan, it considers alleviating the transit situation for an existing employment and economic situation, and it is not really considering changes and evolution of the economy and labor centers. If you look at the trends in terms of new employment opportunities and the type of workforce that is required, we have to consider an economic development plan together with the transportation plan. So there is a very large investment tied to this transportation plan to serve a current employment structure. I mean, the whole plan continues to be fixed in the same static employment and economic structure. I don't think it is looking into the future of how those changes would be, and instead of looking up into how to develop more distributed employment centers and economic development hubs, it is focused on, here and into 30 years, into servicing existing employment and economic centers. I think there should be a more	The 2021 Regional Plan considers existing employment centers, commercial development that is in progress, and telework policies that influence commute patterns. As SANDAG develops the next Regional Plan, it will consider new trends and policies that may influence employment centers and commute patterns.



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			strategic economic development component tied to this large investment and developing economic hubs more distributed throughout the county.	
M56	Martin M		Thank you for the presentation. The one thing that I am concerned of is that there seems to be three legs of this plan, but it seems like it is primarily driven by the need, desire to meet mandates for climate change mitigation. I think that a better solution for the people would exist if it wasn't the primary focus. Now one of the things that I have concerns about as a scientist who studied climatology before it was called that is that the human-caused greenhouse gases that would be saved if indeed everything in weather and climate is by that one factor very insignificant, if anything at all. I believe that we are trying to fit the other two parts into something that has the mandates. I understand that the region has to meet state mandates, but I have concerns that those mandates aren't feasible, and they aren't in reality. The one thing that I do have to take umbrage with is when CO2 and greenhouse gases are called a health issue, and strictly speaking CO2 is not a pollutant, but I do know that we do need to have a better overall transit situation. I am supporting that, but I think it has to include everything, which includes the fact that people do need cars, people who visit the area and vacation here, and this is a very important part of the San Diego economy. They need their cars to travel, and they are not going to take buses and transit to the beaches and to the hotels. I think we need something that is more inclusive. I think it is just overall skewed toward meeting climate mandates, which I don't believe are all valid.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The process for developing the transportation network considered many factors, including trips made by residents and visitors to the region. The transit system will be a compelling alternative to driving for many trips, while still allowing for a roadway system that supports people that need to drive.
M57	Miguel Aguirre	Grand Central West LLC	I am a managing member of Grand Central West LLC. We own the McDonald's Trolley Station, a private national gateway landmark located at the Port of Entry in San Ysidro. It is the heart of the San Ysidro Transit Center, also known as the San Ysidro ITC. Thank you for holding this South County Open House on SANDAG's Regional Plan update. As a born-and-raised San Diegan border crosser, my public comments are aimed at calling our mobility dynamic what it is: a binational corridor. Socioeconomically speaking, we are not an island separated from Baja or even Los Angeles or Riverside counties. The back-and-forth traffic between the Californias is more than evident. What is not evident, however, is what future we are planning for as a binational region. Repeatedly referring to the San Ysidro ITC as the number two station in the region is misleading. Number two to what? A one-day-in-the-future, maybe 20 years from now, \$5 billion Central Hub Project? I'm not sure what this narrative is all about. Is San Ysidro today the highest volume station by far in our region or not? No disrespect is intended for the Central Hub Project. On the contrary, it is definitely needed; however, calling our national gateway, the world's busiest border crossing, number two to something that doesn't even exist leaves much cross-border vision to be desired. Recent documents report how California's population has declined two years in a row for the first time in our history, how San Diego's home prices surge with limited affordable housing in sight and how SANDAG's previous 4.5 million population forecast by 2050 has been drastically reduced to 3.7 million. A recent San Diego regional EDC article on inclusive growth forecasts by the year 2028 we will have a shortage of 10,000 workers and how these challenges will make San Diego an unattractive place to live and do business. Big question: where will all the workers supporting our growing economy come from? SANDAG must tackle such issues strategically and that is a national need. The U.S. needs Mexico to be competitive with China and that is why we must address cross-border stigmas and focus on bridging disparities. It is time we have a reality check and call what we are planning for what it is: a dynamic binational region and corridor. North American leaders are seeking solutions which have been embedded in our own backyards all along. Thanks again for all your hard work and in sponsoring this public comment open house.	Appendix J of the 2021 Regional Plan includes information on SANDAG's approach to planning within the context of the California-Baja California binational megaregion and the importance of strategies that leverage binational and interregional partnerships to advance regional goals related to environmental, economic, and quality of life. Included in the Appendix A list of proposed projects is the San Ysidro Mobility Hub, which will facilitate and improve mobility for these critical crossborder and interregional flows. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
M58	Randy Torres-Van Vleck	BikeWalk Chula Vista	Congrats to SANDAG staff on the launch of the Regional Plan Draft. My name is Randy Torres-Van Vleck. I grew up in the Castle Park neighborhood of Chula Vista. I am a member of BikeWalk Chula Vista and the San Diego Train Station Equity Working Group. This is a really big moment for our region, a critical milestone for planning what's needed to improve the quality of life from a train station perspective, land-use perspective, air quality perspective. This is really important work and congrats again to the staff. I am most excited about the South Bay to Sorrento Purple Line Alignment. That project will connect our South Bay communities, South East, Mission Valley, Sorrento Valley. Looking forward to expanding the Rapid Network in the near term. As Carolina from the Environmental Health Coalition mentioned, it is important that we make those near-term investments to make sure that communities that are riding transit now can get to where they need to go and that we have late night/ 24-hour service. That was ranked as the highest priority in the MTS' elevate process so that's	The planned transit frequency improvements and spans of services for all routes, including existing local service and future regional services, will be added to Appendix A for the proposed Final Plan and can be currently viewed as part of the Social Equity Working Group agenda from August 5, 2021. SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (to be included in Appendix B). The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.  One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study.

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			something that is going to be critical as well. The third track for the Blue Line is going to allow for 24-hour service and greater frequencies and express service, and that is something that I support. Creating a dignified transit riding experience is super important, and that could be done through bathrooms. That's one element of a complete transit system, having bathrooms so riders can ride with dignity. That is something that we need to see more of in the plan, I believe. The plan does call for some affordable fare subsidies like the Youth Opportunity Passes, so that's something that I'm definitely excited to see. I was happy to hear about the Rapid Bus Network from Southwestern College to Western Chula Vista. That is definitely needed, and mobility of Southwestern College is going to be really key. Finally, happy to hear about the lane conversions. I want to express my support for those. We need to be more efficient with how we use all the freeway space that we go decades throughout decades. We can't be adding more lanes to the freeway so looking at the conversions is going to be important. Thank you all for your time. Looking forward to working with SANDAG, community members on the next steps to get the plan approved but also make the necessary tweaks to it that advance equity for South Bay communities.	This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.
M59	Rocina Lizarraga		I am a National City resident, and the reason that I wanted to speak today is to thank you to SANDAG for this opportunity to provide this input outlet for us as residents. I have been in National City for a long time, and also I have initiatives of public transportation. I primarily collect direct info from residents here in the area. The feedback portion of this Regional Transportation Plan does not reflect, in my opinion, a short-term benefit for this plan. There are a lot of necessities among our senior population. Our core residents, especially the seniors, are struggling everyday with mobility problems and a sense of safety. This struggle every day for people like the senior population that struggle everyday with mobility and physiological necessities because as we grow older we have more necessities. We want to see that included on the plan. I haven't seen it. These people, specifically that target population, have struggles every day when they use public transit. Neither the presentation or that has been said, and also how the plan is going to be impacting this type of population. I wish to see more of those necessities reflected on the plan. It should be addressed and have its own period.	The 2021 Regional Plan aims to improve access to a quality public transportation system for all San Diego residents, especially for seniors, historically underserved communities, other under-represented populations. Our social equity analysis projects significant improvements for senior access to high-quality transit service, parks, and recreational facilities. In every metric senior access to transit, retail, medical facilities, and parks improves through 2025 and 2050. More data and analysis is available in Appendix H of the 2021 Regional Plan.
<b>June 24, 2021 – East County Open House</b>				
M60	Councilmember Jack Shu	City of La Mesa	Thank you SANDAG staff to Larry, Alex, and Hope for having this workshop, and of course my colleague Mayor Vazquez. I'm very thankful that you're having this workshop for East County and all that this plan may offer those of us in this county that's really looking forward to a much better transportation system to relieve some of our congestion issues as well as help us meet our greenhouse gas reduction goals and reduce pollution in our communities. I have a quick question, and I'm only doing this of course seeing that we seem to have some time with not having other people asking questions. So Alex, when you presented the high-speed commuter rail system as well as the rapid bus systems, would it be possible for you to give me a quick example or maybe a time element as to what those services will do for those people commuting east-west or west-east with if those were put in place? So for example, if someone is traveling from El Cajon or even La Mesa going to downtown or some other part of the region, if we have those systems in place, what would do to their commute time compared to driving and probably driving and doing rush hour with congestion? What would be a comparison in terms of time and cost?	<p>With the 2021 Regional Plan, SANDAG plans to reduce the region's greenhouse emissions while also providing travel options. For these envisioned Transit Leap services, we want to provide competitive travel options for folks traveling to downtown and throughout the region. The way to do that is by providing fast, reliable, and frequent service. In combination with Flexible Fleet services, new travel options should be more competitive than driving alone.</p> <p>Travel times definitely will be increased if we do nothing. In this plan, we're going to, at a minimum, make sure that people are going faster than what they can do today while reducing greenhouse gas emissions and reducing vehicle miles traveled. Appendix T has more detail about travel time in each of the corridors.</p>
M61	Don		What changes has Hasan Ikhata done with SANDAG's grant writing group to increase the number of federal grant dollars that come into San Diego to bring them up to par with what he was able to bring in in Los Angeles?	Since Hasan Ikhata came to SANDAG, a new Grants Division has been formed to centralize grant application efforts at the agency. This staff is focused on searching for and tracking all grant opportunities SANDAG is eligible for and then providing that information to staff at SANDAG and its member agencies so that we can all coordinate on application efforts in the region. Experts in drafting grant applications have been identified to assist staff in preparing application materials to ensure higher success rates on grant applications. In addition, a new "Pursue Funding" initiative was adopted by the SANDAG Board in June 2021 and staff have set performance measures to track progress on grant applications.
M62	Don Wood		I want to thank SANDAG for doing a different sort of planning this round of the RTP. It's, it's refreshing to see SANDAG is changing its style a bit and is certainly more honest and forthcoming about the dollars involved, what the dollars can do. Hopefully SANDAG won't fall back into its old habits of promising more and delivering less, given that the shabby track record has had the last round of RTP	Thank you for your comments and support for the 2021 Regional Plan. SANDAG will continue to be transparent in this process through public and stakeholder engagement as we begin efforts to implement this plan.



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			so hopefully you will keep going straight ahead and start putting some more bones on this, on this frame you're putting together. I think we need more details as we go, certainly details that will convince customers or users of SANDAG and MTS facilities that it is worth their vote to help fund the improvement that you envision. Thank you.	
M63	Savannah O'Toole	SA-SEJ	I am an SA-SEJ fellow, an organizer with SD350. Thank you for your time. I would just like to add a few things, a few comments on your for tonight. So we would like environmental justice to be embedded in San Diego so therefore we're asking for 10 different changes to be included in the 2021 Regional Transportation Plan. We call for an environmental justice-centered RTP that will ensure the projects included in the RTP will prioritize environmental justice communities identified by the CalEnviroScreen, which is abbreviated CES which by listing projects that will directly benefit environmental justice communities by outlining immediate benefits via projects that will be implemented by 2025 and making all public communication easy to understand by the public in order to promote meaningful engagement. So therefore in the RTP we ask that the, that an equity-specific project list be included in an Appendix A for transportation projects, programs, and phasing document. I call for an improvement in the bus system now that is fast, frequent, reliable, and accessible through increasing frequency on popular lines, especially the overcrowded ones. So therefore I call for more clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific and provide improvements to this business system. I call for increased funding for the planning, environmental review, engineering, and capital for the additional Blue Line track that allows 24-hour service and additional frequency enhancements. The information for the Blue Line needs to be more clarified, needs to be clarified. It's currently unclear if the double slash third track included in Appendix A refers to an additional track that will be provided express kind of with, that will provide express connectivity from the border to downtown San Diego. I call for a 24-hour service by 2025 on popular transit routes that to connect late night to early morning workers to their jobs. Therefore, the information in the RTP needs to be clarified. The language in both Appendix A and Chapter 2 should specifically call for the 24-hour service on popular transit routes and present a clear implementation schedule. I call for the funding, planning, environmental review, engineering, and capital for the Purple Line as a rail that connects environmental justice communities in central, central City Heights, and South Bay to Sorrento Valley. According to SANDAG staff, the alignment includes City Heights in the 2050 RTP with a 2035 implementation; however, it should be listed in the document to demonstrate that project phasing prioritizes central City Heights in the South Bay region and a 2035 completion.	The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.
M64	Savannah O'Toole	SA-SEJ	I call for a no-cost transit pass for all youth of 25 or 24 years old or under in order to ensure generations of lifelong transit riders, encourage significant mode shift. Further, I ask that it be accelerated for a 2035 implementation instead of the current delayed plan to be implemented in 2027.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.
M65	Savannah O'Toole	SA-SEJ	So and I call for an electrified bus fleet by 2030. Fund the implementation of California's innovative clean transit rule to accelerate the electrification of the bus fleet 10 years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce our greenhouse gases, and therefore I ask the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources.	The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a> .
M66	Savannah O'Toole	SA-SEJ	I call for funding to protect vulnerable communities living near transit corridors by anti-displacement efforts. Developing an anti-displacement strategy that includes affordable and low-income housing and preservation of the naturally occurring and existing affordable housing community ownership and tenant protections. Therefore, I request an update on the status of the anti-displacement study.	Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's

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				housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.
M67	Savannah O'Toole	SA-SEJ	I call for the development of a bathroom access plan and providing MTS with funding for a clear and accessible bathroom network open at all major transportation stations. It's unclear if a bathroom network is included in the capital operations budgets[...]	The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.
M68	Savannah O'Toole	SA-SEJ	[...]and I lastly call for the funding in of the planning and implementation of a transit emergency response strategy to provide safety particularly to environmental justice communities during the community-wide emergencies, which currently is not included in the RTP. Thank you very much.	MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG's specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.
<b>June 28, 2021 – North County Inland Open House</b>				
M69	Alex Wong		Of course you know though I live out of state right now you know my family is in Rancho Bernardo, and I'm super passionate about transportation in general and just about San Diego geography. So to be honest you know I like some things about the SD Forward Plan, you know the managed lanes to kind of tour lanes, but I'm not, I'm rather a skeptic you know. Personally I'm a bit of a skeptic on rail transit right but if you're going to be building rail transit right but if you're going to be building rail transit I believe you have to convince kind of fiscally conservative suburbanites like me right. We look at the ridership statistics pre-COVID, even the San Diego Trolley was only carrying 120,000 people a day, and I think it's really important to improve existing capability, existing capacity on the San Diego Trolley and prove that it's actually you know moving a pretty big proportion of the inner city population, and it's actually taking cars off the road. So that's why I'm just a bit wary of you know maybe building these commuter rail lines that go all the way into the suburbs because you know if I don't really see a lot of people in inner city using it then I might be a bit skeptical of you know how many people are really going to use it if you extent it into the suburbs if it's simple a some, somewhat faster version of the coaster. So that's why I believe that's the first rail line that you should build if you do build a rail line should be focused on the inner city like maybe a mid, a mid-city trolley that goes from downtown, connects to SDSU and kind of passes through Balboa Park, and a mid-city. I think it's a very dense corridor and you know, it's a lot of low-income people who could really benefit from it, and if you get that right, if you manage actually to attract a lot of riders right, build this high quality rail line, attract a lot of riders then I think suburbanites might be more convinced. I think this is the first step in actually building a more extensive rail system if, if that's desirable and furthermore on the existing export, existing trolley system, I think it's crucial if you want to, if you want to increase ridership to make sure that you have decreased frequencies, and I have heard that you are trying to decrease frequencies on the blue line to five minutes. Five minutes frequencies, and that is a very good first step because I believe frequency is the number one factor in driving up ridership. Now I would like to ask is the proposed kind of commuter rail lines, are they electric? Because you know I would hope that they're electric to reduce these noise emissions. Yeah, that's just my question.	The first commuter rail line that is proposed to be implemented would operate between National City and Sorrento Valley serving the inner city communities of City Heights, Mid-City and Southeast San Diego. This line has the highest ridership potential. The existing system would all move to 10 minute frequency all day. Select routes like the Blue Line would continue to operate at 7.5 minute headways. Going to a five minute headway is difficult downtown due to cross street traffic. The type of vehicles and propulsion will be determined during the advanced planning phase of the project.
M70	Alex Wong		Once again I'd like to go over the real plan, and I kind of heard about the Purple Line right so I've heard about it before, but I don't know if you've heard of this guy called Alone Levy, he's a transit researcher, and he said that's the - he has an article in the Voice of San Diego- he said that the Purple Line is not such a good idea. Why is because it goes through a free freeway median, and he's saying that freeway medians are generally not very attractive because the stations are inaccessible, well generally don't once you live near freeway medians. So for example, he will say that and also that's the Purple Line is kind of circumferential. It doesn't actually take people to the downtown core. I'll take an example -	As part of the Regional Plan development, a new Purple Line alignment was developed that travels through the heart of our most dense communities and employment centers. This line will offer important connections that are not focused in the freeway median.
M71	Alex Wong		So I have looked at your plan, kind of looked at the transit leaps, and I do see what appears to be kind of a commuter rail corridor that kind of parallels I don't know University or El Cajon; however, you	The commuter rail route in the Regional Plan will go through a comprehensive alternatives analysis as part of advanced planning. During this time, a light rail alternative

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			<p>know I previously mentioned that I believe that a mid a mid-city trolley would be fantastic because you know the busiest bus lines like the like the route the route 7 and the rapid 215, they pass through there. However, I strongly believe that this commuter rail corridor should instead be built as a trolley and why is that? Because if you build it as a commuter rail then I think stations will be further apart so so people will have to take the bus or take the or some ridesharing to get to the station right and it will be they will have to make more transfers. Yeah, so instead I think that maybe it would be better to have a trolley line with more stops in between and people can just walk to a neighborhood station and have a one-seat ride and walk and then walk to their destination. And also you know you might think that denser stop spacing, well maybe it would make it slower, but I'm I really believe that if you make it fully grade separated, you know elevated or underground, then it actually would be quite fast you know. I mean maybe at least 20 miles per hour in you know rush hour car traffic on roads like that probably only averages 12 miles per hour at best so that would easily be much faster than driving.</p> <p>[moderator response]</p> <p>Oh can I can I say can I say something here? Oh ok, yeah I do understand that but ok I think what I was meaning is that right on the map, I see a kind of commuter rail line that goes from I don't know downtown to SDSU, but I believe that that perhaps would be better built as a trolley line.</p>	<p>will be evaluated to determine which mode of service performs the best in the corridor. In the interim, Rapid service will improved in the corridor that will provide connections along Mid-City, City Heights and Downtown.</p>
M72	Alla Valedspino		<p>I'm a resident of the City of Vista, and I have been riding the public transit in North County for over 10 years; however, the loss of some bus lines near the Vista Civic Center has prevented me from being able to take transit and that's a shame because I know I'm not the only one. Transportation access for clients is a vital necessity and the lack of accessible transportation to individuals from low socioeconomic backgrounds is a major social determinant of health. Therefore, I suggest that SANDAG partner with community health centers so that patients have better access to health care. Another thing that I would like to add is that if SANDAG, MTS, and CCD wish to see higher ridership, there has to be a stronger effort to advertise public transportation to those that regularly drive a car and also advertise like popular destinations. In addition, SANDAG and local governments need to consider the reality that building luxury housing near public transit will not increase ridership even though they advertise it as such; rather, it will decrease because these people can afford to have a car. If SANDAG wants to have more ridership, they need to have affordable housing built in your mobility hubs in public transit, which I know is something that you have mentioned today so that's a very good thing to hear. Overall, I am in support of the 5 Big Moves, and I'm especially interested to see what those flexible fleets would look like here. The next OS sounds interesting as well, and I hope that through the app there is a way to review the system so that SANDAG has real-time feedback on their bus line routes and schedules. That way they can make adjustments if necessary.</p>	<p>SANDAG partners extensively with Community Based Organizations to outreach to a variety of groups that utilize transit or have a role in getting people around the regions. In North County, SANDAG works with four different groups that cover Vista, San Marcos, Escondido, and Oceanside. With regard to affordable housing and mobility hubs, SANDAG will be working closely with jurisdictions across the region to ensure that a wide mix of housing types are providing close to transit.</p>
M73	Craig Jones		<p>I'm just interested to hear more about the difference between connectors and managed lane connectors on the maps that have been shown. How are they different from each other? What do each of them connect or unconnect? Thank you.</p> <p>[moderator response]</p> <p>So I think so. So I know what managed lane connectors are, that you can go seamlessly from one set of managed lanes to another, and the regular connectors are points where modes come together?</p> <p>[moderator response]</p> <p>Got it. It's, it's another version of roadway improvement. Okay, I got it.</p>	<p>Connectors are facilities that connect two intersecting freeways or highways. Managed Lane Connectors specifically connect Managed Lanes, and direct access ramps allow buses, carpools, vanpools, and motorcycles along with emergency vehicles and low-emission vehicles with appropriate decals to access the Managed Lanes in the center of the freeway. You can find more information about the application of each facility type in Appendix A.</p>
M74	Craig Jones		<p>I really appreciate this is a dialogue rather than a presentation so I think that's incredibly valuable. I should mention I am a member of SANDAG's Social Equity Working Group. I'm a representative to the body from the Alliance for Regional Solutions in North County, which represents the interests of underserved populations. So Alla's comment is incredibly on point. We're trying to look for as much equity as possible and with this I can't overemphasize how important flexible fleets is as an element of this. It's perhaps one of the least developed in detail in the proposed plan because it requires a level of local development and organization, implementation, but I encourage everybody to really support flexible fleets. It's going to be incredibly important. Including providing equity and transportation, so</p>	<p>Flexible Fleets will offer people a variety of on-demand shared vehicles. Flexible Fleet services may complement fixed-route services, even in more suburban communities. They offer additional convenience, as the on-demand nature of Flexible Fleet services allows people to book a ride almost anywhere and anytime. Proposed Clean Transportation policies will also ensure that Flexible Fleet vehicles transition to zero-emission vehicles to further meet air quality mandates. In addition, the Regional Plan proposes investments in active transportation and Vision Zero policies to create a safer environment for biking. These strategies combined will make it easier to drive around without driving a car.</p>

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			<p>much needed access for the underserved populations. One of the things that Alex Wong spoke about earlier, I agreed with what he said. He noted that those who are now skeptics of supporting this proposal might cite the relatively low ridership of the existing trolley, and I just wanted to observe that the reason for that is that we have a poor system right now, a poorly interconnected system. It doesn't compete with the automobile. What's promised with the 5 Big Moves is a coordinated integrated multimodal system that does compete with the automobile and that should make it work. I had a question. If there is time about the North County system of next rapid buses, if there's time could we go back and look at that map showing those? I want to know if it looked like some of the rapid bus, next gen rapid bus routes, were not using Highway 78, but other routes that might be more curvilinear. So I just wanted to know more about the-</p> <p>[moderator response]</p> <p>I just want to observe it before I retired from Monday through Friday employment. I was one of those who drove the entire route from Oceanside to Escondido, and I really hope there's a direct rapid bus route that makes that entire that entire connection that can compete with the automobile.</p>	The North County CMCP work is digging into the finer details of what is proposed in the Regional Plan and may propose additional Rapid Routes.
M75	E Aenelle		<p>I just wanted to first of all, I just came back from a short trip to Seattle, and I just wanted to tell you about my experience upon landing at the airport. I used a common application, Google Map, and they directed me to the most nice experience I had in public transportation in a while. I was directed to the light rail system, and I got on it. It took us right to downtown Seattle, but not only that. There were alternatives to the way to get there. You know, I could have it told me on how to walk how far to walk to the stop, if I wanted to switch to a bus, take a different route and so on and so forth. I had about three different ways of getting where I had to go so that was great and we need something like that. I live in North County, and I think the public transportation availability here is very limited. My sister had to go to four appointments, medical appointments, from Oceanside, and it was very difficult for her because she had some you know physical problems in getting around. So I think we need we need more variety and more ability to connect the multiple methods of getting around that's already been mentioned. They need to be all coordinated so that you know, one can hop, skip, and jump. I've had to give up jury assignments down at the county because of the transportation issue. So it affects us and more ways than you think, not just work so.</p>	The draft 2021 Regional Plan includes, as part of the 5 Big moves, Complete Corridors where multiple modes are accommodated and NextOS that can both inform the traveling public of options and dynamically manage lanes for improved efficiency. Additionally, access to the airport is addressed through a whole suite of transportation solutions identified the "Central Mobility Hub" corridor in Appendix A.
M76	Kevin Delmastro		<p>I really appreciate all this information. I'm really excited. Me and some neighbors here in Tierrasanta actually would love to just take a short trip over to Kearny Mesa and hop on either light rail or rapid bus or something. Get different places. I actually have a saxophone business, go downtown a lot for gigs so that would be great. Parking is limited in a lot of the popular areas so I think that's a big plus for the public transit and integrating technology and all the big moves you guys are talking about is really great. So I don't really have any questions. I just want to say bravo for trying to tackle this problem that San Diego has had for a while with limited transit.</p>	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.
M77	Kori Jensen		<p>I'm a member of the Oceanside City Council and first I'd like to thank you for holding these open houses on the Draft 2021 Regional Plan. I like, I'm sure other local elected officials view this plan as essential to our region's future, and I appreciate the initiative displayed by board members and senior staff to plan and hold these open houses regarding a specific issue. It is apparent to all of us that San Diego County and indeed our entire state faces a dramatic shortage of housing for virtually all income levels. Now there will effort to address the need for housing for those at lower income levels, but I do want to note the similar need for affordable housing and accessible middle market housing in San Diego County. Many cities in the county including my own are moving fast to address that market need, if we hope to attract and retain good paying middle and upper income jobs. We need to make sure the workforce finds available homes appealing and that's where we need SANDAG to be a partner with us by ensuring that transportation network of the near future supports the homes that will be built. The transit and road networks must be accessible to the new home communities that will come online in the next decade and beyond. I hope for the maximum possible communication between SANDAG and our local planning staff so that the transportation plan for the rest of the century matches San Diego's 21st Century housing supply.</p>	SANDAG recognizes the need for more affordable housing for people of middle to low incomes households that are near employment centers and a variety of transportation options. SANDAG is currently developing a Regional Housing Incentive Program that will consider climate change, climate resilience, and consistency with the transportation improvements and land use goals included in the 2021 Regional Plan.
M78	Mario Ingrassi		<p>I really want to see you guys build all this. I'm really enthusiastic. I've made comments before, I probably sound very pessimistic. I'm not pessimistic. I just want to make sure it works, but a couple little questions while you're in North County there. Well this is North County but how much are you</p>	The Blue Line Trolley will be speed up through an extensive network of grade separations along the line and a third track that could help bypass specific stations. SANDAG will also be partnering with MTS to complete a study on a Blue Line express option that could



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			<p>guys looking at possibly doing work on the existing trolleys to speed them up? Or on the Blue Line, there was a lot of talk about adding a third track so that you could have an express lane. Are any of those things still in the works or are they kind of like by the wayside? That's my first question.</p> <p>[moderator response]</p> <p>Yeah because I was when you said the speed up time it gets to Old Town, I thought you were talking about probably using the Purple Line, not speeding up the Blue Line that much, but how about just speeding it up enough so that it's faster? Because I know the trains can run pretty fast, much faster than they do. You know curves and safety, and I understand there's a lot there, but when I when this when the trolley started it yeah well I won't say definitely moved faster. It just seemed like it moved a lot faster and especially going through downtown right now the perception of how long it takes is really crazy. Let me ask a couple quick questions and -</p> <p>[moderator response]</p> <p>Well that's true, but I'd like to see you get the mayor, and I can't pronounce your boss's name together in a room and so to get them to tell their engineers fix the traffic signals and the trolley downtown because if they wanted to, they could do it but either each one keeps blaming the other one. Every time when I talk to engineers ""oh it's the city's problem. Oh no it's SANDAG's problem. Oh no it's MTS' problem."" If you guys told your engineers to do it, they could fix it because those trolleys didn't used to stop. When they when they opened up they stopped only at the troling stations. Speaking of I-5 and 78 and that connector, how about just making a regular connector there? When is that going to happen going from westbound to southbound? I'll be quiet.</p> <p>[moderator response]</p> <p>I mean that's been like that since I was a kid.</p>	<p>provide another set of rails that would allow for a true express service and potential 24 hour service. With regard to the downtown traffic signals, that is a component of Next OS and traffic signal progression will be evaluated on all of our corridors throughout the region.</p>
M79	Mario Ingrasci		<p>How about Mission Valley here? Quick on. Well it could be specific, maybe I could talk to somebody offline off later, but I'm wondering about the most information I can get out of UCSD as far as what they're doing with you guys and whatever is they think the best place for a train station is going east-west along parallel to the existing station. For the I'm talking about the Purple Line through there.</p> <p>[moderator response]</p> <p>Not UCSD, SDSU. Mission Valley. In order to make that work, that Purple Line, well got a bunch of questions here together. You've got a rapid bus now running through down 15 and then goes up to Kearny Mesa. Now I don't if the before the Purple Line comes through you want to have that going into the stadium or not. That's would be nice, but I don't think, I don't even know if that's what you're talking about. Anyways, when you get the Purple Line in there there, I would like to see something worked out for with you guys and I would like to see on paper because I can't get a, I know it's up in the air, you can't make them you know. It's too early, but that project is being constructed now so the sooner you guys come to a corridor in there the better, and if you if this is going to be a high-speed train you want going north and south, not going east and west, and they're talking about a station for the Purple Line being parallel to the existing green line, I guess that's there now yeah and that doesn't make a whole lot of sense. You're gonna be coming down and then go back up again. You should have an elevated train that goes right through the valley up in the air so it doesn't have to you know through even parallel to 15 would be better but in the middle of their project would be the best place for it. I know they don't want to do that exactly, but do you guys have any kind of, how do you negotiate with them?</p> <p>[moderator response]</p> <p>I think you should publicize that more so we all know what you're doing. SDSU won't say anything. They say ""oh that's in the works, we'll do it"" and then that's all they want to talk about.</p>	<p>SANDAG staff have worked closely with SDSU to ensure that a future transit station will be available when the Purple Line is in operation. SANDAG conducts reviews of all projects under development to ensure that when appropriate transit can be incorporated. The 2021 Regional Plan Appendix A and data viewer can be used to explore other projects in your area. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>

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M80	Mary Ann Horton		<p>I have attempted to use rapid transit from Poway, I live in Poway, to downtown when I can make the schedule work. It's a wonderful experience, and I would love to have been able to use it more. Unfortunately, it really hasn't worked out for me. I live in Poway, I used to work for SDG&amp;E before I retired in Mission Valley. Trying to make the schedules work on transit, it took two hours to get anywhere. The BRT won't stop in Mission Valley, and you pretty much have to drive. So what I'm seeing from North County Inland, which to me means the I-15 Corridor, the solutions that we've been presented are the managed lanes and the BRT. And the managed lanes I love, but they require you to drive and so you're putting out pollutants out there, and there's still that big bottleneck at 163 and 15 in the evenings when you're trying to merge that the managed lanes really aren't helping. The BRT would be much more useful if it could actually get people there in a reasonable amount of time. Takes two hours to get anywhere and if you're if you're going outside of commute times, they don't fun at all. So for example, if I wanted to go to a Padres game from Poway, I have to leave the Padres game by 6:30 p.m. in order to get home, or I'm going to get stuck overnight. This the scheduling really drastically needs to improve in order to make it useful. What I would am hoping to see and I haven't really seen much attention to this and maybe you can address it. I would love to see and may this is what you call flexible fleets. I would love to see an Uber-styled shared ride experience that you could use an app that would get you from point A to point B in a shared four-passenger, 10-passenger, 20-passenger vehicle from point A to point B in half an hour, door-to-door at a at a priced approaching what you spend for a commute. Five bucks in each way or whatever. I think with your next OS the modeling ought to be able to support getting some kind of sharing going that would get people efficiently from point A to point B, reduce the traffic on the freeways by having four or ten people on there instead of one person and allow errands to all kinds of point-to-point places that the main lines aren't going to support. I would love to see it if you would put more publicity and energy into that, and I would love to see more publicity and energy put into the I-15 corridor, north and south, to help people get there.</p>	<p>Transit and Flexible Fleets will work together to provide the experience that you've identified in your comment. It may be that one shared vehicle is used for the full trip or the trip is broken into two pieces with transit providing a portion of the trip. Next OS will be utilized to help passenger make those types of decisions. This type of trip could be applied throughout the San Diego region.</p>
M81	Maz Hadaegh		<p>I also live in or I live in the suburbs of San Diego, and I'm very supportive of the 5 Moves and my I'm generally you know any basically I'm supportive of anything that helps to for all the reasons that you stated. I think the mass transit plan would be my preference. Anything that favors or prioritizes high-speed rail, light rail, and etc. over you know lane expansion would be my preference, even if I personally don't end up using it, I see great benefit to the region, although I will, I will personally use it as well. My question is about the funding and sorry if it sounds a little naïve but how far into this 2050 plan have we already approved funding for and what remains to be approved and can you just comment a little bit about that process? Is it going to be done in phases? I imagine. And you know sort of what's the next funding target and what can we as residents in the region to do push our elected officials to make sure this happens? Obviously this is a very refreshing change from previous years, looking at the big picture, looking taking a very long view approach to our region's transportation. So thank you again for the presentation. I'll wait for your answer.</p>	<p>The Cost Estimation Methodology and Funding Strategies for the RTP were presented to the SANDAG Board of Directors on March 12, 2021, Item No. 8B. This report and presentation described the various funding assumptions developed for the draft 2021 Regional Plan and the time phases proposed. The entire Board meeting can be found at <a href="http://www.sandag.org">www.sandag.org</a>.</p>
M82	Maz Hadaegh		<p>My question, I think you had a slide about where the densest work areas are, and it was a little hard to read for me, but I believe you were probably pointing to the UTC area and Sorrento Valley area, if I'm not mistaken. What is the plan for to connect those two regions? Because currently as far as I know there is not an efficient way to get between those two areas. It's is there a light rail or any kind of rail or anything high speed planned?</p> <p>[moderator response]</p> <p>If you can leave your email address that would be really helpful.</p>	<p>The regional plan includes a Transit Leap commuter rail line that will connect UTC to Sorrento Mesa. The COASTER service along the LOSSAN rail corridor will also have station connections at UTC.</p>
M83	Mike Bullock		<p>Let me apologize because I do live close to the coast, and I had a conflict when you had your coastal meeting so here I am. I really support the 5 Big Moves. They, they really are big moves, and they're exactly what we need, and I appreciate the change from the previous regional transportation plans, which I think were off track, and this one is, is doing an awful lot of things very well. I, I just want to state that now one thing I miss is the, the transit leap that you put out quite a few months ago and maybe a year ago, I don't know. Included a, I believe it was probably a Sprinter line from Carlsbad Village to Vista Transit Center, and I thought that had a lot of potential, and I know you have to pick and choose, but I, I would love to see that that reconsidered, and I also think that it would be good to explain what the future might really look like in terms of managed lanes. That state has a draft plan</p>	<p>As we refined our planning analysis, the Sprinter line was truncated to Oceanside Transit Center because it had the highest ridership potential and there are two Next Generation Rapid routes and the Coaster that serve the Carlsbad Transit station. This allows for a comprehensive system of transit. As indicated in the comment, it is our intent to use Road User Charge to fund the operation of the transit system.</p>



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			<p>out now, it's a climate action plan, for transportation infrastructure called CAPTI, and it includes a road-use charge to replace the gas tax, and it is means based and we like to talk about equity. This really could produce equity. The gas tax is very inequitable. It definitely penalizes low-income drivers, but we do need full-cost pricing. I think that would go a long way towards explaining some of the misinformation that we've seen in the UTM about you know using funds from road use to fund some transit. You have to put that into context that we are heavily, heavily subsidizing driving, and that's inequitable right there, and it should be means-based, and the state is saying that and that would mean all lanes you know as soon as we get out of our driveways and start driving we are on managed lanes and that could prevent congestion because there are algorithms. I've written some myself because I'm interested in this topics to eliminate congestion. As the lane occupancy approaches some percent of 100 full, you immediately start adjusting your price, and you present you prevent congestion and of course somebody gets a stroke and needs to go to the hospital, you realize congestion is unacceptable, and it is a failure government, and government should stop failing there. So anyway, those are some of my comments.</p>	
M84	Mike Bullock		<p>The reason I raised my hand is because of the discussion about greenhouse gas, and you're right, that is my primary concern, and I think it needs to be everyone's primary concern because of the time urgency, and I don't hear that in the discussion that's going on and especially when you are saying that it's kind of hard to predict, and we'll do other regional transportation plans, and you were talking about regional transportation plan in four years, and you'd know better, and you know I just want to point out that what happened, what is happening in the northwest, and there's always things like this going on. Things that just are shocking you know. They're breaking all-time temperature records by record amounts, by 11 degrees. Unheard of temperatures in cities like Spokane and Seattle and that is not the scariest thing that's going on right now. The fact is there is a heat wave in the Russian permafrost which is going to be releasing methane gas and that is a feedback loop which could get so strong that it doesn't really matter what we do, and I think the discussion here seems to be in in awareness that cars are the biggest problem and that we have to reduce driving, and I would say that the climate scientists are telling us that we need to reduce our emissions to 80 percent below what we emitted in 1990 by 2030. You know and the state mandates are 2035 and they're only 40 percent down, and they need to be 80 percent 5 years sooner and so we have an emergency situation and I love all the rail, but that takes a lot of time. And I love the zoning improvements, but that's going to take a lot of time and what could we do that would could be done in just several years, and you've heard me say this over and over again. It is pricing. We have really bad systems to charge people to use roads. We have really bad systems to charge people to use parking. We think it's free parking, and it's absolutely not free at all, and it's not equitable. Craig Jones, my friend, always talks about equity, but I don't hear him concerned that people are working downtown for the county, and they're not driving and that and a parking space down there can earn \$350 a month. That \$350 a month should go to them, and then you have a lot more people that aren't driving and that path to get the system that has been defined by the plaintiffs in that Climate Action Plan lawsuit, that system needs to be talked about and implemented. There has to be a path shown that will make that happen soon. We're running out of time.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT.</p> <p>The 5 Big Moves will ensure connectivity and result in people having more travel options and operating solutions, reducing per capita VMT. Local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
M85	Patricia Borchman		<p>I live in Escondido, and I was interested in hearing more about what you were talking about you were talking about you were responding to Toshi Ishikara's comments regarding greenhouse gas emission reductions, and you were referring to SANDAG plans about open space preservation carbon</p>	<p>Appendix AA of the 2021 Regional Plan outlines the Regional Habitat Conservation Vision for the region. The appendix provides a brief history of habitat conservation in the San Diego region; describes how SANDAG, through the Environmental Mitigation Program,</p>

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			sequestration. So I'd like to know more about that because we are interested in pursuing an alternative to a project that's proposed to be annexed to Escondido for the Harvest Hills project, and we're trying to develop an alternative, and I think that this idea about the alternative to you know possibly you know pursue acquisition of open space to preserve sensitive habitat and wildlife corridors is you know is very consistent with the SANDAG strategy for open space preservation for the purpose of greenhouse gas reductions. So is there an appendix that I could go to find out more about the this plan?	<p>has contributed to habitat conservation and presents the goals and objectives of the Regional Habitat Conservation Vision in order to protect sensitive habitats and resources for future generations.</p> <p>As part of the 2021 Regional Plan, SANDAG will establish a Nature-Based Climate Solutions Program that will promote natural infrastructure that uses or mimics natural processes to benefit people and wildlife. SANDAG will prioritize resilience and innovative solutions in transportation infrastructure, Comprehensive Multimodal Corridor Plans, and consistent regional planning and implementation of the Sustainable Communities Strategy actions, emphasizing both nature-based and technological climate solutions. There are also further opportunities to expand upon ongoing efforts to assess the amount of carbon storage and sequestration potential of open space lands and the co-benefits from preserved open space, land management, and restoration activities.</p>
M86	Toshi Ishishara		So I live in Rancho Penasquitos. Any first of all, I want to say thank you very much for setting up this like a community forum, and they give us opportunity to provide inputs on RP. So I would like to know that in principle, I really support the MV. I mean a vision behind RP. Hasan called it's 5 Big Moves right so I like that and I also like you to know that I take transit as much as possible; however, pandemic kind of stopped me taking from taking training but so that I'm thinking about restarting, taking transit pretty soon I believe, but my question is about greenhouse gas emission reduction target. So according to Chapter 1, I don't remember, may not be Chapter 1, but also Sunday Staff stated the RTP will reduce per capita greenhouse gas emissions from transportation sectors to 10 below 2005 levels by 2035. That's right so 20 and as you know transportation sector actually accounts for 50 percent of - somebody came to my doorbell - 20, 50 right, so if we reduce 20 from 50 then we still end up with 40 percent, and as you know population is increasing. So if you look at Appendix X, so that's X, that estimate that - oh somebody came to my door so and then the person is yelling at me so I think I'm gonna stop now and I hope I can continue sometime later today.	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT.</p> <p>The GHG Inventory (Appendix X) analyzes emissions from all sources and the projections account for state and federal legislation currently in place, as well as strategies within the 2021 Regional Plan. The 5 Big Moves will result in people having more travel options and operating solutions, reducing per capita VMT, and the Local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
M87	Toshi Ishishara		I'm calling and then everybody listening to this community forum, I'm sorry. What's happened actually somebody tried to break into one of my neighbor's house so that's what happened. So anyway so I I'm gonna keep my comment in less than a minute so anyway. So my concern is the greenhouse gas emission target and what the ROT will bring, and I read Appendix X and the Appendix X shows basically the prediction of the greenhouse gas emissions in this region, and I think the estimate was done by UCSD, but if I look at the trend, so after 2035 basically it's showing flat. There's no reduction beyond 2035. Of course we expect the population to increase, right? So the per capita greenhouse emission will continue to decrease; however, because it's fixing fixed at a certain level, and I see that level is still very high so that really concerns me. So how we are going to fight the climate change, and I thought Santa GRP would be the one of the weapon, biggest weapon for us to fight climate change in San Diego. So I would like to hear more about what SANDAG is trying to do, and if you can include some kind of specific specificity in the Regional Plan, how it will conform to the ambitious greenhouse reduction like a goal set by not only state of California but also like a San Diego County and the other I mean municipalities.	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT.</p> <p>The GHG Inventory (Appendix X) analyzes emissions from all sources and the projections account for state and federal legislation currently in place, as well as strategies within the 2021 Regional Plan. The 5 Big Moves will result in people having more travel options and operating solutions, reducing per capita VMT, and the local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
M88	Toshi Ishishara		<p>So I have one question and one comment. So my question is very simple. So some of my volunteers asked me about are we working on RTP or RP? Because I thought we were working on RTP by automotive so it became our business.</p> <p>[moderator response]</p> <p>Ok great, thank you. So then my comment is basically about this greenhouse gas reduction. So Chapter X, not the Chapter X. I'm sorry. Appendix X actually lists a whole bunch of sources of greenhouse emissions not only from like cars and light duty vehicles, electricity, natural gas, and solid waste, you name it. Everything there, and then I'm seeing basically reduction stop as I told you at 2035 and just stay flat from the point on so that's very concerning to me so I just want you to know that I'm-</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT.</p> <p>The GHG Inventory (Appendix X) analyzes emissions from all sources and the projections account for state and federal legislation currently in place, as well as strategies within the 2021 Regional Plan. Local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.</p>

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<b>June 30, 2021 – Central San Diego Open House</b>				
M89	Alex Wong		<p>So yes, it's Alex from Monday, and I just wanted to short a question first of all. Now the mid-coast trolley, when it opens in November what will the frequencies be?</p> <p>[moderator response]</p> <p>So I think that's very good but and yeah but do you have any plans to increase the Green Line frequencies? Because it seems like with all the development happening in Mission Valley you know that might be a good place too.</p> <p>[moderator response]</p> <p>Oh well not the Orange Line in particular but rather I was thinking about this line through kind of mid-city and yes Hillcrest, right. I see it on your map. It's commuter rail, but I'm thinking that maybe it could be built as a trolley instead or even because I think it would be better if people could walk to their neighborhood stops instead of you know having to you know take a bus or a rideshare to a bigger station. And also I wonder if you've ever considered on any of these new lines that you're going to build that maybe you build something like the Vancouver SkyTrain, the Montreal REM. You know something that's fully automated. You know you can run them up to two minutes ,to two minutes per train at peak hour and then you know they could be very the operational cost could be very low because you know 17 percent of operational costs are from drivers.</p>	<p>Our goal really is to get the entire transit system on at least 10 minute all day service. For the trolley and all the railroads, we plan to go to seven and a half minute frequency all day. So we do have extensive improvements in overall frequencies of our light rail system.</p> <p>Blue Line is the route that goes from the border at San Ysidro to Old Town today. Ultimately, when Mid Coast opens in November, it will go all the way up to University City, with a stop at UTC at the very end of the line.</p> <p>The Green Line travels through Mission Valley, connecting to El Cajon and Santee, and it comes all the way through the center of Mission Valley into Old Town and downtown San Diego. So it's one of the connections that provides access through the center of San Diego.</p> <p>Our new line that will connect the Central Mobility Hub to the airport—that's our new transit connection—we are planning on that operating at every two minute headways throughout the day. So that's part of the capability that we're looking at for our system. We're not going to start out at two minutes on our bigger commuter rail service, but we'll be evaluating technology throughout the advanced planning of these services to make sure that we're using the most up-to-date and current technology. And if that includes automation, then certainly it will be included in our analysis.</p> <p>The regional plan is a big picture blueprint and further studies have to be on all of this. Regarding the purple line, we're looking at that whole line right now. We think we know where the stations are going to go, but this is at a really high level that gets further refined later. We were calling it a commuter rail. Now, when we do the further study, I don't want to say it would be a trolley, but that's a possibility, or we may find out some other kind of automated system is available and could make that work. Those things happen further down in the planning, but that is to give you a sense that the level of planning we're doing right now is very high level, very regional.</p>
M90	Deborah Jones		<p>Hi, how are you? I don't know how to turn on my camera but anyway. You know what I look like. In full disclosure I do work for SANDAG but just from a personal on a personal level, living in this area and also working in this area a couple of things that I'm wondering about as a citizen is whether ferry transportation is being considered for the plan. I've always thought it would be great to have some hovercraft ferries that go from downtown to the airport or from downtown over to Point Loma military base or from Chula Vista up to downtown or over to the airport just as a way to use our waterways as a transportation network and something maybe faster than what is currently used across to get to Coronado.</p>	<p>We do have a couple ferry projects in the plan, and really the first pairing that I'm going to talk about is a connection from Chula Vista to our military bases near 8th Street. That's a really strong commute, and then up to downtown San Diego. That probably has the highest level of potential ridership. The other one would be to connect Chula Vista to Coronado and then ultimately downtown San Diego, kind of creating a triangle. And we are in fact, looking at ferry levels of speed that are much higher than the existing ferry today.</p> <p>So those are the initial two that we have in the plan, but I'm sure that once we experience the value of those, we'll be pursuing that as a bigger strategy in future plans.</p>
M91	Deborah Jones		<p>And then I'm wondering if you can talk a little bit more about how sea level rise is being factored into these transportation projects knowing what our bleak future looks like. That's something that we're obviously needing to plan for so if we're going to have tunnels, do we have anything that stops the sea level intrusion?</p>	<p>For sea level rise, it's all about how we engineer these projects. If anyone's familiar with what we're doing even today on the LOSSAN corridors, all about raising up the bridges so that we're addressing sea level rise is exactly why we need, as Steven was bringing up, to get the tracks off the bluffs. That is very problematic.</p> <p>So it's really about, as we build the new infrastructure, that we're respecting sea level rise. The other aspect of climate change is making sure that we've got evacuation routes for the people in the rural areas. That's a big part of when we talk about improvements on the rural roadways, getting the evacuation routes so the people can get out in the instance of a fire.</p> <p>The design and construction of new infrastructure will consider the best available science, tools, and technology.</p>

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M92	Deborah Jones		And then lastly because this is the topic du jour or certainly was for the year 2020, what impact telework or even the future of work and what industries will look like in the future. So where are we assuming, it is being assumed in the plan, that everybody's going to be commuting into an office or will we be teleported, you know? What does what does Star Trek vision look like for work and has that been factored into congestion and the way we work? Thank you.	<p>Telework is one of the strategies that is helping us to achieve our GHG reduction targets in the Regional Plan and SCS. Our assumption for the 2021 Regional Plan is that telework will grow much more than we've anticipated in past plans, but we know that many occupations cannot be done from home. To understand the potential for telework in the region and inform the telework target setting process, SANDAG conducted an analysis of jobs that are conducive to telework and found that 39% of all occupations in the region are considered home workable. This is a bit higher than the national average at 34%. It's important to keep in mind though that although a job could be done from home, it does not mean it will be. It's at the employer's discretion to determine who gets to telework, when and why.</p> <p>We also looked at the percent of jobs in our region that are considered essential. During the pandemic certain types of jobs were defined as essential and included jobs in grocery stores, healthcare, and transportation. In our region 64% of occupations were considered essential. SANDAG also randomly surveyed businesses and employees in the region. While 2 in 5 businesses expect to incorporate remote working in their business model post-pandemic, just 15% anticipate that half or more of their employees will work from home most of the week.</p>
M93	Haneen Mohamed		I am from City Heights CDC, and I just wanted to express that I think SANDAG did a great job with the Regional Plan, and we're really excited for some of the upcoming projects. Especially what it means for environmental justice communities, especially for those of us in City Heights, and we really like just seeing some of the transportation equity goals that we've been advocating for, for decades in the City Heights region come into fruition. We're really excited about the Purple Line serving City Heights. We think that's really going to bolster connectivity and really just connect some of our residents to job centers. So I ultimately just wanted to really express my appreciation for the SANDAG staff and that we hope to continue on this track of equity and really prioritizing the wellbeing of our communities, the wellbeing of the environment, and the climate.	<p>I'll just take this opportunity to mention to everyone here that SANDAG does have an Equity Working Group that is specifically assigned to advise on the Regional Plan and ensure that equity is at the forefront of this plan. That working group is chaired by City Councilmember Vivian Moreno. And within the next few days here, we are going to be having a discussion with the, the working group. And by the way, these are public meetings, so anyone here on the call is more than welcome to attend. The information about the meetings is posted, on our website, they're all done virtually. So, you know, you can do this from the comfort of your home, or your office, and we're really going to be talking about what is something, what's an early action that we can take, when it comes to equity. We're going to be asking our SANDAG board of directors to set aside some funding here in the next couple of months so that we can start to show what this Regional Plan could look like and pilot some of those ideas. So, thank you for your comments Haneen, and I know that City Heights CDC is really involved in the working group and appreciate all that participation.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 does include that station in the current proposed alignment.</p>
M94	Maria Cortez		I just want to know about the Purple Line because I would like for it to go underground. This way, we would be saving a lot of emissions and save a lot of time on traffic so from what I understood with the Purple Line it's supposed to be going underground, coming through City Heights going from the border all the way to Sorrento Valley, and another one that I'm involved in is that the buses to the beach. We would love to have the buses go to the beach because a lot of our kids and the different underserved communities have never been to the beach, and it's heartbreaking when you see that and hear that. I think it's a great opportunity to have these kids going to the beach exploring other communities outside of our communities, and also I would like to see more buses running more frequent. Having 24-hour service if possible because there are a lot of people that go to work, and they're out of luck when they go to work but getting back to the Purple Line. We need the Purple Line here in City Heights because we are one of the highest transit users in San Diego and to see it come through City Heights that would be a dream come true, and Todd knows all about that and everybody else. I'm Colleen, I want to say as always you have done a wonderful job and not only just you but everybody there at SANDAG. What a wonderful way to end the evening. So if I could have some answers maybe I guess on my questions that would be great.	<p>The purple line plans are that it would be fully grade separated.</p> <p>Grade separation means that you're either above on a bridge or below in a tunnel. It means that you're not in traffic. Right now, the trolley stops at intersections, and that can cause it to slow down.</p> <p>And for the beaches, we have over 10 routes that now will provide direct access to the beach. And once the central mobility hub is in place, people coming from all over this region will have access to routes that take them directly to the beach. So, that's a really great new story.</p> <p>For 24 hours service, we are evaluating, as I said earlier, increasing the spans of service across the system. And of course we are looking at, you know, we've heard time and time again that you'd like 24 hours on the blue line, so we're absolutely looking at that. We're trying to come up with a really good solution because right now we have the freight operating and that's causing us a little angst. So we're trying to figure it out, and I think we have a solution that we can come up with that will answer that request for 24 hours service.</p>



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				<p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 does include that station in the current proposed alignment.</p> <p>The 2021 Regional Plan includes increased service spans for the trolley and bus service up to twenty hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24 hours.</p>
M95	Nastassia Patin		I'm a resident of Normal Heights in San Diego, and I, similar to Haneen, I just wanted to express my strong support and my gratitude for SANDAG's work on this plan and some of the issues that it addresses with regard to environmental justice and just overall quality of life improvement in the San Diego region. And so some of the highlights for in this plan based on tonight's presentation were the grade separated routes that you just talked about to get East County folks out to the beach, the light rail and the dedicated bus lanes linking job centers like Sorrento Valley to the South Bay, and these fully connected bike routes. I can't wait to bike you know from Oceanside all the way down to downtown or even to the border one day so thank you so much for all your hard work on this, and I'm really excited to see it move forward.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> .
M96	Randy Torres-Van Vleck	City Heights CDC	"Hey, Colleen. How's it going? Thanks for hosting this. Good evening, Central San Diego, and my name is Randy Torres-Van Vleck, director of policy and planning at the City Heights CDC. I'm really excited for the opportunity that the 5 Big Moves creates to transform our regional transportation system in a way that improves quality of life. Congrats to staff on the release of the Regional Plan Draft, and I really appreciate that staff has a lot like a live dialogue here between the agency and the public. I think that's really important so thanks for like taking our questions on the on the fly. That's awesome. Again yeah there's a lot to analyze in this 2,000-page document through both the San Diego Transportation Equity Working Group and the City Heights Built Environment team. We've been collectively analyzing the plan so here are just some of the takeaways and some of the things we like, some of the things we hope to see improvements on. So we're very excited about the Purple Line Commuter Rail, also known as Maria's Purple Line, that's gonna connect South Bay, Southeast, City Heights, Mission Valley, Sorrento Valley. Really excited for that route. That's going to be really critical improvement.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="https://www.sdfwd.com">SDForward.com</a> . The 2021 Regional Plan data viewer can be used to explore draft plan projects in your area.
M97	Randy Torres-Van Vleck	City Heights CDC	Expanding the rapid network is going to be key and making those near-term investments to increase transit frequencies is going to be important and as part of those local investments in the transit system, we believe it's important to look at 24-hour transit. Late night and 24-hour transit was ranked as the highest, most supported public improvement during MTS' Elevate San Diego Outreach process. The third track for the Blue Line that'll allow 24-hour service, greater frequencies, eliminate that conflict between freight and transit, and allow for express service is going to be important as well.	SANDAG will be undertaking a Blue Line study in 2022 to refine how the travel time could be speed up. SANDAG is also working with our Community Based Organizations to increase service frequency on routes that would benefit our social equity communities.
M98	Randy Torres-Van Vleck	City Heights CDC	We want to see enhancements maybe through the mobility up process that allow for dignified transit riding experience, specifically bathrooms because that's something that we don't really have a plan for here, and lastly I think we could do a lot better at. The youth-opportunity passes and free transit scenarios is going to be important.	The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M99	Randy Torres-Van Vleck	City Heights CDC	That's something that residents and mid-city have supported for a long time, and we're supportive of converting general purpose lanes on freeways and to better uses. So we appreciate the planned calls for that. As you recall, Colleen, you know 2015 we helped secure that analysis for the 94 freeway but through that work residents identified concern, expressed concerns with adding more lanes that would increase vehicle miles traveled on the 94 and 805. So we want to we have some questions about those new managed lanes. Love to get more about that	The intent of the managed lanes is to create a flexible system that can be managed in real time. This is similar to how the I-15 corridor is currently managed in North County today. Solo drivers will have options to use the lanes but at a price and transit services can travel congestion free. The result is better optimization of the system that encourages higher occupancy travel but with real alternatives that are competitive with driving.
M100	Randy Torres-Van Vleck	City Heights CDC	and then equitable coastal access, as Maria pointed out, is something that's important. The beach and coast should be enjoyed by everyone, not just those who can afford to live nearby at the coast or afford a car.	The 2021 Regional Plan includes upgrades to existing transit service through the creation of <i>Rapid</i> Routes 10, 30, 103, 473, and 950 with service to many beaches along the coast. Further development of the Coastal Rail Trail and other active transportation routes will improve non-motorized access to the beaches as well.

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M101	Randy Torres-Van Vleck	City Heights CDC	And then finally we just have general questions about the phasing of the projects. You know that's something that is very just like personal to City Heights residents as we've waited for decades for active transportation transit improvements. So what are we gonna do? The question is what are we gonna do differently in these next 15 years compared to what we've done these past 15 years to get projects, transformative ones, built more quickly? Yeah looking forward to these you know some of these answers and working with you all on getting the 5 Big Moves approved. Thank you."	Response provided during the public meeting: Ultimately it is the voters of the San Diego region that are going to decide if they want to buy this plan. And so at some point in the next year or two years, there will very likely be something on the ballot for consideration. So that's the first thing I wanted to mention, and that would not be the only funding source. A new sales tax measure, for example, would allow us to leverage state and federal dollars. And for anyone who's been following work that SANDAG's been doing, on average for every dollar we raise in the San Diego region, we're usually able to get two dollars and fifty cents in return from state and federal programs. So that's a start. We also have laid out a number of other funding strategies, because it's not just the sales tax measure that's going to get us there. So I wanted I want to share that with you. The other thing with the team is working on right now is if you've had a chance to look at the two appendices U and V, that's how we fund the plan. And some of the phasing plan is also in appendix A. We're working to really align that and get more refinement on things. It's really important to keep in mind, again, as I mentioned earlier, this is really a big picture blueprint. There's a lot of additional work that needs to get done to really refine that phasing. But we're at least going to lay out a more detailed phasing program as we develop the final.
M102	RightCow LeftCoast	San Diego Wikimedians User Group	You do have it correct. RightCow LeftCoast. It's my username on Wikipedia. I'm actually with the local Wikimedia Foundation affiliate, San Diego Wikimedians User Group. Again, thank you for the opportunity for letting me speak. I have a couple questions regarding the topic you have presented today. Actually four here. As you may know, the navy plans to shift 60 percent of the overall fleet to the Pacific, which will including basing ships and units here in San Diego as it is home to the two-third fleet. Has San Diego factored that population growth into its planning?	We have been working very closely with the US Department of Defense, and we ask them to provide us information on their anticipated growth, and that goes into what we call our regional growth forecast. So to the extent that our friends at the Navy are able to provide us that information, we include that in our population projections and in our projections about job growth. The Navy is such an important partner here in the region, big part of our economic engine, and so we do work closely with them to make sure that we have the latest information from them.
M103	RightCow LeftCoast	San Diego Wikimedians User Group	Then my next question. Many individuals who work within the County of San Diego commute from Riverside County and few from Imperial County. How has SANDAG worked with out neighboring counties to increase transit interoperability?	<p>When it comes to Imperial and Riverside, we do work with the neighboring counties to look at what's happening with that cross border transportation. We do multiple surveys, and we're always looking for ways to look at travel options there. I think probably the best way to do that is through the connections of our managed lanes.</p> <p>For RCTC, the Riverside Transit Authority, we have worked closely with them. When we first started this plan, we drew connections and big circles around Orange County, Riverside County, the border, Imperial County, and further east towards as you're heading into Arizona. We know that these are connections are really important, and San Diego isn't landlocked. We are dealing a lot with our neighbors in each area. So the plan currently has a lot of connections in Escondido, and then there are plans in the future to extend our routes up to potentially Temecula to coordinate with RCTC.</p> <p>But in the plan is high speed rail, and high speed rail connects our Inland Empire along Riverside County, across the center of our region, and down into downtown San Diego. So, that's really the route that we see as the fastest connection from those inland Empire areas over to our downtown San Diego area.</p> <p>Related to Orange County, we work with our neighbors to the north, and today we have we have the transit service Metrolink that stops at the Oceanside Transit Center. And we also have the Amtrak Pacific Surfliner that serves both Orange County, Los Angeles, and our region. So it's something that we're always looking at ways to align all the transportation between Orange County and our San Diego region, and also with Imperial county and Riverside.</p> <p>On LOSSAN too, part of what we're looking at is creating an interconnected rail service. So the Metrolink trains could come all the way down and operate through the LOSSAN corridor, and then we can provide those direct connections. That is part of the state rail plan, that's part of SANDAG's plan, and that's part of why we're doing those improvements on the LOSSAN corridor.</p>



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M104	RightCow LeftCoast	San Diego Wikimedians User Group	Next, many of many persons commute to from our international neighbor to the south, Mexico. How has SANDAG worked with federal authorities to ease the commute to our coworkers who live in Mexico?	SANDAG appreciates your support and feedback. The SANDAG Borders Committee was established in 2001 to bring together elected officials and representatives from all neighboring jurisdictions to address joint challenges related to regional planning and collaborate across jurisdictional and international boundaries to develop and implement strategies within the broader context of the megaregion. The Mexican government is represented through the Mexican Consulate as an advisory member of the Borders Committee as well as Board of Directors. The 2021 Regional Plan is designed to build on the close working relationships among partners throughout the California-Baja California binational megaregion, including those at all levels of government in Mexico. Efforts will include completing the Otay Mesa East-Mesa de Otay II Port of Entry project, implementing the Regional Border Management System (RBMS), and advancing the San Ysidro Mobility Hub project. These and other initiatives will help create the momentum needed to improve crossborder mobility. Appendix J includes more information on SANDAG's approach to working with binational partners. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
M105	RightCow LeftCoast	San Diego Wikimedians User Group	And lastly, though this might be outside the present presentation's purview, do you have any information about real connectivity of San Diego to Baja California and Imperial County to include the historic Goat Canyon Rail Bridge in Carrizo Gorge. Thank you very much for taking the time to answer these questions.	SANDAG is working with MTS and Caltrans to identify future freight opportunities on the Desert Line. For additional information on the Desert Line, please visit: <a href="https://www.sdmts.com/about-mts-meetings-and-agendas/sdae">https://www.sdmts.com/about-mts-meetings-and-agendas/sdae</a> .
M106	Stephen Tessier		So I think a quick and easy way to facilitate traffic or trolley movement through downtown would be to give it a signal priority. I lived in France for six years back in the 1990s and that's just what they did. They just gave it automatic signal priority and there you go. Secondly, just a quick question regarding double tracking the line all the way down to well eventually ideally take the commuter rail all the way down to the border is the existing line extending it through Santa Fe Depot all the way down to the border is and then taking it off the bluffs you have to take it you know. That's just a to anybody really looking at that situation, that's just an a disaster waiting to happen and it's not going to get cheaper by waiting to move it off the bluffs. I don't I just wanted to to see what you guys I'm certain yeah I'm certain that's on your plate. I just like to know if there's anything specific that you guys have to speed that up.	<p>SANDAG recognizes addressing the bluffs as a priority. The Regional Plan identifies funding for bluff stabilization in the short term while also prioritizing funding to start work on a long term solution to realign the rail corridor into a tunnel in Del Mar by 2035. There is also a project to bypass Miramar Hill and realign the tracks in a tunnel with a new station at UTC by 2050.</p> <p>Regarding your idea to go all the way down to the border, we are working to take the Blue Line trolley and create a type of service that would be express.</p>
<b>July 16, 2021 – SANDAG Transportation Committee Meeting</b>				
M107	Maria Cortez		So I too also want to mention that we do need more bathrooms because a lot of times as has been said those of us that are younger need to use the restroom and can't, we have to go somewhere else and when we get back we've either missed the bus or we've missed the trolley, and we have to wait again. And also families with younger kids, it's you know painstaking to see them having to hold it and sometimes they can't. And also I am in agreement also with Stephanie about the no expansions on the freeways because my god, we're already bad enough as it is and so we need to be more, having more buses running on time and also more frequency. This way we will reduce the gas emissions and carb and also I too would like to see more information being used by the by the buses and the trolleys vocally because sometimes you miss what they, what's been flashed or what's been said. Sometimes they're not saying it frequently enough, and I too would like to see that happen. And also I've noticed that the security guards there are much nicer now, and I just want to say thank you for you guys and MTS. I'm taking hold on that and I too would also like to thank SANDAG's staff for everything that they've been doing. As I said earlier, it's about time and my hat's off to Hasan here who is who has shown incredible leadership. And also I would like to congratulate him for having to having to be with us for the next three years, and as you will see the community is also now starting to see and trust SANDAG more with the transparency.	<p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p> <p>The 2021 Regional Plan is not proposing any new highway expansions or addition of highway general purpose lanes but rather is focusing on a regional network of managed lanes to ensure that the Regional Plan meet state and federal greenhouse mandates, reduce traffic congestion, and address social equity. Proposing a managed lanes network that uses existing infrastructure by converting shoulders or general purpose lanes gives an opportunity to increase capacity on lanes that traditionally would not benefit from increased use of high occupancy vehicles or transit.</p> <p>Your comment has been forwarded to San Diego Metropolitan Transit System (MTS).</p>
M108	Michelle Krug		I have not had a chance yet to have someone go over the details of the Regional Plan yet. I will do that, but I do want to emphasize as much as possible to please bear in mind having as many audio sim signals. So when I'm at a trolley, because I'm blind, when I'm at a trolley station I love that we do have more information written you know on signage, but can you also keep in mind maybe having more audio saying when the troll- what trolley is arriving, but you know that's in the public transportation and on the buses. And the other thing is pushing or emphasizing the 24-hour service which as someone who's retired now but as a wastewater operator I worked rotating shifts, and it would be	<p>The transit operators work on the ADA announcements at stations. We will forward them your comment. SANDAG is undertaking a study to determine which routes would be eligible and able to be operated 24/7. This study should be done in late 2021.</p> <p>Your comment has been forwarded to North County Transit District (NCTD) and San Diego Metropolitan Transit Service (MTS).</p>

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			great if we really were able to safely use transportation no matter what shift we were all working. Thank you very much for your work, and Hasan is just our angel. He has just brought hope in a way that I've never felt for decades since I've been here in 1979.	
M109	Rocina Lizarraga	Olivewood Gardens	I would like to appreciate all the comments from my colleagues that are joining in this movement of advocacy and activism and both being vocal in this Regional Plan. I'm Rocina Lizarraga, and I work for Olivewood Gardens in National City, and our city has been historically disinvested and been penalized despite the efforts of the local jurisdictions to provide most of the amenities. Our I just want to advocate for this time for the senior population. After revisiting all the graphic and reading and reading and inquiring about that, and I know there's a great report in all the data that shows that our communities are in necessity. The assessments that we've been done after doing that we just I discovered myself that there's very little amenities for people with that is aging. That we have a large population of seniors that they decide they deserve considerations of biological necessities and also disabilities not only physical but sensorial and also disabilities on necessities that they need when using transportation. Most likely they use public, private transportation because it's more convenient but doesn't align with this non-used cars and use public transportation gold that we have with this draft plan. I'm looking for Appendix Q, Appendix L, and there's figure that says safety but it doesn't it does not reflect what we wanted to see. I'm so purely support what member Jennifer Martinez is saying that there's biological necessities that they have because they're aging. So I would like to see more of that and I think the team on SANDAG is completely in that they will revise again and see if we can reflect this type of necessities for our our disabled population in all ages because it says all ages are included in this and considered in this draft plan. So I would like to see more of that, and I would like to see in the future the lengthy implementation of these programs.	<p>We would like to refer you to Appendix H: Social Equity Engagement and Analysis. There, you will find an increase to regionwide access to basic needs -- such as medical facilities, parks, and retail -- for seniors through 2050. According to Appendix H, transit access for seniors to medical facilities increases from 79.5% in 2016 to 84.5% by 2050.</p> <p>In Appendix B: Implementation Actions, you will find our curb management strategies, which will aim to best-use and manage all modes of transportation on our streets for everyone safely and efficiently. One of the key elements of curbside management are paratransit and accessible loading areas to serve our disabled populations.</p> <p>Also in Appendix B are our strategies to align with the goals of Vision Zero, a national policy aimed to protect especially those most vulnerable to fatalities (i.e low-income, those with disabilities, children) involving people walking, biking, and traffic collisions. One of SANDAG's near-term actions towards Vision Zero includes developing and implementing a regional safety policy.</p> <p>For more details on these initiatives, please see Appendix B.</p>
M110	Scott Anglum		I'll be very brief. Once again, the draft Regional Plan is revolutionary and hopefully, if anything, it'll be expanded in its scope and depth. There is widespread support for the initiatives that are outlaid within them and once again please recognize that there is great public support, great public emphasis behind sustainable, regular and reliable transportation in the region so that car dependency is not the default in the area. All right, that is all.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
M111	Stephanie Hernandez	City Heights CDC	I am a program manager at City Heights CDC and also a member of the SANDAG Social Equity Working Group and San Diego Transportation Equity Working Group. I just really wanted to emphasize and recommend that Transportation Committee members read that transit, the 10 transit lifeline document that the San Diego Transportation Equity Working Group has shared with you all that really addresses our priorities for the Regional Plan, such as, as mentioned, bathroom access, transit frequency, Purple Line alignment in City Heights. But I also wanted to just mention that a lot of our residents that we've spoken to also want, we'll be sharing a letter fairly soon, but a lot of many have addresses just making sure there's an increased access to the bay, the beach area. A lot of youth cannot access the beach who live in City Heights, and it takes about two hours to get there so we really recommend that there is some type of mention of beach access in the Regional Plan again and also making sure that there is no freeway expansions. You know freeways definitely have divided communities like City Heights, and so we recommend that bus transit-only lanes are prioritized moving forward.	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582 (Purple Line). The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>The Regional Plan outlines the following projects in the Pacific Beach/Mission Beach areas. These proposed projects can be viewed in more detail using the Dataviewer on <a href="http://SDForward.com/envision">SDForward.com/envision</a>. Pacific Beach Mobility Hub.</p>

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				<p>Complete Corridor Arterial improvements on Ingraham Street, Mission Boulevard, and Grand Avenue.</p> <p>On-street and off-street bike and pedestrian facilities from Pacific Beach to East Mission Bay</p> <p>On-street bike and pedestrian facilities on from Mission Boulevard to Pacific Beach Drive</p> <p>Rapid 292 - Pacific Beach to Kearny Mesa via Balboa Avenue to Grand Avenue</p> <p>On-street bike facilities from Pacific Beach to Mission Beach via Cass Street</p> <p>Next Gen Rapid service on Route 30 to the Balboa Station</p> <p>Specific community plans and decisions regarding land use will remain under the authority of local jurisdictions and will require future collaboration with community members and the City of San Diego.</p>
M112	Toshi Ishihara	SanDiego350	<p>I'm a member of San Diego 350, and I'm also a member of San Diego Equity Transportation Working Group. So I'm a climate change and transportation equity advocate. So Hasan, his staff and also board members and also public, I really appreciate you putting together this draft Regional Plan. I like a part of it, but I think it is not challenging enough, means it is not challenging the reality we have today in terms of like greenhouse gas emissions and climate change. As you know, the world is burning, and our survival is at stake. And if I look at the Chapter 1, page 13, it says the Regional Plan will reduce net capital greenhouse gas emissions from cars and light duty trucks to 20 percent below 2005 levels by 2035. Of course that exceeds the region's mandate target of 19 percent, but if we look at the fact that more than 50 percent maybe around 50 percent of the greenhouse gas emissions in these regions are coming from transportation right and the 20 percent to 50 percent like a simple state maybe 10 percent reduction, but it is not the case because we are talking about reduction of 20 percent below 2005 level. So that means to me we are talking about target which can make only tiny dent to the entire and overall greenhouse gas emission from the transportation system in San Diego. So I like Regional Plan, but I would like to see SANDAG take some more like aggressive stance in order to fight greenhouse gas emissions and also fight climate change.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT. The 5 Big Moves will enhance connectivity and result in people having more travel options and operating solutions, reducing per capita VMT.</p> <p>Senate Bill 375 also requires the 2021 Regional Plan include a Sustainable Communities Strategy (SCS) for the San Diego region. This SCS describes coordinated transportation and land use planning. When combined with the transportation network, the SCS exceeds the state's target for reducing per capita GHG emissions set by the California Air Resources Board.</p>
<b>July 23, 2021 – SANDAG Board of Directors Meeting</b>				
M113	Ariana	Mid-City CAN	<p>I'm calling in with Mid City CAN. I want to say thank you to SANDAG for working so hard in drafting the 2021 Regional Plan. We are asking that they include youth opportunity passes, no-cost transit passes for youth for ages 24 and under. When it comes to the transit subsidies we are asking for them to be the priority group. In the pandemic we have seen that there is a need to develop lifelong transit riders. I think that YOP can definitely do this. When we are investing in young people we are ensuring that young people have the opportunity to access school, work, and other activities. I myself was a transit rider for many years. Because of this, I was able to get a lot opportunities I couldn't get as a young person. Youth opportunity passes really addresses the need for sustainability. We are hearing from other speakers that there's a lot going on that is impacting our world and we need more folks from all economic backgrounds to ride transit as a method to reduce emissions. And YOP is actually a key strategy to make sure that we increase ridership for all these folks. YOP is already a program that has been invested in in other cities in California so I hope that YOP is listed as a priority group.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
M114	Bee Mittermiller	SanDiego350	<p>I'm from the San Diego 350 Organization, I'd like to congratulate SANDAG staff for putting together this incredibly detailed Regional Plan. It finally sets the goal of creating a public transportation system that has the potential to attract new riders who want a way to get around without the frustrations, headaches, and costs of congestion, car ownership, and parking. Shifting people to the use of public transportation, bicycles, and walking are the most effective ways to improve mobility and reduce greenhouse gas emissions. Improving this will also keep the riders who are already depending on the system. As everyone mentioned, we are living in a nightmare of the climate crisis. This cannot be denied any longer. San Diego can do its part to address this crisis by adopting the 2021 Regional Plan but we want SANDAG to prioritize all of the projects, big and small, that will reduce greenhouse gas emissions as fast as possible while also addressing equity. We appreciate the staff's past and future outreach to all individuals and organizations who want the best planning for our region. As members of San Diego 350, we plan to remain engaged in the process and look forward to further discussions.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>

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M115	Belen Hernandez	Mid-City CAN	I am a policy advocate with Mid-City CAN. We are calling to request that you amend the 2021 Regional Plan to state that youth opportunity passes, no-cost transit for youth ages 24 and under, will receive priority when transit subsidies are allocated. When you invest in youth opportunity passes, you are truly investing in youth lives. Young riders depend on transit at a much higher rate than adults. In San Diego, young commuters ages 16 to 24 use public transit at a rate double that of adults 25 to 59. YOP is about equal access to opportunity. Transit-dependent youth ages 24 and under need no-cost transit to get to school, work, medical care, recreational sites, and life opportunities. The cost of a pass is a barrier for many families earning minimum wage. It is also an investment in sustainability. We need more people from all socioeconomic backgrounds to be riding transit as a method to reduce carbon emissions. YOP is a key strategy to increase ridership from all socioeconomic backgrounds and develop lifelong transit riders in our region. We need YOP to increase ridership and be sustainable. Lastly, it is also an investment in a proven program. San Francisco, Sacramento, Los Angeles, Santa Ana, Alameda, and more jurisdictions across California and outside of California have already implemented similar programs. SANDAG must take bold action and include YOP in our 30-year vision for transportation in the region. The program has proven to work for people and transit agencies. Please amend the 2021 Regional Plan to include youth opportunity passes, ages 24 and under, and funded as an early action pilot program. Also included the 10 transit lifeline projects brought forth to you in a letter from the San Diego Transportation Equity Working Group, which represents the priorities and needs of the communities we serve.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M116	Catherine Harrison		I live in San Diego, and I taught in city schools for over 32 years. I truly appreciate the shift SANDAG has taken to accomplish transit goals but I think the greenhouse gas reduction goals are too low and the project timelines are too slow for the speed and gravity of the current climate emergency. There is still too much emphasis on roads for private vehicles. Climate change is manifesting itself quickly all around us so our response needs to be big, bold, and fast. A way to cut car emissions, which are about half of the county's total emissions, is with attractive and enhanced public transport that provides efficient and easy mobility for all of us. I've taught many years at a small public high school downtown on the campus of City College, where students come from surrounding low income neighborhoods. The school district provides free or discounted youth passes for MTS, depending on family circumstances, and this has made a huge difference for our students allowing them to flourish and take college classes early. I've seen the problems that occur when they can't get those passes in a timely manner or when trolleys don't run efficiently enough to help them juggle their time commitments to school, work, and family. The Regional Plan should include free transit passes for all school-age youth and young adults much sooner than 2027. To help them in every way possible, join our vibrant economy and citizenry. Furthermore, no-cost passes will encourage significant participation in public transportation and shift expectations for how San Diegans use transit, allowing us to meet more accelerated targets for greenhouse gas reductions. We can do better than forty percent by 2030 if we act quickly on public transit goals.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M117	Cheyenne Martinez		I request that you amend the draft 2021 Regional Plan to state that youth opportunity passes, no-cost transit passes for youth ages 24 and under, will receive priority. As a youth from National City and recent graduate from UCLA, I have firsthand experience understanding how no-cost transit promotes accessibility for youth to excel in school, jobs, and early career opportunities. In Los Angeles, I benefited greatly from no-cost transit as it allowed me to navigate the city and go to work in order to support myself in my undergraduate career. The low income youth of San Diego region deserve better mobility. With that, I ask to please amend the 2021 Regional Plan to include youth opportunity passes for all youth 24 and under and funded as an early action pilot program.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M118	Craig Jones	Alliance for Regional Solutions	I'm a representative to the Social Equity Working Group from the Alliance for Regional Solutions, which represents communities with unmet need in North San Diego County. One of the points that Mr. Bullock, Mike, was making before when he ran out of time on your public comments was that the world is literally on fire here with climate change, and this is true. Let's just look around and admit what's happening here. We have a local, regional obligation to act as quickly as possible to counter and stop the production of greenhouse gases. The Regional Transportation Plan, the draft and the Regional Plan that has been proposed moving forward as quickly as possible will fulfill our moral obligation to do so. So I'm speaking in favor of the five big moves and the 10 items as well. Those who show some reluctance on supporting this plan are fearful about change and economic impact. If we	Thank you for your support of the 2021 Regional Plan and the climate strategies contained in the Plan.



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			don't address climate change, the economic impact to all of us is going to be horrendous. So we must move forward on this.	
M119	David Grub		Climate disruption is here now. Just look at the headlines. Floods, droughts, massive fires getting worse every year, people dying from extreme heat, and our agricultural industry having to scale down from lack of water. Anyone who is paying attention and taking it seriously knows what we need to do. We must reduce greenhouse gas emissions in every way we can before it is too late. What that means is as good as this plan is, it needs to be better. Don't get me wrong, I have been looking at regional plans for twenty years, and this is the best plan I have ever seen for our region but I worry that it does not go far enough or fast enough spending money on highways when we all know that we need to drive less, is not the best thing we can do. We need to prioritize active transportation and transit, and put off expanding freeways. We must choose actions that get the most greenhouse gas reductions per dollar first. Transportation demand management and cutting subsidies to driving are fast and effective ways to reduce greenhouse gas emissions at low cost. Do them first. I'll close with a quote from the past. "You don't need a weatherman to know which way the wind blows".	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.
M120	Denise Lopez		I will be going to UCSD this fall. I request that you amend the 2021 Regional Plan to include that youth opportunities passes will be used for youth 25 and under. As a youth dependent on transportation for my four years in high school, I have seen that we have struggled getting to school on time. This is very important to us. I will need the youth opportunity pass to attend UCSD which is very far away from me. There have been opportunities that I've had to turn down due to lack of transportation options. We are unable to travel safely at night because the buses stop running at 10 PM.	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
M121	Haney Hong	San Diego County Taxpayers Association	<p>I am the President of the San Diego County Taxpayer's Association. It's good to see everybody again. You may recall that a couple months ago, Hasan invited me to moderate a panel of experts around different revenue streams and mechanisms to finance the future region's transportation system.</p> <p>I'm here because I want to acknowledge first that there's a lot of hard work that's gone into the Regional Transportation Plan, and I think it's important to say thanks to all of you as well as the staff under Hasan's leadership for putting in all the time and effort to develop this draft.</p> <p>I also want to state that it's really important that as we go through this draft and go through this discussion and achieve the public policy discussion that Hasan talks about the region needing to have, we need to understand what goes into the plan. What are the assumptions that are built into the plan? What were the methods that were used to develop the plan, as well as what are the sensitivities in terms of the finance, when assumptions change or rates are different than for instance, what might be assumed in the plan? So, I just want to share for the record that the San Diego Taxpayers Educational Foundation, the research arm of the Taxpayers Association, has a working group of folks here who've submitted a bunch of questions to staff. And it also has been submitted here for this meeting for the record, and I think that addressing those questions will help assure trust and assure understanding around the Regional Transportation Plan, the final draft. And I just want to say thanks in advance to the staff and Hasan for addressing the questions that we submitted.</p>	We have received the list of questions regarding revenue and cost estimates on the 2021 Regional Plan and are responding to each concern raised.
M122	Jim		I am from Encinitas. In the many years since World War II we have devoted a vast majority of our transportation dollars to cars, cars, and more cars. In the past, it made sense, but now we know about the many downsides of cars which are climate change and social inequity. While there are cars and more cars, let's build a cleaner, healthier, more convenient, and more inclusive transportation system. We don't have to start from scratch because there are many examples from around the world that we	The 2021 Regional Plan seeks to offer fast, safe and reliable transportation options for the San Diego region that make public transit a competitive alternative to personal vehicles. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .

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			can leverage. We don't have time to waste. So let's start right now aggressively and assertively as possible.	
M123	Karina Gonzalez	Hammond Climate Solutions	<p>I live in Chula Vista, and I am with Hammond Climate Solutions. I want to thank the board and staff for your leadership in drafting this plan. I'm encouraged by SANDAG's bold, new direction, and I want to ensure that the 2021 Regional Plan is as strong as possible for climate, jobs, and justice.</p> <p>As you all know, the climate crisis is rapidly accelerating, and we need bold action from SANDAG in order to ensure that the region is doing everything possible to reach zero carbon. I encourage the board to exceed emission targets put forward by the state, prioritize mode shifting away from gas-powered vehicles, and provide much needed funding to the regions communities of concern, who have historically experienced underinvestment when it comes to transportation improvements. I grew up driving my dad to and from public transit and have seen firsthand how our transit system is not working in communities of concern. We need to invest in these communities who are on the front lines of environmental injustice and who suffer from disconnected public transit.</p> <p>Finally, I encourage the board to fully fund youth opportunity passes, something that community-based organizations have been advocating for years because every San Diegan deserves access to high-quality transportation and economic mobility, especially our young people.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
M124	Katie Meyer	SanDiego350	<p>I'm calling with San Diego 350. I'm calling because I both wanted to thank the staff at SANDAG for their progress around transportation in this Regional Transportation Plan. This is a huge step forward, and as a lifelong transit rider, I appreciate this progress. I also want to encourage you all to move further in this plan to meet our emissions targets and properly address our climate crisis. San Diego 350 wholeheartedly supports incorporating the 10 transit lifelines into the plan, and I especially want to encourage you to accelerate the timeline for all transit projects. So that includes trolleys, buses, rail, and biking infrastructure. Environmental justice communities need transit solutions the most and need them right now, and they disproportionately suffer from the effects of climate change.</p> <p>We need to move these projects up as well as encourage you all to adopt 24-hour service and 10-minute frequency on popular bus routes right now. I personally have been trying to take the bus late at night many times, and I know from experience how frustrating it is, and that is not serving the needs of the community or the needs of environmental justice communities.</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p>
M125	Laura Walsh	Surfrider Foundation	<p>I'm with the Surfrider Foundation. I just want to thank the board and staff for their leadership on the draft RTP. I represent the Surfriders and we talk about the value of the coast. I'd like to make a point that the beach and coastline affect all inlanders as the rising temperatures as the rising temperatures we are all currently experiencing continue. This just brings home the point that the climate crisis will impact people who are already disadvantaged. I live in Ocean Beach but my office is in Hillcrest and the temperature change is dramatic just driving to work. I appreciate that this plan is beginning to acknowledge this and hope that it leads to solutions that can solve these inequities. On behalf of Surfrider, we really hope that this plan will ultimately enable measures and funding to get people to visit the many beautiful beaches in our community. I echo the point of amending the RTP to include youth opportunity passes. I took the bus to all my internships as a college student and it really is a frustrating experience to make a name for yourself as a professional and always be late. Anything we can do to make this easier especially for people who are trying to make ends meet is really important.</p>	<p>SANDAG recognizes the urgent need for reduction of GHG emissions, especially in our most marginalized communities, as a key aspect in an equitable and sustainable future for the region. I would like to direct you to Attachment2 in Appendix A: AB805 Pollution Reduction Strategy, where you will find a list of transportation projects aimed to reduce pollution exposure in our region's disadvantaged communities in accordance to AB805 and CalEnviroScreen 3.0. More detail on phasing and funding allocations to these projects can be also be found in Appendix B: Implementation Actions.</p> <p>One of the plan's near-term Implementation Actions listed in Appendix B will be a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, students, and youth.</p> <p>For more information on the the Regional Fare Impact Study and anticipated transit fare subsidies, I would like to direct you to Appendix B: Implementation Actions and Appendix U, respectively.</p>
M126	Lori Saldana		<p>I want to start by thanking you for including the Black Contractors Association under project labor agreements. It's essential to address the long term and ongoing lack of equity for black citizens here in San Diego. We see the racial and economic injustice in our region where we have 5 percent of our community is black, yet 20 percent of our unsheltered population are black. This shows why we need</p>	<p>SANDAG is currently developing a Regional Housing Incentive Program that will support the development and adoption of policies and process improvements to accelerate housing production for very low-income-, low-income-, and moderate-income housing while taking several factors into consideration to ensure the program meets the goals of</p>



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			<p>to have the executive order signed this year by President Biden to make sure that public contracts addressed as ongoing racial inequity. Related to that, an increasing number of riders on transit are unsheltered. We need to consider adding them as a community of concern. They're disadvantaged, their health is often challenged, yet many of them are employed they are workers. They need transit to get to and from their jobs. Related to that, I would encourage looking providing safe parking near MTS stations. So that people who are working and lack a permanent home have a place to park that doesn't kick them out and put them at risk. Regarding convenience, please coordinate events that are ongoing regarding being more competitive in transit. Please have extended hours especially for areas that have nighttime events so people who are not comfortable driving at night and want to partake in community events later in the evening have a later transit ride. I know that this is a MTS issue, but please take this into account. Making the ride safe and comfortable again goes back to addressing the needs of very diverse people including our unsheltered population.</p>	<p>the 2021 Regional Plan. Additionally, SANDAG will coordinate with the Social Equity Working Group and other interested stakeholders to ensure the housing program promotes equity and addresses issues like gentrification and displacement.</p> <p>Most of California's unsheltered population resides in major metropolitan areas; however, homelessness impacts communities of all sizes. Efforts to address homelessness are led by local jurisdictions in the region and SANDAG supports their efforts to seek funding sources from the State Department of Housing and Community Development (HCD) to address homelessness, begin initiatives, or conduct pilot programs. For more information, please visit: <a href="https://hcd.ca.gov/policy-research/specific-policy-areas/homelessness.shtml#">https://hcd.ca.gov/policy-research/specific-policy-areas/homelessness.shtml#</a>.</p> <p>SANDAG agrees that Safety in and around regional mobility hubs including transit stops situated throughout these communities is of utmost importance. Future improvements to create well-lit stations that also offer amenities like clean public restrooms or secure parking for personal bikes and other micromobility devices will contribute to comfort and convenience as well.</p>
M127	Mike Bullock		<p>I'm from Oceanside. I'm a systems engineer. I have written a peer- reviewed report showing how cars and light duty trucks can achieve the first climate stabilization target, which is 80% below our 1990 levels by 2030, very quick. I plan to write a detailed letter, but I just want to give a few short comments today.</p> <p>I support the 10 lifeline provisions as stated by the 350.org speaker, and I agree with the call for the youth opportunity passes, but I think we have to make this much bigger than that, part of an overall system as called for in the California Democratic party platform.</p> <p>I just want to quote what's in that platform. Support the design and implementation of a single, environmentally sound technology system that will collect and distribute fees for the use of roads, parking, and transit that is both economically fair and convenient and protects user privacy and the interest of low income users. And certainly youth would be free, and a lot of other individuals would also be free. That would be means-based, of course.</p> <p>Now just broadly, in Chapter 1, you've got that big triangle there with the three challenges: congestion, and the best way to do that is with congestion pricing, road use charge will provide a platform for that; social equity, and you need a good road use charge, you need a fair car parking system if you want social equity; state and federal mandates has to be expanded. I'm sorry, there's too many words at the bottom part of that triangle, but it should say state and federal mandates and climate science-based climate stabilization targets. And just to let you know what's coming down, the mayor has asked CARB to come back and tell him what it would take to reach zero by 2035 instead of 2045. So things are changing very fast.</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
M128	Noah Harris	Climate Action Campaign	<p>I am with Climate Action Campaign and a member of the San Diego Green New Deal Alliance calling to comment on SANDAG's Draft 2021 Regional Plan. We thank the staff and board for their work and our very encouraged by SANDAG's bold new direction to start the process of transforming the San Diego region's transportation system, so it is more sustainable, equitable, and climate safe. The most up-to-date climate science says that we must slash emissions towards zero carbon as soon as possible to stop the worst impacts of the climate crisis, which, as we've seen this summer, are worsening each year. Extreme heat, wildfires, drought, flooding, and more: these have and will disproportionately impact historically underinvested communities of concern.</p> <p>As such, we urge you to first exceed state mandated emissions reduction targets by maximizing mode shift towards bike, walk, and transit. We must get people out of their fossil fuel cars and into more</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT. The 5 Big Moves will enhance connectivity and result in people having more travel options and operating solutions, reducing per capita VMT. Local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.</p>

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			sustainable modes of travel. Aggressive mode shift should be pursued in partnership with the cities, particularly the city of San Diego, to achieve the Climate Action Plan's ambitious mode shift targets.	
M129	Noah Harris	Climate Action Campaign	Second, investments should be prioritized in the communities on the front lines of the climate crisis and environmental justice: the communities with disconnected transit trips, dangerously polluted air, and lack of access to job centers.	The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. This list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.
M130	Noah Harris	Climate Action Campaign	Finally, we are in strong support of youth opportunity passes, no cost transit passes for youth 24 and under. This is an essential investment in our youth, and it should be included in Appendix A and implemented in partnership with MTS and NCTD as soon as possible in the early earliest implementation of the plan.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.
M131	Pamela Heatherington		I'll start with thanking everyone for your leadership and getting us this draft regional plan. But I want to start with the premise that the environment is the foundation for all living things. We owe it to future generations to secure a regional funding source to protect and manage a comprehensive habitat system. Our substantial acreage has been permanently conserved, additional acres must be acquired, and the conserved lands must be maintained and monitored to ensure that sensitive local plants and wildlife do not become extinct. As a critical partner, we ask SANDAG to continue to foster the effort to secure a regional funding source. Without a sustainable environment, all else is lost.	<p>As outlined in Appendix AA - Regional Habitat Conservation Vision of the 2021 Regional Plan, SANDAG identifies that a regional funding source is needed to implement regional habitat conservation plans to protect species and their habitats from extinction into the future. The Regional Habitat Conservation Vision identifies specific goals to Protect, Connect and Respect species and their habitats within our region.</p> <p>A steady, secure regional funding source is needed to complete the land acquisitions as proposed and to provide for ongoing land management. Acquisition of land has primarily been through state and federal funding leveraging offset from land development. As the land use patterns shift in the region toward more compact, urban development focused around urban Mobility Hubs, less greenfield development will occur, resulting in less development offsets. Similar state and federal funding are diminishing as more areas in California and the nation follow San Diego and adopt these habitat conservation plans. This will place increasing pressure on the region to complete the acquisition and management of natural lands without a dedicated funding source.</p> <p>While several barriers have been identified in implementing the vision for regional habitat conservation, the role of SANDAG as the regional planning agency and its commitment in its development of a Sustainable Communities Strategy will provide new opportunities to fulfill the promises made during the adoption of the region's various regional habitat conservation plans.</p>
M132	Rita Clement	SanDiego350	<p>I'm with San Diego 350, which is a member of the San Diego Green New Deal Alliance. I'm speaking because I wanted to thank the staff at SANDAG for their progress around transportation and this Regional Transportation Plan.</p> <p>However, this plan doesn't move quickly enough to meet the urgency of the climate crisis, and give those reliant on transit the relief they need. I traveled from my home in Chula Vista to Downtown San Diego for 12 years. I took two buses and then the H Street trolley. It took me an hour and a half to get there and two hours to come home. We need to accelerate the timeline for all transit: trolleys, buses, rail, and biking infrastructure improvements. And prioritize the environmental justice communities that need transit solutions the most. Environmental justice communities, who disproportionately suffer from the effects of climate change, cannot afford to wait. They need immediate improvements while the long-term infrastructure projects are being planned. This means no new roads and specifically accelerating the Purple Line and collaborating with MTS to improve the Blue Line that serves these communities. It also means transitioning to zero-emission vehicles.</p>	<p>The 2021 Regional Plan includes a Sustainable Communities Strategy (SCS), as required by California Senate Bill 375 (Steinberg, 2008) (SB 375), for the San Diego region. This SCS describes coordinated transportation and land use planning, and identifies Priorities for Adaptation Planning, which include serving as a resource for local agencies' Climate Action Planning efforts and the general public on the impacts of climate change. When combined with the transportation network, the SCS exceeds the state's target for reducing per capita GHG emissions set by the California Air Resources Board.</p> <p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on</p>

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				<p>these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p>
M133	Shayla Ott		<p>I'm a resident of North Park, San Diego. I wanted to thank you all for your effort drafting this plan and putting in the necessary steps to combat the climate crisis. I do want to ensure that the 2021 Regional Plan is as robust and comprehensive as possible for climate, jobs, and justice. As other folks have said today, the climate crisis is already here with what we are seeing with fires, flooding, storms, droughts, and record-breaking temperatures across the U.S. especially here in California. The worst impacts of the climate crisis already have and will continue to disproportionately impact low income communities and communities of color first and the longest. SANDAG must do its part to ensure that we reach zero-carbon as quickly as possible. And I recommend the following strategies, first exceed state-mandated emissions reductions; second, prioritize investments in bike, walk, and transit; and third, direct funding to historically underinvested communities of concern to bring about immediate transportation improvements in the neighborhoods on the front lines of environmental injustice. Please prioritize youth opportunity passes within the transit funding as an early action pilot program.</p>	<p>Many of the items in this list are included in the Regional Plan. SANDAG staff are also working with our Community Based Organizations to develop pilot projects that could lead to early implementation.</p>

### August 5, 2021 – SANDAG 2021 Regional Plan Social Equity Working Group Meeting

Comments below are summaries compiled by SANDAG staff based on discussion from several CBOs during the meeting; full approved meeting minutes are attached at the end of this document

M134	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 1. - 08.05.21 SE-WG Meeting - An Environmental Justice Centered RTP: Ensure the projects included in the 2021 Reprioritize environmental justice (EJ) communities as identified by CalEnviroScreen (CES) by listing the projects that will directly benefit EJ communities, outlining immediate benefits via projects that will be implemented by 2025 in EJ communities, and making all public communication easy to understand by the public in order to promote meaningful engagement. Status: We ask that an equity specific project list be included in Appendix A: Transportation Projects, Programs, and Phasing document.”</p>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p>
M135	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 2. - 08.05.21 SE-WG Meeting - Improve the Bus System Now (BCC, CF, NLRC, NSDI, VCC, EHC): Develop a bus system that is fast, frequent, reliable, and accessible by increasing frequency on popular lines, especially overcrowded ones. This should be done immediately as a way to introduce the public to a new transit era with short-term and long-term solutions. It should be done by providing MTS with the necessary financial support for implementation. EJ communities cannot afford to wait 10-20 years for solutions. We need immediate improvements while the big infrastructure projects are being planned. Status: We request more clarity in Appendix A: Transportation Projects, Programs, and Phasing that</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>

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			provides a list of specific improvements to the bus system. Currently, the document only describes changes to bus frequency in planned key corridors. Bus improvements are one of the most affordable ways to immediately increase connectivity, reduce toxic air pollution and greenhouse gas (GHGs) emissions in the region.”	
M136	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 3. - 08.05.21 SE-WG Meeting - Blue Line Express (CHCDC, EHC): Fund the planning, environmental, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. Rail-grade separations should only move forward with the addition of a third track that eliminates conflict between the Blue Line and freight. The Blue Line is the backbone of our transit system. It has the highest ridership and is one of the best-performing transit lines in the San Diego region. However, it is overcrowded, has limited frequency, delayed connectivity, and no 24-hour service.</p> <p>Status: The information listed needs to be clarified. It is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.”</p>	The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.
M137	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 4. - 08.05.21 SE-WG Meeting - 24-Hour Service by 2025 (BCC, CHCDC, NSDI, OWG, EHC): Provide 24-hour service on popular transit routes to connect late-night and early morning workers to their jobs by 2025. Participants of the Elevate SD 2020 community engagement efforts ranked this as their highest priority.</p> <p>Status: The information listed needs to be clarified. Appendix A includes local bus route enhanced frequencies to ten minutes in key corridors but does not state if that would result in 24-hour service. Simultaneously, Chapter 2 includes all-day services from 20-22 hours per day for rail and rapids, but it excludes local bus routes and a clear implementation schedule.”</p>	The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.
M138	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 5. - 08.05.21 SE-WG Meeting - Purple Line Serves (CHCDC, SHC, EHC): Central City Heights: Fund the planning, environmental, engineering, and capital for the Purple Line as a rail line that connects EJ communities in central City Heights and South Bay to Sorrento Valley.</p> <p>Status: According to the SANDAG staff, the alignment includes central City Heights in the 2050 RTP with a 2035 implementation. However, it should be listed in the document, demonstrate that the project phasing prioritizes central City Heights and the South Bay region, and a 2035 project completion.”</p>	The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.
M139	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 6. - 08.05.21 SE-WG Meeting - Youth Opportunity Passes (YOP)(CF, CVCDC, ECC, NLRC, UCP, VCC): Provide no-cost transit passes for all youth 24 years old and under in order to ensure generations of lifelong transit riders and encourage significant mode shift. Connect youth to school, work, internships, and other early-career opportunities.</p> <p>Status: We ask that it be accelerated for a 2023 implementation rather than the current delayed plan to implement in 2027.”</p>	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth 18 and under.
M140	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>Lifeline 7. - 08.05.21 SE-WG Meeting - Electrify Bus Fleet by 2030 (EHC, UCP, NLRC): Fund the implementation of California’s Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board. We cannot afford to wait 20 years to reduce GHGs.</p> <p>Status: We ask that the transition to zero-emission buses be accelerated for a 2030 completion with the support of recently approved state and federal funding sources. In addition, all the rapid bus route expansions listed should be implemented with ZEBs. According to Appendix A, the plan includes \$75 million for zero-emission buses and infrastructure by 2025 and \$250 million by 2035.</p>	The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a> .
M141	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 8. - 08.05.21 SE-WG Meeting - Identify Anti-Displacement strategies (CHCDC, NSDI, VCC): Fund anti-displacement efforts to protect vulnerable communities living near transit corridors by developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections.</p>	SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resiliency, consistency with the transportation improvements included in the Regional Plan, and alignment with other SANDAG grant programs. Additionally, SANDAG will



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ID	Commentor Name	Agency	Comment	Response
			Status: SANDAG staff has expressed interest in an anti-displacement study. We request an update on the status of the anti-displacement study. “	coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.
M142	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 9. - 08.05.21 SE-WG Meeting - Bathroom network (CF, EHC): Develop a bathroom access plan and provide MTS with funding for a clean and accessible bathroom network open at all major transit stations. And a bathroom at the San Ysidro port of entry.</p> <p>Status: It is unclear if a bathroom network is included in the capital operations budgets. The 2021 Regional Plan states that “mobility needs to be widely accessible, affordable, easy to use, and tailored to a person’s individual needs. In short, mobility must be viewed as a basic human right”. State-of-the-art bathrooms are mobility and key to a successful transit system.”</p>	The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.
M143	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Lifeline 10. - 08.05.21 SE-WG Meeting - Emergency Ready Transit System (EHC, NLRC): Fund the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. EJ residents are more likely to live in proximity to hazardous land uses that frequently result in fires and neighborhood emergencies. Simultaneously, frontline communities are also most vulnerable in the face of climate disasters. Status: Not included in the RTP.”</p>	MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.
M144	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Addendum 1 - 08.05.21 SE-WG Meeting (BCC, CF, CHCDC, ECC, OWG, SHC, UCP): SE-WG request improvements to transit stop, which includes items such as benches, bus shelters, and bike racks. Shelters should also include lighting and protection from the elements such as sun and rain.”</p>	MTS and NCTD currently provide shelters wherever it is physically feasible. As part of larger infrastructure projects like Next Generation Rapid, Trolley and Commuter Rail, all stations will have shelters.
M145	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>Addendum 2 - 08.05.21 SE-WG Meeting (ARS, ECC, NLRC, OWG): The SE-WG requests a prioritization of flexible fleets. Communities outside of the urban center such as North County, South Bay, and East County, especially need access to flexible fleets. In less urbanized regions, and regions with higher vulnerable populations, flexible fleets can connect populations into the transit system.</p>	SANDAG will also be conducting pilot programs for the implementation of Flexible Fleets and other micro-mobility options to help connect people in less dense regions into the greater transit network. Information regarding Flexible Fleets can be found in Appendix A and N. Additional materials can be found at: <a href="https://sdforward.com/docs/default-source/2021-regional-plan/5039-sdfrpvisionfivebigmovesonesheets-flexible-fleets-june2019_final.pdf?sfvrsn=79d3f865_2">https://sdforward.com/docs/default-source/2021-regional-plan/5039-sdfrpvisionfivebigmovesonesheets-flexible-fleets-june2019_final.pdf?sfvrsn=79d3f865_2</a> .
M146	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>Addendum 3 - 08.05.21 SE-WG Meeting (ECC, OWG (2), UCP): SE-WG requests a prioritization of pedestrian and bicycle infrastructure be implemented into the 2021 Regional Plan, with a focus on social equity communities.</p>	<p>As an early action of the Regional Plan, SANDAG will be developing a new Active Transportation Plan. The plan will take a fresh look at the network and the options to make it safe and comfortable to use active transportation. SANDAG prioritizes community engagement and will develop these connections in partnership with the community so that we can make sure the routes take people where they want to go.</p> <p>As each of these transportation projects moves forward there will be a great deal of planning, engineering, and design work ahead of the project’s construction. In the future there are opportunities for bike, pedestrian, and neighborhood safety projects in conjunction with the RTP’s transportation projects. The Current Community Planning Projects are a good example and we strongly encourage you to be involved in the South Bay to Sorrento project. See more info here: <a href="https://www.sandag.org/index.asp?subclassid=83&amp;fuseaction=home.subclasshome">https://www.sandag.org/index.asp?subclassid=83&amp;fuseaction=home.subclasshome</a>.</p>
M147	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Addendum 4 - 08.05.21 SE-WG Meeting (ARS, NLRC (3), BCC, VCC): SE-WG requests that the 2021 Regional Plan includes considerations for special transit connections. Specifically connections in North County to Orange County and Southern Riverside County, East to West Sprinter Connections, and Temecula to Border connection. “</p>	Regional connections are provided in the plan connecting Orange County to San Diego at the Oceanside Transit station. The Sprinter line is also planned for upgrades. Additional regional connections will be assessed in the 2025 Regional Plan.
M148	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>Addendum 5 - 08.05.21 SE-WG Meeting: All CBOs of the SE-WG, broadly expressed an interest in SANDAG pursuing pilot programs and fund for early implementation of the various strategies expressed in the 2021 Regional Plan.</p>	SANDAG is working directly with the CBO’s on transit pilots that could be adopted earlier than what this is identified in the plan. SANDAG will continue to seek opportunities to implement projects early as funding becomes available.
M149	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>“Addendum 6 - 08.05.21 SE-WG Meeting (BCC, OWG, SHC): SE-WG request that free senior passes be included as part of the 2021 Regional Plan especially in our low income communities with disproportionately elderly populations such as Chula Vista, National City, and South East San Diego. “</p>	One of the plan’s near-term Implementation Actions listed in Appendix B will be a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth.

## Draft 2021 Regional Plan Responses to Comments – Public Meeting Sourced

ID	Commentor Name	Agency	Comment	Response
				In Appendix U: Cost Estimation Methodology, Table U.2 captures the transit fare subsidies to riders throughout FY2026-FY2050. For more information on the Value Pricing and User Fee Implementation and the Regional Fare Impact Study, please see Appendices B and U.
M150	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	“Addendum 7 - 08.05.21 SE-WG Meeting (CHCDC, OWG, UCP): SE-WG requests that transit outreach and a transit education campaign be implemented into the 2021 Regional Plan. Community members are unaware of how to utilize the transit systems of San Diego. “	SANDAG is actively working on developing an outreach program for all roadway users focused on the projects being constructed in the Regional Bike Early Action Program. We have received a \$1.9 million competitive State Active Transportation grant to develop and implement an education and outreach program that is beginning soon. Additionally, staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. Included in this pilot will be an education component, asking CBO partners to help get the word out on public transit benefits.
M151	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	Addendum 8 - 08.05.21 SE-WG Meeting (ECC, OWG, VCC): SE-WG request that transit security be implemented into the 2021 Regional Plan. Especially in El Cajon, National City and Vista.	SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.
M152	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	“Addendum 9 - 08.05.21 SE-WG Meeting (BCC, CHCDC): SE-WG requests that access to the beach be implemented into the 2021 Regional Plan. Many community members from disenfranchised backgrounds lack access to the beach. Transit riders have prohibitively long rides to access the beach and other San Diego waterfronts. “	The transit network that has been developed for the Regional Plan includes faster access to the beach. There are Rapid and Commuter Rail routes that will operate between Mid-City and the proposed Central Mobility Hub. From that location you can seamlessly transfer to routes that will take you to Ocean Beach, Pacific Beach and La Jolla.
M153	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	Addendum 10 - 08.05.21 SE-WG Meeting (ECC, NSDI, OWG): SE-WG Requests that multilingual language materials and signage be implemented into the 2021 Regional Plan. The San Diego region currently has large Spanish-only and Arabic-only speaking residents. The language barriers these residents experience on a daily basis, is only further exacerbated by a lack of multilingual signage and informational materials. Furthermore, a lack of adequate language materials only further alienates these populations, excludes them from job markets, and excludes them from utilizing our transit systems.	SANDAG will be applying a social equity planning framework throughout the implementation of the Regional Plan. Through this framework, one of the Regional Plan's near-term actions includes developing a Digital Equity Strategy and Action Plan that will address regional accessibility gaps in communications infrastructure, technology, and digital literacy. Within digital equity, we have been working with our Community-Based Organization partners (or CBOs) to ensure that language translations and educational resources on transit are available to all San Diegans as we advance with our next OS system. Additionally, one of the points our CBO Partners have emphasized in our outreach is addressing the accessibility of existing infrastructures like multilingual language materials and signage for our current transportation system, which will be an essential to our early-action plans.  For more information, I would like to refer you to Appendix B: Implementation Actions, Table B.1 on the Digital Equity Strategy and Action Plan. For more information on our community-based outreach please see Appendix H: Social Equity: Engagement and Analysis.
M154	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	Addendum 11 - 08.05.21 SE-WG Meeting (OWG, VCC): The transit fare of the San Diego regional are still prohibitively expensive for our low income riders. The SE-WG implores SANDAG to explore avenues to make transit more affordable and even free for certain areas or segments of the population. The SE-WG requests that these considerations be included in the 2021 Regional Plan. Examples to consider include LA Metro with single fares of \$1.75, LA Go (County Bus) with \$14/30 day senior passes.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth 18 and under.
M155	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	Addendum 12 - 08.05.21 SE-WG Meeting (UCP , CF, EHC, ECC): For decades, San Diego has implemented housing without consideration of the transportation needs of the residents that will inhabit those housing units, and without consideration of the greater impact to the transportation network as a whole. The SE-WG requests that SANDAG consider the implementation of housing near transit stations, especial in National City and El Cajon, and the implementation of Mobility Hubs in City Heights, Euclid & Market, and San Ysidro.	SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with other SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.
M156	SANDAG Social Equity Working Group Members	SANDAG Social Equity	Addendum 13 - 08.05.21 SE-WG Meeting (UCP): High-speed fiber optic internet access has become more vital for our region, and an increasingly more integrated part of our transportation systems and infrastructure. Certain communities and	The transportation system envisioned in the 2021 Regional Plan relies on a vast network of digital infrastructure to connect and manage the transportation system. For Complete Corridors, NextOS, Flexible Fleets, Transit Leap, and Mobility Hubs to succeed, a robust



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		Working Group	populations have not benefited from this emerging technology and are a risk of being left behind. NextOS is a major component of the 2021 Regional Plan, and to deter inequity from emerging, the SE-WG requests that SANDAG include language that describes a more equitable access to this emerging technology. The SE-WG acknowledges that fiber optic internet will be an integrated and inseparable part of public transportation and infrastructure; and the SE-WG requests that SANDAG amends the 2021 Regional Plan to better address this inequity.	broadband and telecommunications network is essential. The Plan includes an investment in the backbone fiber infrastructure needed to support the transportation network however SANDAG is also developing a Regional Digital Equity Strategy & Action Plan to support the expansion of broadband county-wide. The Strategy & Action Plan will define strategies for expanding broadband and internet connectivity in the San Diego region to support quality of life, transportation, and equity.
M157	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	“Addendum 14 - 08.05.21 SE-WG Meeting (VCC): Communities in the North County are experiencing an elimination of transit routes without replacement. SE-WG requests that SANDAG give special consideration to deter the elimination of such routes.”	Transit service planning changes are guided by SANDAG's Policy 18 which outlines the requirements for service changes and transit agency and SANDAG responsibilities with regard to those service changes. These include steps to be taken with regard to, but not limited to, social equity analysis and outreach. More information can be found here: <a href="https://www.sandag.org/organization/about/pubs/policy_018.pdf">https://www.sandag.org/organization/about/pubs/policy_018.pdf</a> .
M158	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	Addendum 15 - 08.05.21 SE-WG Meeting (VCC): The presence of ICE and Border Patrol officers at transit is a deterrent to ridership and participation in our transit system. SE-WG implores SANDAG to work with its partners to eliminate the presence of such officers at transit centers and transit stations, and to include such language in the 2021 Regional Plan.	<p>Transit station security and operations are a function of MTS and NCTD. MTS's website states that they have been making changes to its security policies and practices, to ensure their operations are in line with best in practice policies. Recent measures include increased training for internal and contract security staff, updated use of force policy, conducting an outside audit, using more visible and customer friendly uniforms, and more. Details can be found at <a href="https://www.sdmts.com/inside-mts/news-release/mts-makes-significant-changes-use-force-policy">https://www.sdmts.com/inside-mts/news-release/mts-makes-significant-changes-use-force-policy</a> and <a href="https://www.sdmts.com/inside-mts/news-release/new-uniforms-mts-security-teams-aim-increase-trust-and-public-safety">https://www.sdmts.com/inside-mts/news-release/new-uniforms-mts-security-teams-aim-increase-trust-and-public-safety</a>.</p> <p>NCTD's website states that they contract with the San Diego Sheriff's Office and local law enforcement agencies to patrol and provide law enforcement and security services at our transit centers. Your comment was shared with Dennis Desmond (denis.desmond@sdmts.com) and Robert Calix (rcalix@nctd.org) from MTS and NCTD respectively.</p> <p>SANDAG's Public Safety Committee provides a forum for which regional public safety issues and concerns can be addressed. NCTD and MTS serve on the Public Safety Committee as advisory members. Information regarding the Public Safety Committee can be found at: <a href="https://www.sandag.org/index.asp?committeeid=66&amp;fuseaction=committees.detail">https://www.sandag.org/index.asp?committeeid=66&amp;fuseaction=committees.detail</a>.</p>
M159	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	“Addendum 16 - 08.05.21 SE-WG Meeting (VCC): SE-WG requests that trash cans be included at all transit stops and transit stations, and that the 2021 Regional Plan be amended to reflect this language. “	The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. Improving these facilities would also include trash cans at transit stops and transit stations to ensure cleanliness and safety.
M160	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	“Addendum 17 - 08.05.21 SE-WG Meeting (VCC): SE-WG wants reassurance and accountability from SANDAG that it will follow through on the requests and recommendations made by the Social Equity working group, as described in Item 5 of the August 5th, 2021 Social Equity working group meeting, entitled The Ten Transit Lifelines and all other subsequent language attached to the aforementioned Item 5 or Ten Transit Lifelines.”	SANDAG has provided a response to each request and recommendation made by the Social Equity Working Group regarding the Ten Transit Lifelines and all other subsequent language attached to the Ten Transit Lifelines. SANDAG looks forward to continuing to partner with the Social Equity Working Group on implementation of the 2021 Regional Plan.
M161	SANDAG Social Equity Working Group Members	SANDAG Social Equity Working Group	<p>***10 Transit Lifelines - Closing Language***</p> <p>EJ communities are at the frontlines of toxic air pollution and the nearing climate disaster. The RTP is the region's biggest opportunity to dramatically address the course of climate change in the region. According to SANDAG, transportation represents 41% of the region's GHG emissions and only 7% of low-income residents have access to fast and frequent transit. Simultaneously, San Diego has the seventh-worst ozone pollution in the U.S, and EJ communities are disproportionately impacted. Inadequate investment in the mass transit system harms our most vulnerable communities' health and quality of life.</p> <p>The RTP should include assertive and prompt policy solutions by 2025 because the climate emergency is here. The RTP is a visionary document by nature, however, it must outline immediate benefits to improve the region's economy, quality of life and sharply reduce air pollution and GHGs in EJ communities. Communities that suffer the brunt of environmental harm cannot wait any longer for prompt relief.</p>	<p>SANDAG recognizes the urgent need for reduction of GHG emissions, especially in our most marginalized communities, as a key aspect in an equitable and sustainable future for the region. Attachment 2 of Appendix A includes a list of transportation projects aimed to reduce pollution exposure in our region's disadvantaged communities in accordance to AB805 and CalEnviroScreen 3.0.</p> <p>SANDAG will be implementing a social equity planning framework throughout the entirety of the Regional Plan. For more information on how the plan will benefit our region's most underserved communities, please refer to Appendix H to find comparative analyses of projected social equity performance measure outcomes (such as PM2.5 emissions exposures) through Build vs. No-Build scenarios.</p>

September 23, 2021

Action: **Approve**

### **August 5, 2021, Meeting Minutes**

Chair Vivian Moreno (SANDAG Board Alternate) called the meeting of the 2021 Regional Plan Social Equity Working Group to order at 10:01 a.m.

#### **1. Welcome and Introductions**

Chair Moreno welcomed the Working Group members.

#### **2. Public Comments/Communications/Member Comments**

Randy Torres-Van Vleck, City Heights Community Development Corporation, spoke about the Metropolitan Transit System (MTS) Trolley 40th Anniversary celebration held on Saturday, July 31, 2021, and acknowledged that it was a great event. Randy Torres-Van Vleck announced that MTS is changing their fare system from MTS Compass to PRONTO.

Brian "Barry" Pollard, Urban Collaborative Project, spoke about the success of the MTS Trolley 40th Anniversary celebration. Brian Pollard acknowledged MTS for the outreach efforts with members of the public living in the San Diego region, free Trolley and bus ridership during the month of August, and to contact him or Randy Torres-Van Vleck for additional information on PRONTO cards.

Robin Joy Maxson, Ramona Community Planning Group and member of the public, spoke about the Latino population of Ramona, a geographical area currently not being represented, and expressed wanting to join the Working Group.

#### **3. Approval of Meeting Minutes (Approve)**

Action: Upon a motion by Brian "Barry" Pollard and a second by Carol Lewis (El Cajon Collaborative), the Working Group approved the minutes with corrections made from its July 22, 2021, meeting.

The motion passed.

Yes: Craig Jones (Alliance for Regional Solutions), Rose Ceballos (Bayside Community Clinic), Lisa Cuestas (Casa Familiar), Randy Torres-Van Vleck (City Heights Community Development Corporation), Brendaly Rodriguez (Chula Vista Community Collaborative), Carol Lewis, Konane Martinez (National Latino Research Center), Breanne Lash (Nile Sisters Development Initiative), Claire Groebner (Olivewood Gardens), Fe Seligman (Samahan Health Centers), Brian "Barry" Pollard, and Erica Leary (Vista Community Clinic).

No: None.

Abstain: None.

Absent: None.

Mohammed Tuama, Nile Sisters Development Initiative, spoke about language barriers and inaccurate translation on public transit flyers and videos. And suggested SANDAG provide outreach efforts on how to ride public transit to the community in various languages.

Rocina Lizarraga, Olivewood Gardens, spoke about the concerns affecting residents in community like limited transportation for senior citizens, unfinished bike lane connectivity, safety for bike riders and pedestrians, and the development of a bus system that is affordable, frequent, and reliable. Ms. Lizarraga also spoke in support of addressing the homelessness issue in National residents do not feel safe walking in their community.

Fe Seligman, Samahan Health Centers, spoke about having a micro-level analysis on social benefits for low-income community from proper infrastructure of purple line serving Central City Heights and South Bay to Sorrento Valley, fund the planning, environmental, engineering and improvements for proper bus stops.

Brian "Barry" Pollard, Urban Collaborative Project, spoke in support of a transit hub at Euclid Avenue and Market Street, having a tremendous amount of need of a transportation center located in the area. The Orange Line Trolley needs numerous calming crossing improvements, installing electric buses to help eliminate pollution in community, emphasized how education is *vital* among all transportation groups and how community-driven process for all under-served communities is important. Increasing the marketing budget analysis was discussed.

Erica Leary, Vista Community Clinic, spoke in support of developing a safe bus system that is sheltered for users - students and additional frequency enhancements, the 10 Transit Lifelines, provide YOP and savings in general, completing the managed lane on 78, and fund anti-displacement efforts to protect North County residents.

Craig Lewis, spoke in support of comments made by Konane Martinez and Erica Leary on observations made relative to North County on an alternative travel time on the Sprinter, and fund the implementation of next generation rapid going east and west between Oceanside and Escondido (see reduction of travel to ½ hr.).

Carmela Munoz, Vista Community Clinic, spoke in support of improving frequency of the Sprinter and accomplishing the rapid bus route expansions project before 2023, by providing an accelerated implementation to the North County Mall in Escondido.

Randy Torres-Van Vleck, Community Development Corporation, spoke in support of all the regional priorities shared by the CBO communities and summarized a brief description of implementing an equitable, efficient, and affordable transit system, having equitable access to the beach, fund an anti-displacement strategy to protect vulnerable communities in the San Diego region.

Carolina Martinez, Environment Health Coalition, San Diego Transportation Equity Working Group, provided a summary of the collective and collaboration on the 10 Transit Lifelines and spoke in support of Item 5. Congratulated the CBOs for participating in the San Diego Transportation Equity Working Group they represent.

Ghina M. Yamout, Marrs Services Inc., member of the public, expressed interest in being an advocate on areas of green infrastructure, areas of low-income residents, improving water quality and asked SANDAG to incorporate green infrastructure for best transit in the Equity Plan.

Maritza Garcia, member of the public, spoke in support of incorporating an electric bus fleet system to help reduce pollution that affects residents and incorporate transit lifelines.

Jose Franco Garcia, Environmental Health Coalition, spoke in support of the 10 Transit Lifelines and provided a brief testimony of the community feedback in developing a bus system that is safe, reliable, and holistic to make a great transit plan for the San Diego region. SANDAG needs to develop an anti-displacement plan.

Allie Fen, Community Organizer, Environmental Health Coalition, spoke in support of funding for restroom access in public transit stations, and the 10 Transit Lifelines.

Sally Smull, member of the public, spoke in support of the 10 Transit Lifelines, Trolley crossing issues, the desperate need for YOP, seven-day a week bus service, trees and benches needed in all public bus stops in the area. And thanked everyone for their time and energy in working on this important process.

Nancy Cruz, member of the public, spoke in support of the 10 Transit Lifelines, transit initiatives that allow for investing in public transportation, improve commute times and environment in her community.

Laura Benavidez, City Heights Community Organizer, Environmental Health Coalition, spoke in support of the 10 Transit Lifelines and her experience as a community organizer, and the community-driven process with the SDTEWG.

Esperanza Gonzalez, Community Organizer, Environmental Health Coalition, spoke in support of the 10 Transit Lifelines and to prioritize funding to provide 24-hour bus service to working residents in the City Heights community. Mrs. Gonzalez depends on public transportation to move around the region.

Jack Shu, Councilmember City of San Diego, thanked everyone for their comments, participation in advocating for equity, environmental justice, and to think big and encouraged to move forward with this plan.

Maria Magdalena Cerda Baez, Border Environmental Justice Policy Advocate, Environmental Health Coalition, spoke in support of increasing transportation services in Imperial Beach for youth attending college and universities in the region. Maria Baez shared personal experiences her children endured while attending college from Imperial Beach.

Nicole Burgess, Board Member of Walk San Diego, commended everyone in this group and spoke in support of equity and environmental justice, the YOP, providing 24-hour bus service, transit to integrate mini mobility hubs – bike shares for all San Diegans and add to the RTP.

Karla Montevisa, member of the public, spoke in support of developing a bus system that is frequent and reliable for her community.

Roddy Jerome, Community Member, Environmental Health Coalition, spoke in support of the 10 Transit Lifelines.

Konane Martinez, National Latino Research Center, spoke about an official key aspect provided by the community making the County of San Diego and SANDAG accountable to the feedback received by the working groups and community by providing them with an update on changes.

Action: Upon a motion by Lisa Cuestas and a second by Craig Jones, the Working Group recommended that the Board of Directors approve support of the 10 Transit Lifelines and all of the other recommendations from the Working Group to be integrated into in the 2021 Regional Plan.

The motion passed.

Yes: Craig Jones, Rose Ceballos, Lisa Cuestas, Randy Torres-Van Vleck, Brendaly Rodriguez, Carol Lewis, Konane Martinez, Breanne Lash, Claire Groebner, Fe Seligman, Brian "Barry" Pollard, and Erica Leary.

No: None.

Abstain: None.

Absent: None.

**6. Transit Equity Early Action Budget Amendment Update (Discussion)**

This item was postponed to a future meeting.

**7. Possible Topics for Next Meeting (Discussion/Possible Action)**

Chair Moreno asked the Working Group to discuss possible topics for the next meeting.

Action: Discussion

**8. Upcoming Meetings (Information)**

The next Working Group meeting is scheduled for Thursday, September 23, 2021, at 10 a.m.

**9. Adjournment**

Chair Moreno adjourned the meeting at 11:54 a.m.

## Confirmed Attendance at SANDAG 2021 Regional Plan Social Equity Working Group Meeting

August 5, 2021

Organization	Name	Attended	Comments
SANDAG Board Alternate	Councilmember Vivian Moreno, Chair	Yes	
Alliance for Regional Solutions	Craig Jones	Yes	
	MaryLynn McCorkle, Alternate	No	
Bayside Community Clinic	Kim Heinle	No	
	Rose Ceballos, Alternate	Yes	
Casa Familiar	Lisa Cuestas	Yes	
	Monica Hernandez, Alternate	Yes	
	Goyo Ortiz, Alternate	No	
Chula Vista Community Collaborative	Brendaly Rodriguez	Yes	
	Angela Tomlinson, Alternate	No	
City Heights CDC	Randy Torres-Van Vleck	Yes	
	Stephanie Hernandez, Alternate	Yes	
El Cajon Collaborative	Carol Lewis	Yes	
	Dana Stevens, Alternate	No	
National Latino Research Center	Ana Ardón, Alternate	Yes	
	Konane Martinez, Member	Yes	
	Elizabeth Lou	No	
Nile Sisters Development Initiative	Breanne Lash, Alternate	Yes	
	Mohammed Tuama	Yes	
Olivewood Gardens	Claire Groebner	Yes	
	Jen Nation, Alternate	No	
	Rocina Lizarraga, Alternate	Yes	
Samahan Health Centers	Fe Seligman	Yes	
	Lorna Delossantos, Alternate	Yes	
Urban Collaborative Project	Brian "Barry" Pollard	Yes	
Vista Community Clinic	Erica Leary	Yes	
	Carmela Muñoz, Alternate	Yes	

### Other Attendees



Nicole Boghossian Ambrose  
Jesus Amial  
Leticia Ayala  
Maria Magdalena Cerda Baez  
Laura Benavides  
Clay Myers-Bowman  
Nicole Burgess  
Silvia Croft  
Nancy Cruz  
David Curtis  
Monica de la Cruz  
Joann Delgado  
Samaya Elder  
Lilia Escalante  
Angelica Estrada  
Kathleen Flannery  
Fox 5 San Diego  
Kristal Feilen  
Allie Fen  
Derek Gade  
Maritza Garcia  
Jose Franco Garcia  
Steve Gelb  
Georgette Gomez  
Esperanza Gonzalez  
David Grubb  
Keane Gruending  
Kyle Heiskala  
Belen Hernandez  
Trevor Hill  
Tiffany Boyd-Hodgson  
Toshi Ishihara  
Roddy Jerome  
Travis Knowles

Bob Leiter  
Roman Partida-Lopez  
Jacob Mandel  
Robin Joy Maxon  
Rebecca Miranda  
Bee Mittermiller  
Haneen Mohamed  
Monica Montano  
Karla Montevisa  
William Morgan  
Megan Moore  
Dominique Navarro  
Dionne Nguyen  
Scott Norris  
Rosa Olascoaga  
John Osborne  
Keara Pina  
Ramona Rosas  
Jacqueline Luna Reynoso  
San Diego350  
Angelica Santiago  
Danny Serrano  
Larry Shaw  
Jack Shu  
Sally Smull  
Eddie Sprecco  
Marc Steele  
Diane Takvorian  
Julia Tuer  
Ed Vea  
Rich Whipple  
Ghina M. Yamout

#### **SANDAG Staff**

Evelia Castellanos  
Jack Christensen  
Elizabeth Cox  
Tuere Fa'aola  
Brian Lane  
Lauren Lee  
Lindsey H. Lindsey  
Catherine Matel  
Irene McCormack  
Antoinette Meier  
Sanjiv Nanda  
Sam Solis  
Phil Trom

Anna Van  
Chris Velasco  
Robyn Wapner  
Julie Wiley

# Appendix G Attachment 7E: Letter-Sourced Public Comments and Responses

The table below contains all comments on the draft 2021 Regional Plan provided to SANDAG in letters during the public comment period. Full copies of the letters received are included at the end of this attachment.

The comments and responses are organized alphabetically by the commentor or commenting agency/organization.

Table G7E: Draft 2021 Regional Plan Responses to Comments – Letter Sourced

Draft 2021 Regional Plan Responses to Comments – Letter Sourced		
ID	Comment	Response
ACCE; ACLU SD/IC; CPI; City Heights CDC; CAC ; EHC; Logan Heights CDC; Mid-City CAN; MAS-PACE; Outdoor Outreach; Parent Voices San Diego; PANA; Planned Parenthood Action Fund of the Pacific Southwest; Youth Will; Viet Vote		
L1	<p>We are excited for the future of transportation in our region. The 2021 Regional Plan includes visionary elements to building an efficient, accessible, and sustainable transportation system. Thank you for everyone’s effort on it. However, we bring to your attention that a key program is missing. We request that you amend the draft 2021 Regional Plan to include Youth Opportunity Passes (YOP), no-cost transit passes for youth ages 24 and under.</p> <p>For 10 years, the Improving Transportation in City Heights Team (ITCH) has advocated to have no-cost transit passes for youth in San Diego. Mid-City CAN, the ITCH team, and the undersigned supporters request that you include YOP (ages 24 &amp; under) in the 2021 Regional Plan. YOP requires a spot among to priorities in our 30-year vision for transportation in the region.</p> <p>We ask the Board of Directors to take the following actions:</p> <ol style="list-style-type: none"> <li>1. Amend the 2021 Regional Plan to state that Youth Opportunity Passes, no-cost-transit passes for youth ages 24 and under, will be funded when transit subsidies are allocated.</li> <li>2. Amend the 2021 Regional Plan to state that transit subsidies will be allocated at the earliest implementation possible.</li> <li>3. Fund Youth Opportunity Passes (24 &amp; under) as an early-action Transit Pilot Program this year. YOP (24 &amp; under) is a necessary program, as illustrated by the following facts: <ul style="list-style-type: none"> <li>1. Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic. In San Diego County, there are approximately 86,000 young workers (ages 16-24) who work in the industries that were hard hit by the COVID-19 epidemic.<sup>1</sup> The industries include hospitality, food services, retail, oil and gas mining, transportation, employment services, travel, and leisure.</li> <li>2. YOP (24 &amp; under) is a way to increase ridership and develop a transit-culture. Only 10,463 youth (ages 16-24) use public transit in San Diego, but these young commuters use public transit at a rate double that of their older counter parts (adults ages 25-59). YOP will further promote transit use among young San Diegans.</li> <li>3. YOP (24 &amp; under) helps divert youth away from the school to prison pipeline. MTS officers decide who to check for fare evasion, YOP prevents the criminalization of youth of color due to their inability to afford a pass. Literature suggests that Black youth are arrested for fare evasion at a rate 5 times higher than their white peers and Latino/a/x youth are arrested at a rate 4 times higher than their white peers.</li> <li>4. YOP (24 &amp; under) promotes the reductions of GHGs. A person who switches from a 20-mile round-trip commute by car to using existing public transit, can reduce his or her annual CO2 emissions by 4,800 pounds per year.<sup>5</sup> Decreasing greenhouse gas emissions is a matter of equity. Residents in low-income, BIPOC communities are exposed to more pollution than their more affluent counterparts. For example, City Heights residents are exposed to twice the amount of diesel particulate matter from trucks &amp; cars than La Jolla residents.</li> </ul> </li> </ol>	<p>One of the Implementation Actions listed in Appendix B is a Regional Transit Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>SANDAG looks forward to partnering with the “Improving Transportation in City Heights” team in implementing the 2021 Regional Plan, including Youth Opportunity Passes.</p>

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ID	Comment	Response
	<p>5. YOP (24 &amp; under) addresses climate justice. Mid-City CAN has conducted 250+ conversations with residents in Communities of Concern (CoC). Over 86% of residents noted that climate change directly impacted them. Extreme weather has become a barrier to work and school for CoC residents who already face significant barriers to education and employment. Residents who normally walk or bike to work must increasingly rely on cars or public transportation that is inaccessible due to cost or distance. YOP eliminates the cost barrier to transportation for youth ages 24 and under.</p> <p>6. YOP (24 &amp; under) is a proven program. Similar programs exist in Alameda County, Los Angeles, Sacramento, San Francisco, and Santa Ana. Youth Opportunity Passes helps ensure youth from all background are connected to their schools, internships, medical care, and early-career opportunities.</p>	
<b>Andrew Puls</b>		
L2	<p>My wife and I have been Logan Heights residents for approximately five years. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities. Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan (Draft Plan).</p> <p>Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know ReConnect Logan Freeway Lid will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.</p> <p>As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.</p> <p>Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out ReConnect Logan Freeway Lid as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:</p> <p>The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)</p> <p>Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)</p> <p>Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)</p> <p>Besides being in line with the 2021 Draft Regional Plan, ReConnect Logan Freeway Lid is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.</p>	<p>Caltrans District 11 has also expressed interest in exploring opportunities for freeway caps. In alignment with the 2021 Regional Plan, SANDAG and Caltrans District 11 are currently developing Comprehensive Multimodal Corridor Plans in coordination with agency partners and local city governments. Comprehensive Multimodal Corridor Plans (CMCPs) are data-driven plans to reduce congestion and generate transportation choices while preserving community character and creating opportunities for enhancement projects. Opportunities for freeway caps will be considered in the CMCPs.</p>

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ID	Comment	Response
<b>AVAD Investments Inc.</b>		
L3	1. Extension of the Home Avenue Route to Market Street for Pedestrians, Bicycles, and Vehicles. The Home/ Market connection would provide significant economic development stimulus to the Mt. Hope and City Heights areas. It would assist in congestion relief by providing an alternate to freeway traffic on the SR 94 - Martin Luther King Freeway.	1. While Home Avenue is not on the Adopted Regional Bike Network, the 2021 Regional Plan includes the nearby and parallel Chollas Creek Bikeways: North Fork - Bayshore Bikeway to University Bikeway and South Fork - Petway Park to Market Creek Plaza which will improve the connections described in this comment. The project alignment and details can specifically be found in the updated data viewer and Appendix A.. Your comment was forwarded to the City of San Diego.
L4	2. Completion of the Transportation markings along Home Avenue . Curbs are not marked for safety, to promote proper parking, traffic movement, and access for Buses and the Disabled. The Bicycle route is not fully painted and warning ramps for the visually impaired are not in place. Bulbing out at key intersections should be funded to increase pedestrian crossing safety.	2. Home Avenue is not in the Adopted Regional Bike Network. The City of San Diego and Metropolitan Transit System are the implementing agencies for these improvements. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is in development and provides another opportunity to provide input on transportation solutions for this area.  Your comment was forwarded to the City of San Diego.
L5	I believe that the business community, along Fairmount and Home Avenues, would be open to establishment of a Business Improvement and Maintenance Area to assist in cooperative funding of some of these improvements. We would appreciate assistance in establishing such special districts.	Establishing special districts is under the purview of the City of San Diego.  Your comment was forwarded to the City of San Diego.
<b>California Air Resources Board</b>		
L6	As part of CARB's SCS Policy Commitments evaluation, CARB staff will also need to consider whether and to what extent these actions advance the region's land use vision. To support this analysis, CARB staff request that SANDAG provide information that summarizes differences between existing residential and commercial density and type assumptions in its Mobility Hub areas, compared to what is currently allowable in local land use plans for the corresponding geographies as part of its final SCS Submittal.	SANDAG will provide requested information on residential and commercial density in Mobility Hubs as part of its final SCS Submittal to CARB.
L7	CARB staff notes that the draft RTP/SCS plans for a regionwide road user charge to be operational and generating revenue in the region starting as soon as 2026. CARB staff recognizes both the importance of, and difficulty in, implementing this pricing strategy. While the draft RTP/SCS includes actions committed to support implementation of this strategy (e.g., partnering on pilots, pursuing legislation, and investing in studies), which we support, they appear to be similar to those being pursued by other regions around the state that are assuming operations starting no sooner than 2030. CARB staff requests further clarification from SANDAG on how it may be able to implement sooner than others around the state as part of its final SCS Submittal.	In the proposed final 2021 Regional Plan, the road usage charge would begin in 2030 to align with efforts at the state and other regions.
L8	The draft RTP/SCS identifies that \$29 billion needs to come from new funding sources in order to implement the plan through 2035.3 Of those new funding sources, about \$18 billion, or 25 percent of the plan's total funding need through 2035, is attributed to new pricing strategies including Ridehailing Company Service Fees, Future State Revenues for Transportation, Regional Road User Charge, and Future Federal Revenues for Transportation. CARB staff is concerned that other strategies that contribute to the SCS meeting its targets may be at risk if the region is not able to fully secure these new funding sources within the timeline assumed in the draft RTP/SCS. CARB's evaluation will look at the extent to which the RTP/SCS strategies will be supported by existing revenue sources, as one measure of likely implementation. CARB requests that SANDAG identify whether and to what extent the high- impact strategies for achieving the GHG reduction targets in the plan are reliant on new revenue sources versus existing revenue sources as part of its final SCS Submittal.	In Appendix V: Funding and Revenues, Table V.2 includes a summary of availability assumptions and risk assessment for each new revenue source. SANDAG will coordinate with CARB staff if additional information is required as part of its final SCS Submittal.
L9	CARB staff reviewed Appendix A of the draft RTP/SCS and appreciate the detail provided on the region's transportation project investments by corridor. CARB staff is encouraged to see that the draft RTP/SCS includes planned investments across modes within the region's key corridors and that when investing in roadway projects, the region is prioritizing conversion of existing free-flow lanes into managed lanes with priority access for transit, carpool, and vanpool users, and fee access for single-occupant drivers. CARB staff observe that the plan also includes some managed lane projects whose scope includes adding new lanes. Specific to those projects, CARB staff requests that SANDAG provide further information that contextualizes the risk, if any, to the region's ability to achieve, and maintain its 2020 and 2035 GHG targets when adding new lanes in those locations (e.g., clarifying whether and how those projects align with and facilitate the region's preferred land use pattern, identifying whether other policies or mechanisms that will limit adverse passenger vehicle GHG/VMT emissions impacts are present in those locations) as part of its final Submittal.	In its final SCS Submittal, SANDAG will provide additional information on the managed lane projects whose scope includes adding new lanes. All managed lane projects were identified as part of the Complete Corridors concept, which also includes technology-driven solutions to manage demand, support the deployment of RAPID bus and Flexible Fleet services, and align with the Mobility Hub areas. As this comment notes, the 2021 Regional Plan proposes a conversion of general purpose lanes to managed lanes where possible to implement the managed lane system.
<b>California Coastal Commission</b>		
L10	As an initial and overall comment, we want to applaud this document and the important direction it sets on multiple policy issues. Coastal Commission staff specifically appreciate the acknowledgement that bold changes to San Diego's	SANDAG looks forward to partnering with the Coastal Commission on implementation of the 2021 Regional Plan.

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	<p>regional transportation network and compelling alternatives to driving alone are needed to meet greenhouse gas (GHG) emission targets. The Regional Plan will provide a key blueprint for reducing transportation air pollution and greenhouse gas emissions (GHGs), minimizing vehicle miles traveled (VMT), improving multi-modal transportation, addressing the need for greater equity in transportation systems, and enhancing the resiliency of our transportation network in the face of climate change, particularly with respect to sea level rise and our coastal highways. We primarily want to offer ourselves as a partner in this important work to carry forward the Regional Plan. In this letter, Commission staff would like to offer a few broad comments on how the Regional Plan could be modified to strengthen its consistency with the California Coastal Act.</p>	
L11	<p>Overall, the policies of the California Coastal Act that guide our work at the Coastal Commission significantly overlap with the goals of SANDAG’s Regional Plan, including policies to protect marine and coastal land habitats, concentrate urban development, maximize public access and expand multi- modal transportation, reduce VMT, and improve coastal resiliency to sea level rise and other climate- change hazards. For example, Appendix B: Implementation Actions identifies eight 2035 goals drawn from the Regional Climate Action Planning Framework which generally align with the referenced Coastal Act policies:</p> <ul style="list-style-type: none"> <li>• “High density, transit-oriented housing” aligns with the Coastal Act policy of focusing development in or near existing developed areas (Coastal Act Section 30250).</li> <li>• “Conserve open space and agricultural lands” aligns with Coastal Act policies related to conservation of sensitive habitat, open space, and coastal agricultural lands (Coastal Act Sections 30230, 30231, 30233, 30241).</li> <li>• “100% of new buses are zero-emission,” “400,000+ electric cars on the road,” “Sustainable freight (transitioning to zero emissions where feasible),” and “Up to 100% renewable electricity” aligns with the Coastal Act requirement that new development minimize energy consumption and VMT and be consistent with requirements imposed by an air pollution control district or the State Air Resources Board on each particular development (Coastal Act Section 30253).</li> <li>• “Walkable and bikeable communities” aligns with Coastal Act policies promoting the protection, addition, and enhancement of public access (Coastal Act Sections 30210, 30212.5, 30252).</li> </ul> <p>Appendix B additionally identifies strategies for the implementation of affordable housing, such as minimum zoning near transit, fee-waiver programs, and accessory dwelling units, which align with Coastal Act Sections 30213 (Lower Cost Overnight Accommodations) and 30013 (Environmental Justice). However, there are aspects of the Regional Plan that could be strengthened to be more consistent with the Coastal Act as described below.</p>	<p>Thank you for this comment and acknowledgement of areas of consistency between the 2021 Regional Plan and California Coastal Act.</p>
L12	<p>Consistent with Senate Bill (SB) 375, the California Air Resources Board (ARB) sets targets for reduction of GHG emissions from passenger vehicles for the target years 2020 and 2035, which Chapter 2, “Sustainable Communities Strategy,” notes the Regional Plan will accomplish. However, as noted in the Regional Plan, Executive Order B-30-15, and California Senate Bill 32 (Pavley, 2016), set a further statewide goal of reducing California’s GHG emissions to 40 percent below 1990 levels by 2030 and the Executive Order B-55-18 set a statewide goal of carbon neutrality by 2045. Recognizing the needs of all residents and visitors to the San Diego region, the Regional Plan rightfully includes improvements to all transportation modes, including roads and parking, but in order to meet or exceed the referenced GHG and climate goals, projects that improve public transit and active transportation to minimize VMT should be completed as quickly as possible, consistent with the Coastal Act (Section 30253). Additionally, active transportation projects that provide emission free transportation options and can be implemented relatively quickly should be prioritized, including completing segments of the California Coastal Trail and Coastal Rail Trail in the near-term (2025) rather than in future phases (2035 or 2050). Specifically, trail segments providing access to major employment centers that would relieve strain on coastal access corridors and that would help relieve congestion on Interstate 5, such as the segments connecting Carmel Valley to Roselle Canyon; Del Mar to Sorrento; and Roselle Canyon/UTC to Rose Canyon, should be prioritized for near-term construction. In general, Coastal Commission staff support greater proportions of investment in transit, active transportation, and environmental enhancement projects as compared to roadway improvements targeting single-occupant vehicles.</p>	<p>The phasing of projects in the 2021 Regional Plan considers many factors including project readiness, connectivity, social equity, and anticipated revenues by implementation period. Projects proposed by 2025 have secured funding and are programmed in the Regional Transportation Improvement Program (RTIP). As the 2021 Regional Plan is implemented and updated, phasing of projects may change as opportunities arise to advance projects into earlier phases of the plan.</p>
L13	<p>Finally, the Coastal Act (Section 30250) encourages new residential, commercial, or industrial development, to be located within, contiguous with, or in close proximity to, existing developed areas. Accordingly, the Regional Plan should prioritize transportation investments which encourage jobs and housing to be concentrated in developed areas and avoid further encroachment into habitat, farmland, and open space recreational areas by moving them forward to earlier construction phases.</p>	<p>Consistent with this comment, the 2021 Regional Plan proposes a land use pattern that complements the transportation investments of the plan and concentrates future growth and development in Mobility Hub areas.</p>
L14	<p>Given that beaches and coastal resources are major destinations in the San Diego region, the Regional Plan should maximize access to the coast, including expanded investments in bicycle and pedestrian routes. The proposal to dedicate 55% of the anticipated \$163 billion in funding over the next 30 years to capital improvements to the transit system will improve public access to and along the coast, and is supported by Commission staff, but projects that</p>	<p>As SANDAG developed the proposed network for the 2021 Regional Plan, data on trip-making was used to understand the critical connections of the region. Connections to coastal areas are represented in these critical connections. Implementation of the regional bike network as well as complete streets in Mobility Hubs will support enhancements for active transportation in coastal communities.</p>



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	specifically facilitate access to beaches and coastal areas from the inland portions of the region should be expedited, as well as options for enhancing connections to public transit, the California Coastal Trail (CCT), the Coastal Rail Trail, and other visitor-serving recreational opportunities. Implementation of the Regional Plan would make significant improvements to the regional bike network, most notably in terms of Class I corridors and in coastal communities that will enjoy enhanced coastal access as a result of these improvements. Coastal Commission staff support these improvements as well as further network and infrastructure enhancements for active transportation, such as widened sidewalks in areas without designated bike lanes, increased funding for bicycle parking and locker facilities, and bicycle-specific signaling integration on local arterials and feeder streets.	
L15	Coastal Commission staff acknowledge and appreciate the inclusion of updated information regarding the completeness and deficiencies in the San Diego region's portion of the California Coastal Trail in the 2021 Technical Addendum to Appendix W: California Coastal Trail. The addendum should also reference the recent work of the California Coastal Commission, California Department of Transportation, and Coastal Conservancy in developing an ArcGIS-based mapping tool that identifies all complete and incomplete segments of the Coastal Trail and classifies them according to trail type, identifies land ownership, and identifies features, such as individual stairways and pathways. The most recent update to the CCT mapping effort is outlined in the California Coastal Commission Memorandum Re: California Coastal Trail Mapping Project, April 2021. In light of these improvements to the available data and SANDAG's identification of large portions of the CCT that are still in need of completion, a stronger emphasis on pedestrian and bicycle improvements necessary to complete the trail should be provided in Chapter 3 and a stronger and more specific funding commitment for the CCT should be provided in Appendix A: "Transportation Projects, Programs, and Phasing." Specifically, a portion of the funding identified for "Local Streets and Roads" (9% of the Regional Plan expenditures) should be allocated to funding the completion of the CCT.	In response to this comment, a reference to the California Coastal Trail mapping effort was added to the 2021 Technical Addendum in Appendix W. SANDAG efforts in bike and pedestrian infrastructure implementation have most recently and intensely been focused on utility transportation for all-weather travel by bicycles, pedestrians, or other ped-assisted devices with strict adherence to local codes and ADA standards. Regarding the recommendation to allocate a percentage of the Local Streets and Roads funding for completion of the trail, this would require a Board action and approval for application to just a subset of jurisdictions with intersecting segments of the trail, while not applying to others.  SANDAG designs, funds and builds All Ages and Abilities bikeway utility routes (like the New Segments identified in Appendix W) to develop a comprehensive regional bike network as approved by the SANDAG Board of Directors in 2010's Riding to 2050: The San Diego Regional Bike Plan, and prioritized with funding in 2013 by the Board of Directors via the SANDAG Bikeways Early Action Program (EAP). More information can be found at the following links:  <a href="https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail</a> <a href="https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail</a>
L16	Further, Commission staff encourage the integration of data related to weekend peak traffic in the planning phase of projects with potential impacts to congestion on major coastal access corridors used to access weekend recreation, such as Interstate 8, Interstate 5, and Pacific Coast Highway. Commission staff encourage SANDAG to implement enhanced transit alternatives where weekend coastal access will be significantly affected.	SANDAG will consider data related to weekend peak traffic as it implements priority implementation action 10: Advance a data science program to better understand travel behavior in the region, update travel demand modeling tools, and improve transparency and reporting on program effectiveness and project delivery.
L17	Coastal Commission staff suggest that the Regional Plan include specific reference to Coastal Act Chapter 3 policies requiring the preservation of coastal resources, as well as specific language concerning the importance of protecting and restoring the region's urban canyons, coastlines, beaches, and water resources. Transportation corridors within the San Diego region bisect or are located directly adjacent to sensitive marine resources including coastal bluffs, streams, lagoons, and the Pacific Ocean. Many of these coastal systems have already been impacted by historical transportation infrastructure development and additional impacts to these resources are restricted by Coastal Act policies. Except for certain specific instances, fill of a wetland or other coastal waters is prohibited (Section 30233), and the marine resources (Section 30230), water quality (Section 30231), and environmentally sensitive habitat areas (Section 30240) often associated with the coastal environment are also protected.	SANDAG provides an analysis of projects' impacts to coastal resources identified under the California Coastal Action in the Draft EIR analysis (Section 4.4 Biological Resources). SANDAG encourages the Coastal Commission to comment on that report.
L18	The Regional Plan should include increased funding to adapt and/or relocate existing transportation infrastructure known to be vulnerable to climate change and sea level rise (e.g., Pacific Coast Highway and the rail corridor along Del Mar bluffs). New infrastructure proposed to be funded should be analyzed not only for vulnerability to H++ projections of SLR over the expected life of the proposed project, but also tidal and fluvial hydraulics as applied to the local area and in the context of storm surge, wave run-up, erosion, and other variables. Projects which reduce vulnerability to climate change and sea level rise (e.g., active transportation projects and relocation of the rail corridor from coastal bluffs) should be prioritized and expedited.	Resilience of transportation infrastructure to climate impacts is a priority of the 2021 Regional Plan. As such, the relocation of the rails off of the Del Mar bluffs is a priority project with planning already underway. Appendix R includes additional information on current climate adaptation and resilience efforts underway and new programs that will reduce vulnerability to climate change and sea level rise. In response to this comment, language has been added related to increasing funding, prioritizing, and expediting projects to adapt and/or relocate existing climate vulnerable transportation infrastructure.
L19	The Coastal Act was also recently amended to add Environmental Justice as a policy to be analyzed in our regulatory work, and to add a designated Environmental Justice commissioner on the Coastal Commission. Accordingly, although we applaud the Regional Plan's focus on equity and recognize the need to generate revenue for implementation, Commission staff urge SANDAG to carefully analyze the equity implications of the Regional Pricing Strategy, including ensuring that dynamic tolling on managed lanes, parking and curb pricing, and road user charges do not regressively impact low-income community members who may not be able to afford to live in transit-oriented neighborhoods.	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help SANDAG to design a road usage charge program that is more fair than current transportation funding sources. SANDAG also will collaborate with state and federal agencies that are partnering to evaluate road charge programs in California.
L20	Further, the Regional Plan should utilize access to coastal recreation as a metric with which to measure the efficacy of its Environmental Justice programs. This should be accomplished by comparing travel times to coastal resources (e.g., the nearest usable beach) in communities of concern to travel times in other nearby communities. Transit programs	The performance measures and social equity analysis for the 2021 Regional Plan considered several access metrics, including access to parks, retail, medical facilities, employment centers, and higher education.



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	should be designed to reduce these travel times and close gaps between communities to achieve equitable coastal access across the San Diego region, consistent with Coastal Act Section 30252.	SANDAG can consider access to coastal resources in the Comprehensive Multimodal Corridor Plans and future updates of the Regional Plan.
L21	<p>Previous Regional Transportation Plans and the North Coast Corridor Public Works Plan / Transportation and Resource Enhancement Program (NCC PWP/TREP) have referenced the need for relocation of the rail corridor that passes along the Del Mar bluffs to an inland alignment. Erosion due to wave action currently threatens the toe of the Del Mar bluffs and the stability of the railroad tracks at the top of the bluffs. Given that this segment of the LOSSAN rail corridor is already experiencing periodic bluff failures, which will only be exacerbated as sea level rise continues, Coastal Commission staff support relocation of the rail corridor and completion of double tracking as quickly as possible. The Coastal Commission has authorized a series of improvements to existing shoreline protection devices in Del Mar to maintain continued rail operations, including the most recent Consistency Certification No. CC-0004-18 in February 2019 and CC-0001-20 in August 2020; however, these projects are intended to serve as interim measures only. Although these types of repair and maintenance projects may be necessary in the short-term, they should not delay the planning efforts associated with a long-term solution, including identifying a preferred tunnel alignment and allocating funding to initiate environmental review of the rail corridor relocation project. If we continue to rely on reactive, hard-armoring measures to protect the rail corridor in place, we will lose our coastal beaches in the face of anticipated sea level rise at Del Mar and elsewhere. Therefore, Coastal Commission staff request that the Del Mar tunnel project be prioritized further by being moved to the five-year capital project list. This would allow double tracking to occur sooner, improving coastal access by sustainable modes of transportation while protecting the Del Mar bluffs, a vital visual and habitat resource for the San Diego region.</p>	The Del Mar tunnel is a top priority for SANDAG. Planning work is underway with preliminary engineering and environmental phase expected to begin as soon as 2022 if funding is secured. SANDAG reviewed the timelines of other similar tunnel projects throughout North America and the 12 to 15 year timeframe is consistent with industry best practices. The 2021 Regional Plan identifies funding to kick start the environmental, design, and right-of-way phases of the Del Mar Tunnel project by 2025 with construction funding in the 2035 phase.
L22	<p>The Coastal Commission has previously approved transportation projects and programs that balance roadway expansion with the provision of transportation alternatives including railway enhancements, bicycle corridors, and pedestrian accessways (e.g., the North Coast Corridor Public Works Plan/Transportation and Resource Enhancement Program). In actions throughout California, the Coastal Commission has found that projects supporting alternative modes of transportation, particularly enhanced rail service, are consistent with Coastal Act policies requiring maximum public access and a reduction in VMT (Coastal Act Sections 30210 and 30253). The Regional Plan proposes funding for high-frequency transit services that incorporate new transit modes and improve existing services. Commission staff supports the vision for vastly improved regional and inter-regional bus and rail corridors, which will offer alternatives to driving and alternatives to roadway expansion in environmentally sensitive areas.</p> <p>The California State Transportation Agency’s Transit and Intercity Rail Capital Program (TIRCP) (2015) emphasizes the objective of “Expand[ing] and improv[ing] transit service to increase ridership.” In 2020, the TIRCP allocated over \$38 million to capital improvements to the LOSSAN corridor, including new maintenance facilities that will allow for longer trains and more frequent and reliable service on the corridor. The Draft 2018 California State Rail Plan website states: “Californians collectively take billions of trips to millions of destinations each year, and the state needs quality modal choices among cars, transit, air travel, and active transportation to efficiently move people and freight to their destinations.” Coastal Commission staff support the expansion of San Diego’s commuter rail network and the double tracking of the LOSSAN corridor funded by the Regional Plan, in addition to other infrastructure improvements that encourage faster and more frequent intercity and intracity rail service such as those identified in the TIRCP.</p>	SANDAG looks forward to working with Coastal Commission and other state agencies to implement the rail network described in the 2021 Regional Plan.
L23	In previous comment letters, Coastal Commission staff have expressed support for the development of an intermodal transit station along the existing rail corridor to provide visitors with direct connections to Amtrak, COASTER, Trolley, bus services, and the southern terminus for the proposed high-speed train service. The acquisition of land for the Central Mobility Hub and the completion of the automated people mover airport connection in 2035 (Pages A-17 and A-18, Appendix A) will significantly improve alternative access to the airport, thereby reducing the anticipated traffic impacts associated with redevelopment of Terminal 1 on North Harbor Drive, a major coastal accessway. Please note that Coastal Commission staff request to be included in future planning efforts related to the Central Mobility Hub, as well as the associated transportation infrastructure projects (e.g., automated people mover).	SANDAG looks forward to Coastal Commission staff participation in future planning efforts related to the Central Mobility Hub and related connections.
L24	Finally, the 2019 Draft Federal Regional Transportation Plan identified a trolley extension from Pacific Beach to the El Cajon Transit Center and a streetcar from Mission Beach to La Jolla via Pacific Beach slated for completion by 2050 (Table A.2, Appendix A). Neither of these projects is identified in the 2021 Draft Regional Plan. The popular beach community of Pacific Beach is already heavily impacted by parking and traffic congestion, which will be exacerbated in the future by redevelopment with increased density and the elimination of parking requirements by the City of San Diego for certain developments located near transit. Coastal Commission staff request the re-inclusion of these projects in the Regional Plan, as the transportation improvements identified for Pacific Beach in the 2021 Regional Plan leave large portions of the community without robust alternatives to single-occupant vehicle travel and increasingly strained access to parking, inconsistent with Sections 30212 and 30212.5 of the Coastal Act.	The 2021 Regional Plan proposes two Rapid bus lines to serve Pacific Beach, offering connections from Pacific Beach to Kearny Mesa (Rapid 292) and from the new Balboa Trolley Station to Sorrento Mesa via Pacific Beach, La Jolla, and UTC (Rapid 30). These projects are proposed by 2025 and 2035 respectively, offering transit solutions to Pacific Beach on a quicker timeline. In addition, Pacific Beach is an identified Mobility Hub area where the 2021 Regional Plan proposes investments in Flexible Fleet services and complete street improvements.

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L25	In general, Coastal Commission staff support improvements to transit alternatives that provide access to coastal areas and recreation. Significant gaps in the regional bus network improvements laid out in the Regional Plan exist in the coastal communities of Encinitas, Solana Beach, La Jolla, Pacific Beach, Mission Beach, and Ocean Beach, whereas other coastal communities are slated to enjoy more robust transit improvements. As such, Coastal Commission staff encourage SANDAG to analyze and prioritize transit improvements that improve coastal access in these communities, and particularly improvements that provide these communities with meaningful alternatives to single-occupant vehicles to access the nearby beaches and recreational areas.	The 2021 Regional Plan proposes improvements to the local bus system and Rapid bus routes that service many of the coastal communities identified in this comment. In addition, Flexible Fleet services will provide on demand services to supplement the transit system and provide meaningful alternatives to single-occupant vehicles.
<b>California Department of Transportation, Office of State Planning, Equity and Engagement (OSPEE)</b>		
L26	With development concentrated at the coastal region, has the scientists' estimates of a 2.5 sea level rise been taken into account for development in this area? (pdf page 9)	As described in Chapter 2, 5% of future housing growth is expected in coastal mobility hub areas. Best available science and data on sea level rise impacts and adaptation strategies will continue to be considered in development in coastal areas. Vulnerabilities are localized and there are development opportunities in coastal communities that are not at risk of sea level rise impacts.
L27	There was a brief mention of the California Transportation Plan 2050 (CTP 2050) in the bulleted list on Page 14. As the State of California's transportation roadmap, it might be pertinent to demonstrate with a few sentences as to how the 2021 Regional Plan meets or aligns with the CTP 2050's Recommendations on Page 6 of the Executive Summary of the CTP 2050 document. Here is language that could be potentially used: o Senate Bill 391 (SB 391, 2009) required the California Department of Transportation to prepare the California Transportation Plan (CTP), a statewide to reduce GHG emissions. This system laid out in the CTP 2050 showed reductions in GHG emissions to 1990 levels from current levels by 2020, and 80 percent below the 1990 levels by 2050 as described by AB 32 and Executive Order S-03-05. The CTP 2050 demonstrates how major metropolitan areas, rural areas, and state agencies can coordinate planning efforts to achieve critical statewide goals. SANDAG will work to align with the goals, policies, strategies, and recommendations laid out in the CTP 2050 where applicable.	The 2021 Regional Plan aligns well with the recommendations from CTP 2050. SANDAG looks forward to coordinating with Caltrans on these recommendations.
L28	Pages 14 and 15 feel a bit out of place and seems like it would be better places after the Table of Contents that is present in the "Forward" section, rather than being right before Chapter 2. The chapter list of Page 15 is essentially the same as the Table of Contents so keeping the nice graphics with the same overview/summary would be good, while having the actual TOC have subsections within the chapters listed, with their corresponding pages as well (5 Big Moves, etc).	SANDAG will consider this suggested edit to Chapter 1 and the table of contents.
L29	It may be beneficial to mention how these goals will contribute to California's overall State goal of reducing GHGs, with a mention of AB 32's goal of lowering statewide GHG emissions 80% below 1990 levels by 2050 as well as SB 32's mid-point goal of lowering statewide GHG emissions 40% below 1990 levels by 2030. Disregard if this was mentioned but overlooked by the reviewer.	Chapter 2, under Climate Strategies, mentions how implementation of the 2021 Regional Plan supports local jurisdictions and state agencies in achieving their climate goals.
L30	On Page 44: "The 2015 update of the regional plan was projected to cost \$130 billion in 2020 dollars. The 2021 Regional Plan is projected to cost \$163 billion. Why the higher cost? As we have detailed in Chapters 1 and 2, the 2021, the Regional Plan completely reimagines our transportation system—". While the 2015 may also be assumed to have taken bold steps to reimagine the transportation system, it might be ideal to refer to the appropriate technical Appendix as to why a newer, updated approach is costing \$33 billion more six years later.	Chapter 3 includes references to technical appendices with details on the proposed projects, estimated costs, and revenues; these include: Appendix A: Transportation Projects, Programs, and Phasing; Appendix U: Cost Estimation Methodology; and Appendix V: Funding and Revenues.
L31	Overall a very good and thorough plan, would just mention of alignment with the CTP 2050.	Thank you for your support of the 2021 Regional Plan and suggestion to mention alignment with the CTP 2050.
<b>Caltrans District 11</b>		
L32	Transportation is the largest source of greenhouse gas (GHG) emissions in the San Diego region; in 2016, on-road light-duty vehicles accounted for 41% of emissions. One strategy to reduce emissions is to reduce Vehicle Miles Traveled (VMT). The Regional Housing Needs Allocation Plan informed development of the SCS land use pattern, and the region's major employment centers and urban core mobility hubs are expected to take on the most housing and job growth in the region over the next 30 years. It is anticipated this development pattern will support VMT reduction from light-duty vehicles by balancing the ratio of jobs to housing land uses. Additionally, the 2021 Regional Plan proposes expansion of the regional transit network such that thirty-minute transit access from mobility hubs to Tier 1 employment centers increases from 13% to 28% for communities of color and increases from 16% to 33% for residents with low incomes by 2050. This improvement will provide important access to economic opportunities to these communities while incentivizing mode shift.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
L33	Caltrans supports SANDAG's embrace of new and improved mobility management strategies such as developing a smart intersection system, a comprehensive system to manage cross-border trips, and real-time traffic management solutions (including dynamic truck parking) to manage many modes of transportation, including freight movement.	Thank you for your support of the proposed investments in mobility management strategies.

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L34	We encourage SANDAG to continue efforts on a recently funded grant to develop a Sustainable Freight Implementation Strategy. This work will help the region execute a road map for a more efficient, economically competitive, and sustainable freight transportation system, establish a framework to transition to a clean freight system, reduce pollution exposure to environmental justice communities, and help implement state sustainable freight efforts such as the California Sustainable Freight Action Plan, the California Freight Mobility Plan, Governor Gavin Newsom’s “Zero-Emission by 2035” Executive Order (N-79-20), and Assembly Bill 617 (C. Garcia, 2017) Community Emission Reduction Program.	SANDAG looks forward to coordinating with Caltrans and other partners on the Sustainable Freight Implementation Strategy.
L35	Caltrans supports consideration and the development of new mechanisms for viable VMT mitigation options for highway capacity projects, such as exploring statewide and regional VMT mitigation bank concepts and evaluating feasibility and exploring potential expansion of an Advanced Mitigation Program to include GHG/VMT mitigation.	SANDAG participates in the statewide SB 743 working group on these topics and looks forward to continuing to coordinate with Caltrans and other agencies on VMT mitigation options.
L36	As the 2021 Regional Plan looks to develop performance measures, analyze, and address congestion, please consider presenting data about how travel, delay, and transit use will evolve with the implementation of the plan.	SANDAG will consider these data as it implements Action 10 of the 2021 Regional Plan: Advance a data science program to better understand travel behavior and issues in the region, update travel demand modeling tools, and improve transparency and reporting on program effectiveness and project delivery. Appendix T of the proposed final 2021 Regional Plan will include forecasted travel time data for key corridors.
L37	Caltrans is encouraged by the investments outlined in SANDAG’s Supporting Policies and Programs. These investments will support programs that complement the capital and operational investments of the transportation system, encourage sustainable growth and development, and implement innovative demand strategies. Please consider inclusion of a program for Highways to Boulevards Conversion or freeway cap/lid/decks to create new park space, housing, or community amenities to help restore and revitalize communities. Proposed locations will be discussed and determined in the future.	In alignment with the 2021 Regional Plan, SANDAG and Caltrans District 11 will continue to develop Comprehensive Multimodal Corridor Plans (CMCPs) in coordination with agency partners and local city governments. Opportunities for Highways to Boulevards Conversions or freeway caps will be considered in the CMCPs.
L38	Please consider including in the listing of transportation projects, programs, and phasing the San Diego- Coronado Bridge Suicide Prevention Barrier Project. The Coronado Bridge has the highest concentration of death by suicide for a spot location on the state highway system. Without mention in the regional plan, the project may not be able to compete for state or federal funding.	A discussion of the San Diego-Coronado Bridge Suicide Prevention Barrier Project will be added to Appendix Q Transportation Security and Safety in the proposed final Regional Plan.
L39	<p>Caltrans recognizes the rural areas of our region play a vital role in California’s economy. Rural communities are often also the gateway to the state’s preserved landscapes that are central to supporting California’s tourism industry. Yet, rural communities are already experiencing the impacts of a changing climate— from unprecedented storms to devastating wildfires. While transportation goals are inherently and fundamentally the same no matter the context— to provide safe access to destinations for people and goods - unique local and regional conditions require tailored solutions to advance these goals, and solutions may look different in varying local contexts.</p> <p>Please consider including additional examples of sustainable transportation solutions that could be applied in rural settings, understanding that these efforts will require collaboration with the local and Tribal governments that serve the locations, such as:</p> <ol style="list-style-type: none"> <li>1. Increasing transit service in a corridor through investments in bus service, vanpools, micro-transit or mobility on demand services, and park-and-ride facilities.</li> <li>2. Roadside land management activities related to wildfire.</li> <li>3. Addressing safety through the multidisciplinary Safe System Approach that employ tools for speed management, such as road diets, conversion of intersections to roundabouts, and signal coordination to slow speeds.</li> <li>4. Improving efforts on coordination for broadband access in transportation and growth, remote work/VMT reduction, economic development, and regional housing strategies. Broadband access remains a critical issue in rural communities and with many Tribal nations.</li> <li>5. Adding and improving connected facilities for walking and bicycling and for first/last-mile connections to local, interregional, and regional transit routes. Rural cores should support walking and biking on commercial corridors and main streets.</li> <li>6. Prioritizing connections to natural areas; Tribal communities may desire access to ceremonial sites outside of the rural core.</li> <li>7. Facilitating emergency evacuations through efficient traffic management strategies, such as the use of contra flow,</li> </ol>	Please see where these examples are included in the 2021 Regional Plan: These examples are included in Transit Leap and Flexible Fleet services. This example is included in the description of the Climate Adaptation and Resilience implementation actions in Appendix B. These examples are included in the description of Active Transportation and Demand Management and complete streets in mobility hubs. These examples related to broadband access have been added to the description of rural corridor improvements in Appendix A. The 2021 Regional Plan includes the adopted Regional Bike Network, which identifies the I-8 Bikeway along that rural corridor. Examples provided in this comment can be considered in County of San Diego-led active transportation projects and in a future Regional Active Transportation Plan. The Intraregional Tribal Transportation Strategy was used to inform many of the improvements identified for the rural corridors. These examples have been added to the description of rural corridor improvements in Appendix A. These examples are included in the Electric Vehicle programs proposed in the 2021 Regional Plan.

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	<p>use of two-way left turn lanes as through travel lanes, construction of full structural sections of shoulders and installation of transportation management systems (TMS) elements, such as closed circuit television (CCTV) cameras, changeable message signs (CMS), and traffic detection equipment.</p> <p>8. Deploying zero-emission vehicle charging or fueling infrastructure—including for battery electric, fuel cell (hydrogen) electric, and other zero-emission vehicle technologies.</p>	
<b>Center for Sustainable Energy</b>		
L40	<p>CSE supports SANDAG’s proposed Mobility Hubs concept to provide integrated transportation solutions. CSE recommends that SANDAG utilize these Mobility Hubs to showcase a variety of clean energy and transportation technologies. Specifically, Mobility Hubs could raise awareness of zero- emission transportation alternatives, including EVs and zero-emission buses. Additionally, the mere presence of visible public charging infrastructure can influence consumers’ willingness to pay for an EV by up to \$5,000. CSE also recommends that additional clean energy technologies be integrated into the Mobility Hubs. For example, EV chargers could be coupled with solar panels and battery storage systems to provide greater utilization of clean electricity. To expand this concept even further, CSE encourages SANDAG to consider deploying microgrids in conjunction with Mobility Hubs. Microgrids can further integrate these technologies to provide additional emissions reductions, while also managing grid impacts and providing resiliency benefits during extreme weather events. Through islanding capabilities, microgrids would enable Mobility Hubs to continue to charge electric fleets during electric grid outages, further alleviating consumers’ concerns about all-electric transportation options.</p>	<p>Thank you for your comment and support of the 2021 Regional Plan. SANDAG plans to explore integrated renewable energy options for EV chargers at Mobility Hubs and will explore microgrid options to address climate and energy resiliency for EV charging and other Mobility Hub amenities that rely on electricity.</p>
L41	<p>CSE is pleased to participate in SANDAG’s Energy Working Group (EWG) and strongly supports the EWG’s role in coordinating regional climate action planning, particularly through the use of analytical tools such as the Regional Climate Action Planning Framework (ReCAP). CSE encourages SANDAG to continue this work by periodically sharing best practices on climate action planning. For example, CSE suggests that the release of the ReCAP Snapshots be accompanied by targeted policy recommendations for local jurisdictions. Additionally, the EWG is an effective venue for sharing best practices on local climate equity planning initiatives, such as the Climate Equity Index reports prepared by the Cities of San Diego and Chula Vista, and applying these “lessons learned” on a broader regional scale. CSE also recommends SANDAG engage its Regional Plan Social Equity Working Group (WG) to gather feedback and recommendations on how to operationalize equity throughout the agency, using the Regional Plan as a starting point. Lastly, CSE recommends that the EWG and the Social Equity WG seek to collaborate with emergency planning and land use officials from state, regional, and local agencies, who are often not involved in conventional climate action planning activities. This type of information-sharing and collaborative planning across agencies and departments will be critical to mitigate the impacts of extreme weather events including heatwaves, wildfires, and droughts, which are expected to continue to increase in frequency and severity.</p>	<p>Through the Holistic Implementation of Adaptation and Transportation Resilience project, SANDAG is currently preparing an implementation tool, economic guidance document, and equity prioritization document to help local planners address climate risks and adaptation needs by holistically implementing projects that link mitigation, adaptation, and broader community benefits. Staff has received input from the Social Equity Working Group and will be incorporating it into the final deliverables. Furthermore, the 2021 Regional Plan includes a Regional Resilience Framework, which could leverage creative partnerships to support regional resilience, such as creating “resilience hubs” for emergency/disaster response; partnering with emergency planning professionals on this effort would be imperative.</p>
L42	<p>CSE supports the development of SANDAG’s proposed Next OS platform to incorporate transportation data and streamline individuals’ travel patterns. CSE offers a number of recommendations to integrate EVs into this platform and facilitate better understanding of travel behavior and associated emissions impacts.</p> <p>First, CSE recommends that SANDAG include data on EV infrastructure locations and availability in the Next OS platform. Lack of access to EV charging is often cited as one of the largest barriers preventing consumers from purchasing EVs. Even EV owners often experience difficulty finding a public EV charger given the number of EV service providers (EVSPs) with proprietary software applications. Additionally, CSE encourages SANDAG to consider integrating information regarding EV charger availability to prevent queues from developing at these sites. While some EVSPs have added waitlist functionalities into their software, there is no uniform approach to addressing this challenge. By integrating these factors into the Next OS platform, SANDAG can support current and prospective EV owners and further promote electrified transportation.</p>	<p>SANDAG will explore ways to integrate EV charger location and availability data into the Next OS platform.</p>
L43	<p>Second, CSE recommends incorporating greenhouse gas (GHG) emissions data into the Next OS platform in order to provide individuals with information regarding the estimated emissions intensity of various transportation modes. For example, an individual could use the Next OS platform to choose between taking transit or requesting ride-hailing services, considering the emissions associated with each mode and making their decision based off of this information. Similarly, the platform could compare the emissions intensity of various options within a specified mode of travel. For example, an individual choosing to use ride-hailing services could assess the emissions impacts of single-occupancy vehicle trips versus pooled trips or the difference between rides in an EV versus in an internal combustion engine vehicle. This functionality could increase public awareness of emissions impacts and encourage greater utilization of clean transportation options.</p>	<p>SANDAG will explore ways to integrate GHG emissions and/or sustainability data into the consumer-facing elements of the Next OS platform.</p>



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L44	<p>Third, CSE recommends that the key analytical insights obtained through the Next OS platform be compiled and highlighted on public dashboards, either on the platform itself or on SANDAG’s website. By its nature, the Next OS platform will collect significant levels of data on individual travel patterns and preferences. Analyzing this data will yield key insights that can further inform regional planning and policymaking. Additionally, highlighting these insights through dashboards and visualizations, and thereby making this data accessible and understandable to the general public, will also enable individuals to better understand their transportation options and impacts. These dashboards should be made available in multiple languages and should be updated at regular intervals.</p>	<p>SANDAG envisions the development of a data analytics module within Next OS that will allow for the analysis of travel data from various modal sources. Next OS will also provide the ability to share the data to transportation operators, planning staff, and decision makers via planned Next OS dashboards. SANDAG will also explore ways to provide data via a public facing dashboard.</p>
<b>Chicano Park Museum</b>		
L45	<p>My name is Josephine S. Talamantez and my family have been Logan Heights residents since 1906 and the CPMCC have been in the area for 6 years. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego’s Barrio Logan and Logan Heights communities. Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional Plan (Draft Plan)</p> <p>Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950’s and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know ReConnect Logan Freeway Lid will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the 1-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.</p> <p>As mentioned, the construction of the 1-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950’s our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that 1-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children’s access to neighborhood schools. It is time for our community to heal - a freeway lid is the answer.</p> <p>Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out ReConnect Logan Freeway Lid as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:</p> <p>The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)</p> <p>Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A- 12)</p> <p>Besides being in line with the 2021 Draft Regional Plan, ReConnect Logan Freeway Lid is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional Plan.</p>	<p>Caltrans District 11 has also expressed interest in exploring opportunities for freeway caps. In alignment with the 2021 Regional Plan, SANDAG and Caltrans District 11 are currently developing Comprehensive Multimodal Corridor Plans in coordination with agency partners and local city governments. Comprehensive Multimodal Corridor Plans (CMCPs) are data-driven plans to reduce congestion and generate transportation choices while preserving community character and creating opportunities for enhancement projects. Opportunities for freeway caps will be considered in the CMCPs.</p>
<b>Chollas Creek Coalition</b>		
L46	<p>Chollas Creek Coalition requests SANDAG include Chollas Creek Regional Park active transportation and recreational facilities in the 2021 update of the San Diego Forward Regional Transportation Plan (RTP).</p> <p>Environmental Justice communities located along the Chollas Creek Watershed have been historically under-invested in and residents are predominantly lower-income people of color with higher-rates of health issues resulting from over-</p>	<p>The Chollas Creek Bikeway will be incorporated into the 2021 Regional Plan.</p>

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	<p>pollution and inequitable access to economic opportunity. These communities bisected by freeways do not have safe mobility connections for people to get around without a car.</p> <p>The future Chollas Creek Regional Park included in the 2021 draft of the City of San Diego's Parks Master Plan has approximately 8 miles of parks, trails, recreational amenities, trees, bikeways and stormwater infrastructure improvements along the north and south forks of the Chollas Creek in need of planning and funding. This trail system once completed would connect City Heights, Southeast San Diego and the communities in between all the way to Barrio Logan and the employment centers along the San Diego Bay.</p> <p>SANDAG has a once in generation opportunity to make a meaningful investment in the many communities along the Chollas Creek by including the Chollas Creek Regional Park and associated bikeway projects in the RTP. These critical active transportation connections to improve community health, resiliency to climate change and link housing to jobs are many decades over-due. We urge SANDAG to invest in the project to advance equity, climate justice and a historic win for communities who have been ignored for far too long.</p>	
<b>City Heights Built Environment Team</b>		
L47	Greater transit frequencies (7 min on peak, and 10 mins all day) in Transit Priority Areas; Collaborate with the Built Environment Team on a Pilot Program to identify and test high ridership routes in City Heights	SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.
L48	Late night and weekend service improvements with 24-hour service on major routes.	The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.
L49	Supporting the Purple Line alignment through central City Heights.	The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.
L50	Bikeways on major corridors with implementation of Early Action Projects in Mid-City by 2023.	The bicycle network outlined in the 2021 Regional Plan were laid out and prioritized based on the analysis performed in Riding to 2050: San Diego Regional Bike Plan. While the horizon year for build out is 2050, this just means it would be proposed to be completed by that time. Many projects will likely be completed sooner, and some are already in construction. This is especially true as new funding sources come available. Additionally, as an early action out of the 2021 Regional Plan, SANDAG will be developing a new Regional Active Transportation Plan in which projects will be reassessed and reprioritized based on data and community engagement. The regional network compliments the much more extensive networks which local jurisdictions plan and construct on their own streets. There are also opportunities for the development of protected bike networks via "Complete Streets in Mobility Hubs" funding included in the Regional Plan.
L51	Implementing traffic-calming measures including but not limited to: protected bike lanes, roundabouts, raised crossings to improve to ensure a safer biking experience.	Traffic-calming measures such as those described in this comment are included in the proposed 2021 Regional Plan through investments in the Regional Bike Network, Complete Streets in Mobility Hubs, and Vision Zero programs.
L52	Planting more trees throughout City Heights to foster a healthier urban environment.	The 2021 Regional Plan includes a nature-based climate solutions program that could be used to fund activities such as tree-planting.
L53	Ensuring Youth Opportunity Passes for those aged 24 and under by 2023.	One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.



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L54	Oppose freeway expansions in City Heights that increase Vehicle Miles Traveled while supporting general purpose lane conversions that prioritize transit.	Improvements to the freeway system are limited to Managed Lanes using existing infrastructure such as general purpose lane conversion and shoulders to facilitate additional transit and high occupancy vehicle travel.
L55	Improve multimodal beach access for urban-core communities.	The Regional Plan includes active transportation, transit, and flexible fleet services that connect communities to various beaches in the region.
L56	Plan and implement Bus Rapid Transit Route 550 on 54th St. to be phased for 2025.	Rapid Route 625 is planned for on 54th St. This project remains phased for 2028 in the proposed final 2021 Regional Plan, however SANDAG has begun advanced planning for this route.
L57	Improve and exceed State of California standards for GHG reduction goals.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.
L58	Maintain transparency with community members by sharing relevant data and progress updates surrounding project phasing, implementation, and funding.	SANDAG will continue to be transparent and share data and progress updates as the Plan is implemented.

**City of Carlsbad**

L59	<p>City staff have attended the series of workshops that SANDAG hosted during the public review period, and respectfully; starts this section with several questions related to; the process of the; Plan and the Draft EIR. By way of introduction, a jurisdiction's General Plan, such as the city's General Plan, identifies the expected population of the city and any lands outside of the city limits but within their Sphere of Influence where future growth is anticipated to occur. The city's General Plan identifies the subject area adjacent to the McClellan-Palomar Airport for development under the designation for limited and light industrial use.</p> <p>For future land use planning, land use assumptions must reasonably proxy and be generally consistent with local planning standards and; programs; to; be considered; growth accommodating; rather than growth inducing. SANDAG has the; authority under Government; Code Section 65584 to; determine existing and projected housing needs, as well as the share of housing needs to be allocated to cities and counties, but it; is unclear; if SANDAG has jurisdiction to; allocate new housing growth to; areas in a manner not consistent with Government Code Section 65584. Attachment 1 includes additional information on the applicable Government Code and standards. Therefore, and as indicated above, the build-out of properties within the Business Park and flight activity zone must be done in accordance; with the city's General Plan Land Use Diagram, as amended, in accordance with city approval.</p>	<p>Government Code section 65080(b)(2)(B) provides that a Sustainable Communities Strategy (SCS) "use most recent planning assumptions considering local general plans and other factors." It also requires that the SCS "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board." The SCS included in the 2021 Regional Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan.</p> <p>The SCS land use pattern proposed in the 2021 Regional Plan focuses growth and development in the mobility hub areas. The allocation of housing units to subregional areas represents general areas projected for future growth in mobility hub areas, not specific parcels, for future housing development or housing unit type. A number of land uses at the parcel level, aggregated up, comprise these general areas. The exercise of land use authority is reserved to local jurisdictions. For Carlsbad, the SCS land use pattern forecasts 6,575 housing units from 2016 to 2050, which is within the total housing unit capacity of the City's general plan as provided to SANDAG (6,992 housing units) and accommodates the City's RHNA allocation of 3,873 housing units by 2035. The Series 14 Regional Growth Forecast Documentation and Sustainable Communities Strategy Land Use Pattern Subregional Allocation methodology is available at: <a href="https://sdforwarddata-sandag.hub.arcgis.com/documents/SANDAG::series-14-regional-growth-forecast-and-scs-land-use-pattern-subregional-allocation-oct-2021-draft/about">https://sdforwarddata-sandag.hub.arcgis.com/documents/SANDAG::series-14-regional-growth-forecast-and-scs-land-use-pattern-subregional-allocation-oct-2021-draft/about</a>.</p>
L60	<p>1. The SANDAG website states, "The SANDAG Sustainable Communities Strategy and Final EIR from its 2015 Regional Plan will remain valid and in compliance for purposes of state funding eligibility and other state and federal consistency purposes until the SANDAG Board of Directors adopts a new Regional Plan and EIR, provided those actions are completed by the end of December 2021." SANDAG needs to clarify how the Draft EIR, Response to Comments and Adoption will be completed this year and what will occur if they are not completed by the end of this year. Additionally, please clarify when the Draft EIR will be available; it is difficult to completely assess the full impacts of this plan when the public review of the documents is piecemealed.</p> <p>a. SANDAG should clarify how public comments on the Plan are going to be addressed in the Draft EIR prior to its release.</p> <p>b. In the Draft EIR, SANDAG needs to clearly articulate the impacts to land use and if the Plan will cause a significant environmental impact due to a conflict with any land use plan, policy or regulation adopted for the purpose of avoiding or mitigating an environmental effect. Appendix F: Regional Growth Forecast and Sustainable Communities Strategy Land Use Pattern appears to be inconsistent with the city's General Plan and rezone program to accommodate the Regional Housing Needs Assessment, as well as the general plans of other jurisdictions such as the cities of Coronado, Del Mar and the County of San Diego. The Draft EIR should clarify how implementation of this Plan can occur if those changes are not made.</p>	<p>1a. The Draft EIR analyzes the draft Regional Plan. Comments and responses received on the Draft Regional Plan will be provided in the Final Regional Plan and inform the Final EIR.</p> <p>1b. The Draft EIR includes the required land use analysis in Section 4.11.</p>

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L61	<p>2. The city has three mobility hubs, associated with the Employment Centers Published supporting the SANDAG Regional Plan. 1 McClellan-Palomar Airport is the fifth largest employment center in the region, with Carlsbad State Beach and Carlsbad Village as “Tier 3 and Tier 4” employment centers. The city thanks SANDAG for providing data for analysis to determine impacts and provide for accurate comments on the Plan . Attachment 2 shows a summary of the Mobility Hubs and housing units assumed in the Series 14 Growth Forecast for the year 2050. In summary:</p> <p>a. The assumptions in the updated Series 14 Growth Forecast contain inconsistencies with the city’s General Plan. The Carlsbad Palomar Major Employment Mobility Hub does include increases in density beyond what the citywide numbers appear to show when they are looked at in more detail.</p> <p>i. There are three locations in which density is shown to be inconsistent with good planning principles, the city’s General Plan and the Airport Land Use Compatibility Plan. The three most problematic areas (shown in Attachment 3) are:</p> <ol style="list-style-type: none"> <li>1. 736 units on parcels immediately adjacent to the McClellan -Palomar Airport runway. The location of the airport within this mobility hub was shared with SANDAG staff multiple times at workshops. This is inconsistent with the regulations provided by the San Diego County Regional Airport Authority and conflicts with standard planning principles for siting housing away from hazards.</li> <li>2. 2,755 units on existing developed resort properties and open space dedicated lands adjacent to Legoland.</li> <li>3. 65 units in a preserved open space area.</li> </ol> <p>ii. SANDAG should provide additional detail why units were assumed in these areas, what planning principles those decisions were based on, and how SANDAG expects this to be implemented.</p> <p>iii. Concentration of units in the mobility hubs alone appears to conflict with the direction received from the California Department of Housing and Community Development (“HCD”) to implement new Affirmatively Furthering Fair Housing (“AFFH”), which seeks to combat housing discrimination, eliminate racial bias, undo historic patterns of segregation, and lift barriers that restrict access in order to foster inclusive communities and achieve racial equity, fair housing choice and opportunity for all Californians. The allocations of land use provided by SANDAG seem to focus all the higher density housing into one area of the city. (This is one of the largest points of analysis that each jurisdiction in the region needs to respond to in order to receive a certified Housing Element.)</p> <p>2b. Additionally, looking at the detailed data provided by SANDAG, it is now clear why the citywide numbers only show moderate increases in population. Our analysis has shown that there is an assumed reduction of population by 2,310 persons in the areas within the city but outside of the mobility hubs. This is likely due to assumed reductions in persons per household over time, but SANDAG should clarify the source and reasonableness of this assumption. If housing is not provided consistent with these areas, is it still reasonable to assume persons per household will be reduced in 2050?</p> <p>2c. Furthermore, this reduction in population is not limited to the City of Carlsbad . There is an approximately 85,000 reduction in population assumed outside of mobility hubs regionwide . SANDAG needs to address if that is a reasonable assumption and if this will result in other impacts to public and private projects that will rely on this growth forecast, and the associated Activity Based Model (2+) to project future impacts to transportation, GHG, air quality and noise.</p> <p>2d. The forecast has decreased in future population based on current trends, but it is not clear if there is enough housing provided with reductions and increases in some jurisdictions. Will the reduced amount of housing that will be provided result in an increased exacerbation of the affordability crisis?</p> <p>2e. There is a lack of clarity about how the Plan would be implemented at the municipal level. SANDAG should develop an approach for engaging with municipalities to ensure local support for delivering the regional transportation network. Staff from local jurisdiction have the knowledge and ability to share where there are land use assumptions that conflict with planning and zoning laws. Our analysis focused on the City of Carlsbad, but if these types of assumptions are made regionwide, it presents flaws in the overall analysis. These flaws put the assumed reductions in vehicle miles traveled (“VMT”) and ability to implement the Regional Plan into question.</p>	<p>2. – 2e. Government Code section 65080(b)(2)(B) provides that a Sustainable Communities Strategy (SCS) “use most recent planning assumptions considering local general plans and other factors.” It also requires that the SCS “set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the 2021 Regional Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan.</p> <p>The SCS land use pattern proposed in the 2021 Regional Plan focuses growth and development in the mobility hub areas. The allocation of housing units to subregional areas represents general areas projected for future growth in mobility hub areas, not specific parcels, for future housing development or housing unit type. A number of land uses at the parcel level, aggregated up, comprise these general areas. The precise zoning at the parcel level is within local jurisdictions land use authority. For Carlsbad, the SCS land use pattern forecasts 6,575 housing units from 2016 to 2050, which is within the total housing unit capacity of the City’s general plan as provided to SANDAG (6,992 housing units) and accommodates the City’s RHNA allocation of 3,873 housing units. The Series 14 Regional Growth Forecast Documentation and Sustainable Communities Strategy Land Use Pattern Subregional Allocation methodology is available at: <a href="https://sdforwarddata-sandag.hub.arcgis.com/documents/SANDAG::series-14-regional-growth-forecast-and-scs-land-use-pattern-subregional-allocation-oct-2021-draft/about">https://sdforwarddata-sandag.hub.arcgis.com/documents/SANDAG::series-14-regional-growth-forecast-and-scs-land-use-pattern-subregional-allocation-oct-2021-draft/about</a>.</p>
L62	<p>3. The area designated is controlled for use and activity density and intensity through its spatial association with the McClellan-Palomar Airport. The McClellan-Palomar Airport is defined by the Federal Aviation Administration (“FAA”) as a commercial service airport that, in addition to private aircraft, has regularly scheduled commercial flights to Los Angeles International Airport (“LAX”). The McClellan-Palomar Airport Land Use Compatibility Plan (“ALUCP”) is prepared according to FAA requirements and adopted by the San Diego County Regional Airport Authority acting as the Airport Land Use Commission for the County of San Diego.</p> <p>a. The ALUCP provides measures to minimize the public’s exposure to excessive noise and safety hazards within areas around the airport and identifies areas likely to be impacted by noise and flight activity created by aircraft operations at</p>	<p>3a. – d. Government Code section 65080(b)(2)(B) provides that a Sustainable Communities Strategy (SCS) “use most recent planning assumptions considering local general plans and other factors.” It also requires that the SCS “set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the 2021 Regional Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan.</p>

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	<p>the airport. These impacted areas include the Airport Influence Area (“AIA”), the Clear Zone and the Flight Activity Zone.</p> <p>b. Within the AIA, the ALUCP establishes six safety zones for the purpose of evaluating safety compatibility of new/future land use actions. The safety zone boundaries depict relative risk of aircraft accidents occurring near the airport and are derived from general aviation aircraft accident location data and data regarding the airport’s runway configuration and airport operational procedures. The ALUCP limits development intensities in these zones by imposing floor area and lot coverage maximums, by incorporating risk reduction measures in the design and construction of buildings, and/or by restricting certain uses altogether. For example, all residential and virtually all non-residential uses are considered incompatible land uses in some zones, while considered to be either compatible or conditionally compatible with the airport in other zones. Attachment 4 shows the McClellan-Palomar Airport, noise contours and SANDAG’s proposed housing units.</p> <p>c. If the proposed SANDAG land use assumptions are endorsed, an amendment to the city’s General Plan would be required to change the land use designation to Mixed-Use Commercial or residential land uses within the existing Business Park in order to effectuate the underlying assumptions of SANDAG staff. This is not a realistic assumption. Further, the protected airspace referenced in the AIA and the ALUCP must also be amended based on SANDAG’s regional planning assumptions. (The FAA establishes airspace protection zones in the airspace above and surrounding airports in order to protect aircraft from obstructions such as buildings, towers, etc. in navigable airspace.)</p> <p>d. When a General Plan is adopted or amended, the allowable growth pattern of an area is identified and the expansion or updating of the various land uses as specified in the General Plan can occur throughout the planning horizon. Without such growth considerations, the expansion or intensification of existing land uses could be considered “growth inducing.” Unplanned and uncontrolled growth may have significant adverse impacts on the environment. CEQA requires a discussion of how a “project” could increase population, employment or housing growth in surrounding areas and the impacts resulting from this growth. The CEQA Guidelines indicate that a “project” would normally have a significant effect on the environment if it would induce substantial growth or a substantial concentration of population.</p>	<p>The SCS land use pattern proposed in the 2021 Regional Plan focuses growth and development in the mobility hub areas. The allocation of housing units to subregional areas represents general areas projected for future growth in mobility hub areas, not precise parcel locations, for future housing development or housing unit type. A number of land uses at the parcel level, aggregated up, comprise these general areas. The precise zoning at the parcel level is within local jurisdictions land use authority. For Carlsbad, the SCS land use pattern forecasts 6,575 housing units from 2016 to 2050, which is within the total housing unit capacity of the City’s general plan as provided to SANDAG (6,992 housing units) and accommodates the City’s RHNA allocation of 3,873 housing units. The Series 14 Regional Growth Forecast Documentation and Sustainable Communities Strategy Land Use Pattern Subregional Allocation methodology is available at: <a href="https://sdforwarddata-sandag.hub.arcgis.com/documents/SANDAG::series-14-regional-growth-forecast-and-scs-land-use-pattern-subregional-allocation-oct-2021-draft/about">https://sdforwarddata-sandag.hub.arcgis.com/documents/SANDAG::series-14-regional-growth-forecast-and-scs-land-use-pattern-subregional-allocation-oct-2021-draft/about</a>.</p>
L63	<p>4. At this point, it is not clear if SANDAG’s assumptions adequately contemplate the development patterns included in the Sustainable Communities Strategy (“SCS”)/Regional Transportation Plan (“RTP”), and Regional Air Quality Strategy (“RAQS”), local climate action planning business-as usual estimates, sub-regional traffic modeling, or the airspace assumptions of AIA and the ALUCP.</p>	<p>4. As with each update of the Regional Plan, SANDAG prepares an updated Regional Growth Forecast and subregional allocation that may be a deviation from prior forecasts that have been used in local or subregional analyses. SANDAG is typically required to update the Regional Plan every four years in order to account for the changes in funding outlooks and planning assumptions and to align with state and federal methodologies and mandates.</p>
L64	<p>5. The city seeks clarity on the Plan’s underlying assumptions made to justify the proposed extensive high-speed rail network considering the significant changes in travel behavior which have occurred throughout the region as a result of the COVID-19 pandemic and due to the advancements in disruptive technologies such as telecommuting, autonomous vehicles, microtransit, etc.</p> <p>a. Recent North County Transit District (“NCTD”) Coaster ridership data show riders are not returning to riding the Coaster in comparison to other modes of travel as shown in Attachment 5.</p> <p>b. This question is consistent with comments made by SANDAG’s panel expert Bob Poole regarding the impact of the COVID-19 pandemic on transit ridership and mega-transit projects. (See comments by Bob Poole during the March 12, 2021 presentation to SANDAG starting at timestamp 1:30 p.m.: <a href="https://youtu.be/q-e6bNY5J8?t=5410">https://youtu.be/q-e6bNY5J8?t=5410</a>)</p>	<p>5(a)(b) As part of the development of the transit services for the 2021 Regional Plan, SANDAG completed a comprehensive data analysis to understand the primary travel patterns anticipated to occur between today and 2050. This analysis is described in Appendix T. In addition, SANDAG incorporated the latest information on telecommute patterns as a result of the COVID-19 pandemic. Employment data for the region shows that only a portion of jobs are “telecommutable” and many individuals must travel to a work location. Additionally, SANDAG has been tracking traffic volumes and congestion is returning to pre-pandemic levels. This demonstrates the need for alternatives to driving.</p>
L65	<p>6. The city seeks clarity on why an alternatives analysis was not conducted with consideration of other transit alternatives such as automated /shared vehicle technologies and personalized zero emissions transit programs that are capable of utilizing the existing regional freeway infrastructure in response to these recent developments explained in the above comment.</p>	<p>6. SANDAG has been tracking AV deployment and found that AVs do not provide the capacity needed to reduce VMT on roadways. Current AVs are small passenger vehicles that carry up to four people at a time. On some of our larger transit routes, like the Blue Line Trolley, we have up to 60,000 boardings per day. The planned Purple Line passenger rail service identified in the 2021 Regional Plan is projected to have upwards of 80,000 daily boardings. If these trips were made in single occupant AVs, it would result in significant congestion on our local roadways. Alongside the transit system, the 2021 Regional Plan proposes Flexible Fleet services, which include shared vehicle technologies that could be automated in the future. Flexible Fleets would be supported by the complete corridor investments in the existing freeway infrastructure.</p>
L66	<p>7. The city seeks clarity on why the Plan does not incorporate policies to promote roundabouts over signalized intersections and include a budget line item under the Complete Corridors to fund the construction of roundabouts at new locations and to replace signalized intersections when found feasible. This clarification would support the Federal Highway Administration (“FHWA”)’s project for Accelerating Roundabout Implementation in the United States and the County of San Diego Air Pollution Control Board’s support for implementing roundabouts to address GHG and reduce fatalities.</p>	<p>7. Roundabouts, curb extensions, and similar traffic calming measures are included in the Mobility Hub complete streets investments as a means for slowing vehicular traffic in neighborhoods where a higher volume of multimodal travel to/from key destinations, particularly active transportation, is anticipated.</p>

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L67	8. The city seeks clarity on the project phasing proposed within the Plan. Specifically, the city is seeking to understand the timing of implementation of unfunded TransNet projects related to the new projects presented within the Regional Plan. To support this, the city is requesting that SANDAG input the information requested in Table 1 (Attachment 6).	8. A comparison between the <i>TransNet</i> Program of Projects and the Draft 2021 Regional Plan was included in the July 7, 2021 ITOC Agenda Item #2 ( <a href="https://www.sandag.org/uploads/meetingid/meetingid_5886_29414.pdf">https://www.sandag.org/uploads/meetingid/meetingid_5886_29414.pdf</a> ). In addition to the report narrative, you will find in Attachment 1 the details regarding the original <i>TransNet</i> projects and how those are addressed in the Regional Plan corridor by corridor.
L68	9. The city seeks specific data on the proposed 200 miles of rail service contemplated in the Plan. To support this, the city is requesting that SANDAG input the information requested in Table 3 (Attachment 7). Specific questions: a. Please provide more information about the scope of the high-speed rail alignments, potential vehicle technologies and their cost estimates. b. Will the Coaster keep the same rail alignment? c. What funding is programmed or planned for the Carlsbad Village railroad trench and the other projects along the current NCTD/Coaster Service right-of-way? d. Will some of the tracks be at grade with fencing and trains traveling at 110 miles per hour speeds?	9(a)(b)(c)(d) Both the Batiquitos Lagoon Double Track and Carlsbad Village Trench projects are included in the 2021 Regional Plan. These projects will complete LOSSAN double tracking within the City of Carlsbad in generally the same alignment. Some segments of the LOSSAN corridor will remain at grade with fencing.
L69	Section 2 In addition to the comments on process and the Draft EIR provided above, city staff remain concerned that there is not enough detail on the feasibility of implementation of this significant shift in transportation strategy. On specific content in the plans, we outline our recommendations and comments below:  1. Paying for the Plan: The draft 2021 Regional Plan sets out an ambitious plan to build and operate a region-wide system of transportation projects, programs and other improvements. This is a substantial role for SANDAG to play in supporting both the construction and operation of these projects, programs and other improvements. SANDAG should set annual revenue targets to directly fund everything and should approve any recommended sustainable revenue tools to help meet these targets. Many of the funding strategies will require legislative changes, or voter-approved taxation. SANDAG should clarify what will occur if the funding is not available, if opposition to projects stops them from construction, and if General Plans in the region are not modified to implement the Plan.	There are over 30 sources of funding included in the projected revenues for the 2021 Regional Plan. While the assumptions used to develop these revenues are determined to be reasonable based on state and federal standards, the level of projected expenditures provides flexibility to account for any changes in the timing or availability of these funds over the next 30 years. SANDAG is typically required to update the Regional Plan every four years to account for the changes in funding outlooks, priorities, and planning assumptions.
L70	2. Appendix D: Sustainable Community Strategy Documentation: Appendix D includes the Sustainable Communities Strategy, which outlines assumptions included in the Activity Based Model 2+ (“ABM 2+”), updated for this. This model will be necessary for use by publicly and privately initiated land use projects preparing documents for consistency with VMT/CEQA Guidelines and Traffic Impact Analysis (“TIA”) Evaluations. City staff respectfully request direction from SANDAG on how to conduct modeling with the service bureau and how to factor in these assumptions applied to ABM 2+. Specifically, the addition of pricing, parking costs for coastal communities, 10% teleworking and micromobility. SANDAG should provide direction on how this could be worked into General Plans that are updated every 5-20 years.	2. SANDAG will work with local jurisdictions on how to conduct modeling with the service bureau and how to factor in assumptions related to pricing, parking, teleworking, and micromobility.
L71	3. Appendix A: Transportation Projects, Programs, and Phasing: Trips to and from school sites result in a significant congestion, VMT generation, and peak hour delay throughout the region. Additional funding and projects should be recommended with a specific focus on improving safety and multimodal access in and around school sites along with programs to incentivize non-single occupancy vehicle trips to schools.	3. Both the Appendix A “Mobility Hubs” and “Policies and Programs” section include investments that would benefit school sites and school access. Within the “Mobility Hub” investments, there are Complete Streets assumptions to make streets safer for people who walk and bike by investing in traffic calming and pedestrian improvements. Under “Policies and Programs” the Plan includes in Vision Zero programming that prioritizes safety through roadway design while working with cities to develop community engagement programs that identify local street safety issues and provide technical guidance to resolve those issues through investment, policies, and programs.
L72	Table A.11: Given the proven success of the Carlsbad Connector microtransit pilot program, the city agrees with the Plan’s recommendations to provide similar on-demand microtransit systems throughout North County at all mobility hub sites and major transit centers.	SANDAG looks forward to coordinating with Carlsbad and other North County jurisdictions on microtransit systems.
L73	Table A.13: The segment of El Camino Real between Poinsettia Lane and Camino Vida Roble is proposed to be widened from two to three lanes to prime arterial standards. With the adoption of the city’s General Plan, the city has determined that the widening of this portion of El Camino Real is not feasible due to constrained right-of-way and would result in negative impacts to other travel modes. City staff recommend removal of this proposed project recommendation CB32 {that is, a ‘do nothing’ scenario, or appraise and evaluate different mobility projects and/or alternative designs}.	Complete Corridors, such as those planned for I-5 via Project IT CC004, provide a variety of travel choices and use technology to manage how highways and major roads are used in real time. They provide a balance of dedicated, safe space for everyone, including freight vehicles and people who walk, bike, drive, ride transit, and use Flexible Fleets. This will not only improve traffic operations and efficient operations along this corridor, but it will help to provide additional access while assisting the region in meeting its greenhouse reduction mandates. More information on Flexible Fleets can be found here: <a href="https://www.sdforward.com/mobility-planning/flexible-fleets">https://www.sdforward.com/mobility-planning/flexible-fleets</a> .
L74	4. Active Transportation: The city appreciates the Regional Plan’s overall approach of providing a connected network of high-quality bicycle facilities throughout the region. Regional bikeways are recommended throughout the city including along Palomar	SANDAG will work closely with the City as active transportation projects advance into project-level design to ensure the project meets the needs of the corridor. SANDAG appreciates suggestions for improving



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	<p>Airport Road which will provide a key east-west connection and El Camino Real which will provide a new north-south bikeway connection through the city. Both roadways are proposed to include “on-street bikeways”. Due to the high traffic volumes and vehicle speeds experienced along most of both corridors, the city recommends considering “off-street bikeways” or Class I facilities where feasible in order to stimulate the shift from personal motor vehicle use to people choosing to bike.</p> <p>It is extremely important that municipal transportation plans align with regional transportation plans to achieve regional goals for land use and transportation and to promote the region working together to build a cohesive regional transportation network. Considering there are currently no mechanisms in place to ensure municipalities coordinate local transportation plans with regional planning documents, the Plan should provide an approach on how SANDAG plans to engage with municipalities, especially in areas of potential disagreement or conflict (as aforementioned in this subsection and others). It is also recommended that the Plan provide additional direction regarding the application of protected bikeways in a variety of applicable contexts. While vertical measures such as soft hit posts may be appropriate in lower volume and lower speed roadways, arterial roadways with high traffic volumes and high speeds warrant much more substantial physical protection from vehicles. In addition, special consideration should be given at intersections and driveways which may be impacted due to the additional width and visibility impacts created by protected bikeways.</p>	<p>coordination with municipalities and will consider these as it develops programs and policies to implement the Regional Plan.</p>
<b>City of Coronado</b>		
L75	<p>First, and most notably, during the South Bay to Sorrento Comprehensive Multimodal Corridor Plan (CMCP) engagement process, City staff expressed concern about the Orange Avenue Business District / village area being designated a Mobility Hub without meaningful engagement with City residents and the City Council. It is highly unlikely the City would agree to construction of a new mobility hub in the Orange Avenue corridor. Therefore, the City requests the mobility hub be removed from both the South Bay to Sorrento CMCP and the 2021 Regional Plan.</p>	<p>Coronado is a major destination due to its location adjacent to one of the region’s top military bases. Additionally, people commuting to hospitality, retail, and dining jobs is a daily occurrence, and the community serves as one of the region’s top tourism destinations for visitors from both outside and within San Diego County. These trip inducing factors contribute to the area’s high propensity for regional mobility hub designation.</p> <p>Not all mobility hub areas are created equal, and they don’t all require construction of a major transit center. Coastal mobility hubs similar to others in the North County area are envisioned to rely upon some transit services supported by an array of on-demand Flexible Fleets to help people complete short trips in and around the hub without needing to rely on a car.</p>
L76	<p>As stated in the City’s “Comments on the South Bay to Sorrento Comprehensive Multimodal Corridor Plan” letter dated July 7, 2021, the City has about 23,639 residents (ACS 2019) and a compact, fully developed village area covering about two square miles surrounded by the San Diego Bay and the Pacific Ocean. The City is highly constrained and does not have additional development capacity or any buffer zones to establish a mobility hub in our village area. While the City is supportive of on-demand travel options, it is difficult to imagine where facilities for the “Flexible Fleets” and “Transit Leaps” might be sited, such as ride hailing zones, electric vehicle charging stations, micro-mobility parking areas, parcel delivery lockers, and sidewalk delivery bots. The description of mobility hubs also includes drone technology, which is a concern given the proximity to Naval Air Station North Island (NASNI).</p>	<p>SANDAG staff will continue to coordinate with the City on planning for appropriate mobility hub services, amenities, and supporting technology for this community.</p> <p>The suite of Flexible Fleets and supporting Mobility Hub amenities as included in the 2021 Regional Plan can be tailored to meet the needs of people traveling to and within Coronado. These features would enhance connections to transit (including the ferry) or help shift shorter, drive alone trips to alternative modes. It’s vital to understand that a variety of personally owned micromobility devices such as electric-assist bikes, scooters, and other motorized rideables are included in this category of options. Such devices are becoming increasingly popular among youth and adults alike. Since Coronado attracts so many residents from other parts of the region in addition to out of towners, it will be important to consider the provision of amenities like secure micromobility storage for these personally owned devices at or very near popular destinations.</p>
L77	<p>The designation of the City’s village as a mobility hub is also concerning as it relates to the future of housing allocations for Coronado. Presumably, given the State and SANDAG’s priority to increase housing density in transit rich areas, mobility hubs and related transportation investment may have a significant adverse impact in Coronado’s village area. The 2021 Regional Plan refers to mobility hubs as areas “to concentrate future development.” The City is concerned that the designation of the village area as a mobility hub will lead to continued increased regional housing needs allocations, which will negatively impact the City’s character, in addition to the challenge of space and regulatory limitations to accommodate more high-density housing.</p>	<p>Coronado is a major destination due to its location adjacent to one of the region’s top military bases. Additionally, people commuting to hospitality, retail, and dining jobs is a daily occurrence, and the community serves as one of the region’s top tourism destinations for visitors from both outside and within San Diego County. These trip inducing factors contribute to the area’s high propensity for regional mobility hub designation.</p> <p>The 6th Cycle Regional Housing Needs Assessment (RHNA) Plan, adopted by the Board of Directors and approved by the California Department of Housing and Community Development, includes a methodology which allocates housing throughout the region near jobs and transit. Consistent with state law, the RHNA process occurs about every 8 years. During the next RHNA process, the Board of Directors will again consider a methodology for allocating housing throughout the region, which may be different from the 6th Cycle methodology.</p>
L78	<p>In the event that the village area continues to be designated as a mobility hub, the City asks that the use of drone security be removed from the plan due to privacy and safety concerns, that the use of e-bikes or scooters be limited and orderly, and that new facilities not block or impede pedestrian movement. Finally, before any strategies are implemented within the village area, more public outreach and interagency collaboration will be required to inform Coronado residents of the plan.</p>	<p>SANDAG will work closely with Coronado staff before any strategies are implemented within the village area. Drone technology is referenced in the plan as something the private sector is exploring for use as last-mile delivery. SANDAG intends to coordinate with local jurisdictions and the private sector on potential applications and policies to guide the use of drone technology.</p>

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L79	<p>In addition to the City's concern for a mobility hub in the village, the City finds that the 2021 Regional Plan presupposes that 2021-2029 RHNA is finalized although there is pending litigation related to the RHNA. To address this issue, the City asks that the following language be inserted as a footnote on p.33 of the 2021 Regional Plan, after the sentence: "The SANDAG Board of Directors adopted the RHNA Plan on July 10, 2020, with the final housing unit allocation" to read:</p> <p>In September 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court challenging, among other things, the Board's adoption of the RHNA Plan. SANDAG demurred to the cities' Petition and the demurrer was sustained by the court in February 2021. The petitioning cities have appealed the ruling on the demurrer to their Writ Petition, and that appeal remains pending in the Fourth District Court of Appeal.</p>	This language has been added to the introductory pages of Appendix K, Regional Housing Needs Assessment Plan.
L80	<p>In addition, the City proposes to add the following paragraph to the end of p.14 of Appendix K:</p> <p>On September 24, 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court, Case No. 37-2020-00033974-CU-MC-CTL, against SANDAG and SANDAG's Board of Directors seeking an order requiring that SANDAG give those cities a fair hearing on their RHNA appeals and decide the cities' appeals in a legal manner without bias and without the use of the weighted voting mechanism. Specifically, the petitioning cities asked the court to order: (1) that the final RHNA allocation approval by SANDAG be rescinded; (2) that SANDAG's denial of the cities' RHNA appeals be rescinded; (3) that the appeals be remanded to SANDAG for fair consideration; and (4) that SANDAG be prohibited from utilizing a weighted vote on the cities' RHNA appeals. On February 5, 2021, SANDAG's demurrer to the Petition for Writ of Mandate was sustained by the Superior Court. The petitioning cities have appealed the ruling on the demurrer to their Writ Petition. That appeal remains pending in the Fourth District Court of Appeal. So long as the litigation is pending, the Board's adoption of the RHNA Plan cannot be considered final.</p>	Similar language acknowledging the pending litigation has been added to the introductory pages of Appendix K, Regional Housing Needs Assessment Plan.
L81	A new Rapid route is depicted from Downtown to NASNI. The City would be interested in extending this route further into the commercial village area.	SANDAG, MTS, and the City can explore extension of the Rapid route from Downtown to NASNI for consideration in the next Regional Plan.
L82	The description of the Transportation Demand Programs includes language that suggests that employers will be required to provide transportation benefits. The City does not support requiring local businesses to provide specific benefits and would not enforce this or any other mandatory regulatory actions.	The 2021 Regional Plan proposes a Transportation Demand Management Ordinance and a near-term implementation action would be to complete a Transportation Demand Management Ordinance Policy Analysis. This policy analysis would detail the employers that the ordinance would apply to and mechanisms for enforcement.
L83	Appendix A identifies a new off-street bike path on Glorietta Boulevard. The City's Active Transportation Master Plan does not identify such a future improvement, the Bayshore Bikeway Plan recommends no changes to this area, and there is already a bike lane on Glorietta Boulevard. Please update A.12 and A.13.	<p>These projects were approved by the SANDAG Board of Directors in 2010 with the development of a comprehensive regional bike network - Riding to 2050: The San Diego Regional Bike Plan and these Class I Bayshore Bikeway segments were identified again and prioritized in 2013 via the SANDAG Early Action Program (EAP).</p> <p>More information can be found at the following links:  <a href="https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail</a>  <a href="https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail</a></p>
L84	In Appendix B one of the strategies to increase housing affordability is to minimize zoning near transit. Since most of the village area is near transit, the City would not implement strategies that adversely alters its community character through reduced zoning requirements or eliminated single family zoning.	While this is a strategy to increase housing affordability and reduce vehicle-miles traveled, land use authority is reserved to local jurisdictions because they are best positioned to effectively implement the objectives outlined in the Regional Plan through understanding of the unique needs of their communities and geographies.
L85	In the land use maps in Appendix F, there are some areas of Coronado shown as mixed use. Although there is some existing, non-conforming mixed-use development in the City, there are no areas in the City that are zoned for mixed use, and there are no plans to zone additional areas for new mixed-use.	The SCS land use pattern assumes mixed use development to accommodate future growth and development in the mobility hub areas. Implementation of the land use pattern is to be refined through coordinated planning with the City as zoning authority is reserved to local jurisdictions.
L86	The City generally supports improvements to the public transportation system, but encourages SANDAG to do so in a manner that does not compromise necessary road maintenance and improvement projects.	SANDAG is committed to working collaboratively with stakeholders, peer agencies, and the City in the development, deployment, and operations of new regional transit services in order to identify and mitigate issues (including coordination with other projects within the same or similar boundaries).
L87	The City also supports new waterborne transportation options, such as ferry routes, and encourages SANDAG to prioritize the financing and expansion of waterborne transportation options in its regional planning documents.	SANDAG is working with MTS and the Cities of San Diego and Coronado on exploring grant opportunities to plan and fund ferry transportation for possible inclusion in the next Regional Plan.
<b>City of Oceanside, Planning Division</b>		
L88	We applaud SANDAG for prioritizing public safety, solutions to traffic congestion, social equity, GHG emission reduction, and air quality. We recommend that SANDAG also acknowledge open space and natural habitat preservation as a key priority of the Regional Plan. The long-term sustainability of the San Diego region, along with the quality of life of its	Both Chapter 2 and Appendix AA include information about open space and natural habitat preservation in the San Diego region.



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	residents, depends on the preservation of these resources. How will the San Diego region help to further the state's "30 by 30" goal, as outlined in Executive Order EO N-82-20?	
L89	We encourage SANDAG to consult with the scientific community on the most recent sea level rise projections for the region's coastline. It is our understanding that NASA now projects sea level rise of less than one foot by 2050, based on roughly three inches of sea level rise over the past decade. While there are many factors that could contribute to significantly greater sea level rise over this period, we believe it important to base regional planning efforts on the most likely sea level rise scenario	At this time, sea level rise guidance from the Ocean Protection Council is considered the best available science and projects 2 feet of sea level rise by 2050. As the science evolves, SANDAG will update its planning efforts to reflect the latest science and guidance for planning.
L90	The modest goals for mobility mode shift over the planning period (reducing SOV commutes by 18% and increasing transit ridership by 10%) do not seem commensurate with the major changes the Five Big Moves would bring to the region. What are the main impediments to achieving more ambitious mobility mode shift goals? What strategies, if any, are available to overcome these impediments?	The 2021 Regional Plan does not include mode shift goals, however, SANDAG's activity based model (ABM2+) estimates the mode shift performance of the proposed plan. The ABM2+ is a state-of-the-art tool for analyzing the transportation network, land use pattern, and other policies of the Regional Plan, however, it is based on the information we know today. There are many emerging technologies and future behavior changes that could impact mode shift in the future. SANDAG will continue to use best available data and research on mobility to inform future updates of the ABM and estimated performance of the Regional Plan. The mode share estimates from ABM2+ are reported for the entire region. We expect in areas of denser land use and a greater confluence of mobility options to have a greater than average modal change.
L91	The regional population forecast for this iteration of the regional plan shows substantially less population growth through 2050 than that projected in prior forecasts. Should this most recent growth forecast prove accurate, there will inevitably be less tax and user fee revenue to support the region's transportation system. To what extent has lower population growth, and concomitant lower regional funding, been factored into the economic analysis of the Five Big Moves?	The regional population forecast is intrinsically tied to several aspects of the Regional Plan and is updated based on the latest forecasts from the California Department of Finance for each update of the Regional Plan. Revenue estimates for gas tax, sales tax, and user fees account for this updated population forecast and related vehicle fuel consumption and vehicle miles traveled estimates from ABM2+. The funding strategy will continue to be updated and adjusted for each Regional Plan to reflect changing conditions.
L92	It is noted that over the next three decades 60% of the region's population growth will be among those who are 75 years old and older. How well do we understand the current and evolving mobility needs and preferences of this demographic, and how will transportation infrastructure and services be designed to accommodate these needs and preferences? How will the region's elderly population benefit from active transportation improvements? How will the elderly access transit? What accommodations will need to be made to ensure that the elderly have equal access to the region's mobility network?	SANDAG has a long history of working closely with senior community members, social service providers, non-profits and community-based organizations to develop and fund specialized transportation services geared specifically towards the needs of seniors. The Regional Plan network includes a variety of modes that work together seamlessly to provide all San Diego residents, regardless of age or ability, access to multiple travel choices. Flexible Fleets are an example of an option that is particularly well suited for the senior population. Flexible Fleet options like ridehail, rideshare, and microtransit, offer a range of mobility options and vehicles that can accommodate many types of trips and meet the needs of various users. They can make it easy for seniors to access medical appointments and other basic needs without relying on a car. Flexible Fleet vehicles and services are adaptable and can offer personalized accommodations, such as wheelchair lifts, door-to-door services, and other options for people with physical limitations. SANDAG has conducted outreach and will continue to engage with seniors to ensure their mobility needs are met. In addition, SANDAG is developing a Flexible Fleets Implementation Strategic Plan that will address potential barriers to accessing Flexible Fleets, options for people without smartphones or internet, educational opportunities about how to access Flexible Fleets, and more.
L93	The Draft SCS establishes the overarching goal of a fast, fair, and clean mobility network. It will be important to devise and consistently apply appropriate metrics for evaluating how mobility improvements and services further this goal.  <ul style="list-style-type: none"> <li>• With regard to the relative speediness of new or enhanced mobility options, it would be worthwhile to consider how travel times associated with alternative modes compare with those associated with SOY automobile trips.</li> <li>• In addition to evaluating the fairness of a particular improvement or service in terms of access, cost, and functionality, it would be worthwhile to also consider the relative safety and comfort of mobility options as experienced by different user groups.</li> <li>• While air quality and GHG emissions are fundamental considerations in determining the cleanliness of the mobility network, so too are water quality, soil quality, hazardous materials, and solid waste management.</li> </ul>	Chapter 3 (Table 3.1) and Appendix E include information on the performance indicators for the 2021Regional Plan, which align with these suggested metrics.
L94	While user fees are both an important revenue source and a potentially powerful means of encouraging more sustainable modes of transportation, it is important that such fees not create financial hardship for lower-income households. To avoid a regressive and inequitable user fee regime, subsidies should be provided to those with both limited financial means and limited mobility options.	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. The study will also assess the potential impacts of user fees on different San Diego residents, visitors, and businesses. SANDAG is committed to developing a carefully constructed program that will promote equity and ensure that no particular group is disproportionately burdened. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system
L95	The efficient movement of goods into and through the San Diego region is essential to the health and stability of the regional economy. Assessment of the efficiency of goods movement should consider how delivery systems contribute to	The 2021 Regional Plan Appendix Y includes the 2021 Freight Gateway Study Update, which highlights freight flows within and to/from our region. SANDAG will be initiating the "San Diego and Imperial Counties

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	overall VMT and how these systems can further evolve to minimize their environmental impacts, including their contributions to traffic congestion, air pollution and GHG emissions, roadway wear -and-tear, and noise	Sustainable Freight Implementation Strategy” (Strategy) in early 2022 to identify regional strategies that transition the region to a more sustainable, efficient, equitable, and economically competitive freight transportation system. The projects and policies identified in this Strategy will be incorporated in future regional plans.
L96	Preparation and implementation of the sub-regional Comprehensive Multimodal Corridor Plans (CMCPs ) is identified as a priority in the Draft Regional Plan. Oceanside staff has been participating in task force meetings on the North County CMCP. In these meetings, we have noted that Caltrans facilities that extend through Oceanside often serve as barriers to active transportation and connectivity between neighborhoods. For example, SR 76 bifurcates neighborhoods in the San Luis Rey Valley, separating residents from commercial areas, recreational facilities, and other community assets. The absence of grade-separated crossings on SR 76 contributes to the highway’s impact as a physical and psychological barrier. The Planning Division recommends that improvements to SR 76, SR 78, and I-5 incorporate new and upgraded pedestrian and bicycle facilities that enable safer and more convenient crossings of these roadways.	<p>The North County Comprehensive Multimodal Corridor Plan (North County CMCP) is a strategic blueprint for identifying and implementing multimodal projects and services within North County communities. The North County CMCP work is using the Regional Plan to integrate the needs and projects identified where they align with sub-regional and regional transportation needs to reinforce the integrated system approach to meeting the diverse demands of North County’s communities.</p> <p>While there are not specific line items listed for within the 76 corridor, under the complete corridor concept for rural corridors like SR 76, the vision is looking into other strategies using technology and roadway operational improvements that could increase access, efficiencies, and safety by considering widening shoulders to allow safe passing lanes and rapid access to first responders, the use of technology (speed control, dynamic lane configuration using reversible lanes) to address crashes and increase capacity during evacuation routes with the use of real-time driver information in the event of fire or other natural disasters. Earlier phases of the 2021 Regional plan for SR 76 include approximately \$55 million proposed for the implementation of smart intersection technologies (2025 phase) and approximately \$222 million for operational and technology improvements (2035 phase).</p>
L97	To a large extent, the success of mobility hubs will depend on the level of comfort and engagement they provide to those who travel through them. The design of mobility hubs should therefore emphasize safety, security, accessibility, visual quality, and a strong sense of place. Mobility hubs have the potential to serve as gathering spaces, cultural venues, and entertainment districts. Improvements and services within mobility hubs should contribute to, and not detract from, the character and appeal of these areas.	SANDAG looks forward to working with the City of Oceanside, and all local jurisdictions, to implement improvements and services in mobility hub areas that meet the needs of the local community including strengthening a sense of place. Mobility hub success depends on featuring a mix of uses—everything from parks and plazas to dining and performance spaces—coupled with a variety of reliable and convenient ways to get there.
L98	It is noted that the Draft Regional Plan considers air pollution exposure reduction strategies promulgated by AB 805 and other state legislation and guidance. While most of these strategies rightly focus on underserved communities, it is important to note that as smart growth takes hold in the region and new housing is built in closer proximity to major roadways and transit facilities, residents across the socioeconomic spectrum could be exposed to excessive levels of air pollution. As we facilitate cleaner forms of transportation, we can also consider ways to enhance both indoor and outdoor air quality in highly urbanized areas through landscaping, ventilation systems, weather-stripping, etc.	These suggestions will be considered as we develop and implement programs related to smart growth, mobility hubs, and housing. The proposed 2021 Regional Plan is a high-level analysis of policies, projects, and programs and does not address specific details of building development such as landscaping, ventilation and weather stripping.
L99	State Route 76 is identified in the SCS as a “rural corridor.” While much of this highway extends through rural areas, most segments of SR 76 in Oceanside abut urbanized areas. Accommodating both pass-through and local trips, these segments of SR 76 could benefit from some of the same improvements and programming slated for other highways in the region.	The complete corridor concept for rural corridors like SR 76 includes strategies using technology and roadway operational improvements that could increase access, efficiencies, and safety by considering widening shoulders to allow safe passing lanes and rapid access to first responders, the use of technology (speed control, dynamic lane configuration using reversible lanes) to address crashes and increase capacity during evacuation routes with the use of real-time driver information in the event of fire or other natural disasters. Earlier phases of the 2021 Regional plan for SR 76 include approximately \$55 million proposed for the implementation of smart intersection technologies (2025 phase) and approximately \$222 million for operational and technology improvements (2035 phase).
L100	Consider Oceanside as a testing ground for the piloting of Next OS technologies, particularly those that serve lower -income residents and those who reside in areas with limited transit options.	SANDAG looks forward to partnering with the City of Oceanside to pilot Next OS technologies.
L101	In partnership with the Orange County Transit Authority (OCTA) and NCTD, consider rapid bus service between southern Orange County and the Oceanside Transit Center	The North County CMCP work is digging into the finer details of what is proposed in the Regional Plan and may propose additional Rapid Routes.
L102	The SCS calls for implementation of “innovative demand and system management” programs. The City of Oceanside has recently adopted TOM standards for new non-residential development of certain types and scales. The City is also exploring possible incentives for TOM in existing non-residential development. Regional funding and/or technical support for TOM plans would be a powerful incentive for existing businesses to consider ways to promote alternative commuting options.	SANDAG’s Transportation Demand Management (TDM) program currently offers jurisdictions and developers technical support and resources for implementing local demand/system management strategies. Most recently, SANDAG developed the Mobility Management Toolbox to help jurisdictions and developers evaluate the potential Vehicle Miles Traveled (VMT) benefits of mobility management measures, including TDM and Transportation System Management (TSM). In addition, SANDAG’s TDM program works with over 200 businesses throughout the region to offer customized solutions that promote alternative commuting options.
L103	As other local jurisdictions have done, the City of Oceanside intends to reduce lanes and implement roundabouts within one of its major commercial corridors (Coast Highway). One of the biggest challenges to implementing “road diets” is maintaining adequate right-of-way for buses and ample curb space for flex fleet service. Regional guidance on road diet design that supports alternative mobility options, developed in partnership with regional transit and flex fleet providers, would be helpful.	SANDAG is considering the development of regional guidelines for designing Mobility Hub and Complete Corridor improvements, which could include specifications for curb space into the design process. Curb Management is included as one of the key policies in the Regional Plan, and SANDAG intends to partner with local jurisdictions and other necessary stakeholders to pilot curb space projects as part of a near-term implementation strategy. Deploying curb space pilots will be conducted in alignment with the deployment of Flexible Fleets, and pilot results can help inform best practices to follow regionwide.

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L104	The proliferation of warehousing and distribution facilities in the San Diego region has major implications for land use, economic development, and climate mitigation. These facilities tend to occupy large tracts of land while providing relatively few jobs per acre. Vehicle trips generated by these facilities can contribute significantly to VMT and associated GHG emissions. We encourage SANDAG to consider guidelines and incentives that promote innovation in the warehousing and distribution sector (e.g., more efficient land use, zero-emission vehicle fleets, etc.).	SANDAG will be initiating the “San Diego and Imperial Counties Sustainable Freight Implementation Strategy” (Strategy) in early 2022 to identify regional strategies that transition the region to a more sustainable, efficient, equitable, and economically competitive freight transportation system. SANDAG will consider these suggestions when developing this Strategy and will work with our local partners on vetting the Strategy’s recommendations. The projects and policies identified in this Strategy will be incorporated in future regional plans.
L105	Value pricing of public parking facilities is key to facilitating efficient use of these resources, generating revenue for local transportation improvements, encouraging alternative modes of transportation, and motivating efficient use of private parking facilities. While parking pricing is largely within the authority of local jurisdictions, SANDAG can support localities in navigating the technical and political challenges of implementing value pricing programs.	Parking Management is one of the key policy areas included in the Draft 2021 Regional Plan. As part of the Regional Plan, SANDAG has designated program funding towards working with local jurisdictions to implement parking management strategies such as parking pricing. In addition, SANDAG develops technical resources to provide jurisdictions with guidance on implementing parking policies, such as the 2014 Parking Management Toolbox. One of the Regional Plan implementation strategies includes updating the Toolbox to account for newer modes and more flexible curb space strategies.
L106	Performance monitoring, as illustrated in Table 3.1, should include public health benchmarks, particularly those that provide insight on the public health impacts of air pollution, lack of access to healthy food, sedentary lifestyles, etc.	SANDAG relies on partner agencies for tracking public health benchmarks, including the San Diego County Air Pollution Control District, San Diego Food Systems Alliance, and Health and Human Services Agency.
L107	In Figure A. 1, SR 76 and SR 78 are not identified as significant corridor geographies, while SR 56, SR 94, and SR 125 are identified as such. The Planning Division recommends that these two important regional roadways be identified in the same manner as other east-west highways in the region.	All corridors identified in the 2021 Regional Plan are critical and considered significant to ensure that the Regional Plan vision meet state and federal air quality mandates, reduce traffic congestion, and address social equity. Figure A.1 reflects the focus areas of the five Comprehensive Multimodal Corridor Plans (CMCP) that are currently under development, as well as the anticipated study areas for future corridor plans and the North Coast Corridor. SR 78 between I-5 and I-15 and the western portion of SR 76 are included in the North County CMCP and are shown in the orange area on Figure A.1.
L108	As identified in Table A.11, the Inland Rail Trail (IRT) through Oceanside is not shown as being implemented until 2035. The IRT is a crucial component of the North County bicycle trails network, facilitating access to NCTD Sprinter rail and Breeze bus services, connecting cyclists to the Coastal Rail Trail, activating north south bikeways (e.g., El Camino Real, College Boulevard), and contributing to complete streets improvements within the Oceanside Blvd corridor. The Planning Division thus recommends that the Draft Regional Plan commit to implementation of this segment of the IRT by 2025.	SANDAG is committed to completing the Inland Rail Trail. The Oceanside segment is identified as the final segment of the Inland Rail Trail to be completed, consistent with the Bike Early Action Program (EAP). SANDAG is actively pursuing opportunities to advance active transportation projects through grant funding, using Demand-Based Criteria to prioritize project implementation, and integrating bike projects into Comprehensive Multimodal Corridor Plans. Recently, the Board of Directors accepted \$12.057 million of Active Transportation Program Cycle 5 (ATP) grant funds for Inland Rail Trail Phase 4 (CIP No. 1223095). That funding will help SANDAG meet the very aggressive schedule to begin construction on this Phase by 2024.  For more information visit: <a href="https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx">https://www.keepsandiegomoving.com/RegionalBikeProjects/inland_rail_trail_intro.aspx</a> .
L109	The Planning Division recommends that acquisition of land in mobility hub areas be identified as a higher priority, as property aggregation will be key to efficient redevelopment of many of these areas.	Some land acquisition may be necessary to implement elements of the regional mobility hub concept if future transit station locations are being proposed. SANDAG will work closely with the City of Oceanside should this need be identified. However, we also recognize near-term opportunities to work with existing rights-of-way at transit stations to retrofit curbside space for active passenger and small goods delivery in addition to siting supporting amenities like wireless electric vehicle charging, interactive travel kiosks, improved shelters equipped with WiFi, and more. Additional land use redevelopment opportunities may be identified in partnership with the private sector to convert surface parking to mixed land uses that integrate shared mobility service accommodations, for example.
L110	The extension of Melrose Drive and the interchange at Highway 78 and Rancho del Oro are not listed among the arterial improvements in Table A.13. Both of these improvements are listed in the City’s Circulation Element (CE). While the City is currently contemplating removal of the extension from Santa Fe Avenue to Spur Avenue from the CE, the unconstructed segment between North River Road and State Route 76 will remain	Table A.13 consists of near-term arterial projects that are included the Regional Transportation Improvement Program (RTIP) and require Air Quality Conformity analysis. The projects mentioned here are either not currently listed in the RTIP or have not programmed funding to a capital project phase and therefore are not listed.
L111	Implementation Action 9 calls for expansion of regional programs on low-carbon transportation options, roadway safety and maintenance, and nature-based climate solutions. While the Planning Division supports nature-based climate solutions where feasible, we note that certain stretches of the region’s coastline face imminent threat from coastal hazards and are not amenable to nature-based solutions. The Planning Division encourages SANDAG to support near-term coastal adaptation measures that address urgent local conditions and buy time for the development and implementation of long-range adaptation strategies.	The SANDAG Shoreline Preservation Working Group is a long-standing advisory group to the Regional Planning Committee on critical shoreline issues relevant to the region’s 70 miles of coastline, including the development of the 2021 Regional Plan. Paramount is continued support for the region’s ongoing and future beach nourishment efforts and other sea-level rise adaptation strategies.
L112	In addition to the enumerated strategies to increase housing availability and affordability (p. 19), the Planning Division encourages SANDAG to consider gap financing for inclusionary housing projects that do not qualify for tax credit financing and/or other federal and state subsidies. In determining eligibility for gap financing, SANDAG should consider key sustainability metrics - e.g., proximity to transit, employment, and essential services, energy efficiency and renewable energy sourcing, pedestrian-oriented design, resilient building materials, etc.	SANDAG is currently developing a Regional Housing Incentive Program and will take several factors into consideration to ensure the program meets the goals of the 2021 Regional Plan. The program will consider climate change and resiliency and consistency with transportation improvements included in the 2021 Regional Plan. Furthermore, SANDAG is developing a new grant program focused on accelerating housing production and have identified potential regional projects such as establishing a regional framework to potentially raise, administer, and allocate funding for affordable housing in the San Diego region. Additionally,



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		SANDAG will be evaluating Board Policy No. 33 to establish a criterion for funding that is consistent with the 6th Cycle Regional Housing Needs Assessment, the proposed final 2021 Regional Plan, and aligns with state planning priorities.
L113	The Planning Division applauds SANDAG for recognizing that the relatively low resale value of certain electric vehicles presents an opportunity for lower-income households to enter the electric vehicle market. SANDAG can further support EV ownership in low-income and historically disadvantaged communities by coordinating with dealerships in the region on marketing and financing programs.	SANDAG will be developing a regional zero emission vehicle (ZEV) incentive program to help low- and moderate-income households purchase electric vehicles. The program is to support the purchase and/or lease of over 100,000 ZEVs by 2035. As part of the program design and implementation, SANDAG plans to engage with car dealerships and/or car associations, as well as coordinate with other vehicle incentive program administrators to enable consistent messaging and information for residents, dealerships and other stakeholders. These incentives will be in addition to other financing and incentives available in the region. As part of the ZEV incentive program development, SANDAG also will explore opportunities to incentivize secondary market (used) vehicles.
L114	The “Fix It First” implementation strategy is described as “bringing transit and road infrastructure back to optimal performance.” The Planning Division questions the notion that the region’s mobility infrastructure has ever demonstrated “optimal performance.” Perhaps a better catch-phrase here would be something akin to “Build Back Better,” as this speaks to more than just perpetuating the status quo.	Thank you for your comment.
L115	In its consideration of tools and strategies that provide for the effective operation and management of regional infrastructure as a coordinated system, SANDAG should work closely with local jurisdictions to identify, enhance, and integrate local data collection and traffic management programs into a regional whole. The City of Oceanside maintains a Traffic Management Center that, with adequate staffing, has the potential to provide real-time traffic data to support signal optimization and other efficiencies.	SANDAG looks forward to coordinating with Oceanside on data collection and traffic management programs.
L116	The Planning Division is concerned that the most recent iteration of the regional population forecast may significantly underestimate Oceanside’s capacity for additional population, housing, and employment. We understand that the statewide forecast prepared by the Department of Finance shows considerably less growth in the San Diego region over the next three decades than previously anticipated, and we acknowledge that population and housing growth in Oceanside has been declining over the past 20 years. Nevertheless, housing demand in Oceanside remains strong, and the City is still one of the most affordable housing markets in the San Diego region. Moreover, the local employment base continues to grow, particularly in the manufacturing, health care, and hospitality sectors. We believe Oceanside has the potential to accommodate significant growth through infill and redevelopment, and that the revitalization of the City’s urban corridors will draw new residents and employers. The City’s outdated General Plan has likely contributed to low growth projections over the past three forecast periods (2008, 2012, and 2016). The City is currently in the process of updating its General Plan, with the intent to incentivize infill and redevelopment through new zoning standards, a streamlined review process, CEQA clearance, and targeted infrastructure improvements.	SANDAG looks forward to continuing to coordinate with the City of Oceanside to incorporate its latest planning assumptions into future updates of the Regional Plan.
<b>City of Oceanside, Traffic Engineering Division</b>		
L117	SANDAG needs to clarify how the Draft EIR, Response to Comments and Adoption will be completed this year and what will occur if they are not completed by the end of this year. SANDAG should also clarify how comments on the plan are going to be addressed in the Draft EIR prior to its release.	The Draft EIR analyzes the draft Regional Plan. Comments and responses received on the Draft Regional Plan will be provided in the Final Regional Plan and inform the Final EIR. SANDAG’s schedule calls for the Board of Directors to consider EIR certification and adoption of the Regional Plan by the end of the year.
L118	Looking at the detailed data provided by SANDAG it is not clear why the citywide numbers only show moderate increases in population. See comments provided by the City’s Planning Division.	As noted in comments from the City’s Planning Division, the regional population forecast prepared by the California Department of Finance shows less growth over the next 30 years than previously anticipated.
L119	In Appendix A: Transportation Projects, Programs, and Phasing, it should be noted that Trips to and from school sites result in a significant congestion, VMT generation, and peak hour delay throughout the region. Additional funding and projects should be recommended with a specific focus on improving safety and multimodal access in and around school sites along with programs to incentivize non-single occupancy vehicle trips to schools.	Both the Appendix A “Mobility Hubs” and “Policies and Programs” section include investments that would benefit school sites and school access. Within the “Mobility Hub” investments, there are Complete Streets assumptions to make streets safer for people who walk and bike by investing in traffic calming and pedestrian improvements. Under “Policies and Programs” the Plan includes in Vision Zero programming that prioritizes safety through roadway design while working with cities to develop community engagement programs that identify local street safety issues and provide technical guidance to resolve those issues through investment, policies, and programs.
L120	Considering FHWA’s project for Accelerating Roundabout Implementation in the United States, and the County of San Diego Air Pollution Control Board’s support for implementing roundabouts to address GHG and reduce fatalities, the Plan should incorporate policies to promote roundabouts over signalized intersections and include a line item under the Complete Corridors to fund the construction of roundabouts at new locations and replace signalized intersections when found feasible.	Roundabouts, curb extensions, and similar traffic calming measures are included in the Mobility Hub complete streets investments as a means for slowing vehicular traffic in neighborhoods where a higher volume of multimodal travel to/from key destinations, particularly active transportation, is anticipated.
L121	Descriptions of the following projects are insufficient. In order to provide comments, the City requests that SANDAG provide more detailed project description, information and clarifications for the following projects:	For the projects listed in this comment (1-4) the cost estimates are a planning-level determination for designing and building an All Ages and Abilities bikeway facility type either on-street, or off. These estimates are based on the most recently completed SANDAG bikeway projects in \$2020 then applied consistently

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	<p>1. AT030: Coastal Rail Trail Oceanside-Alta Loma Marsh Bridge 2035. The Regional Plan’s cost estimate is \$4 million. The actual estimate prepared by the City is \$9 million. Please clarify or correct.</p> <p>2. AT031: Coastal Rail Trail Broadway to Eaton 2035. The project cost is estimated at \$1 million. The Regional Plan recommends trail extension to Eaton Street, with Eaton providing connection to the existing Coastal Trail segment on Coast Hwy. The City’s preferred routing is to extend this trail to the south end of Broadway, then obtain easement from the Buena Vista Audubon Society to continue the trail along the lagoon to connect to the Carlsbad section of the Coastal Rail Trail. We recommend the project description be amended accordingly. We also believe that a higher cost estimate needs to be included; \$1M is not an accurate cost estimate for this project.</p> <p>3. AT049: Inland Rail Trail 2035. The project cost is estimated at \$68M. It is difficult to evaluate the accuracy of this cost estimate without a preliminary engineering study of the potential alignments and the actual field conditions. It is likely the cost of this project will exceed \$70M.</p> <p>4. AT074: Coastal Rail Trail-Oceanside Segment IALT 2050. The project cost is estimated at \$6 million, with on-street routing from Neptune/Pacific to the NCTD station. It is difficult to assess this potential trail routing and the project’s impacts potentially creating a need for street widenings in that area.</p>	<p>throughout the region and phase years, again according to typical project schedules for SANDAG-led bikeways. We appreciate that the City of Oceanside has developed some more specific cost estimates for certain project segments or has recommendations for a methodology to determine the costs of other project segments (which may have different alignments) as well. At this stage, the estimates we are providing are merely a first-step as any of these projects which are identified for inclusion in the Regional Transportation Improvement Program (RTIP) will receive a closer look and more specific coordination for budget estimation and the programming of appropriate funding to advance a project through the planning, design, and/or construction phases.</p>
L122	<p>5. The City requests that the following two projects be added to the Regional Plan:</p> <p>A. A connection between the west and east side of 1-5 at the SR-78 interchange for bicycle and pedestrian traffic. Under existing conditions, there is no safe access for bicyclists and pedestrians across 1-5 in this area.</p> <p>B. Bike infrastructure improvements on SR-76, as repeatedly requested by Caltrans and the City of Oceanside.</p>	<p>A. While this alignment is not in the Regional Bike Network, there are opportunities for the development of protected bike network via “Complete Streets in Mobility Hubs” funding, which is intended to fund retrofits to facilitate short trips of less than 3 miles in a safe and comfortable way to make it easier and more attractive to choose active transportation. This connection you’ve described falls within the Oceanside Mobility Hub.</p> <p>B. Parallel and in close proximity to this highway, the Regional Bike Network serves this corridor and destinations via the All Ages and Abilities existing facilities along the San Luis Rey River Trail which is proposed for extension as project AT113 specifically.</p>
L123	<p>The recommendations made in this section are the results of a conceptual community workshop on what might be considered, and the following recommendations mentioned in this appendix as</p> <p>a result of this workshop shall by no means be construed as the City of Oceanside’s official request and/or recommendations:</p> <ul style="list-style-type: none"> <li>• Oceanside Boulevard reduced to two lanes with protected bikeways.</li> <li>• The Strand closed to vehicle traffic and available only for bikes and pedestrians.</li> </ul>	<p>The Network Planning Workshop was considered an exploratory exercise and the summary memo includes the following language on page 9: “Disclaimer: The principles presented in this workshop are not intended to be fully developed policies, but rather inspiration for an integrated approach to safe and active mobility network solution. Similarly, the workshop outcomes included may not meet local practices and are not intended to be implemented networks, but rather conceptual prototypes to better understand the active transportation network process.”</p>
<b>City of Poway</b>		
L124	<p>Regarding Scripps Poway Parkway, the City of Poway would like to see vehicle, bike, pedestrian and transit infrastructure improvements and connections to be added from the Highway 67 through Scripps Poway Parkway to the I-15 Freeway. I have spoken to several property and business owners within the South Poway Business Park (SPBP) including Geico and parking is a constant issue. There is currently no public transit route into the SPBP. Having public transit, bike, pedestrian and highway/road improvements/connections providing better more efficient access to the SPBP is essential for future employment growth in the area. Many workers in the Poway area live in Ramona and East County and this is a vital connection for the City and the Region. SANDAG has also identified Scripps Poway as a Tier 3 employment center in their draft Employment Center analysis. Construction is also underway to add thousands of more employees in the SPBP. To be clear, we are recommending that Scripps Poway Parkway become a critical connection and a multimodal corridor (<a href="https://www.sandag.org/uploads/publicationid/publicationid_4720_28341.pdf">https://www.sandag.org/uploads/publicationid/publicationid_4720_28341.pdf</a>).</p>	<p>The San Vicente Comprehensive Multimodal Corridor Plan (CMCP) effort is currently underway. The CMCP will include a suite of solutions for consideration in future planning, implementation, and improvement activities along the corridor, including Highway 67 connections with Poway Road and Scripps Poway Road, respectively. The CMCP will include active transportation, clean transportation, transit, resilience and environment, right-of-way and utilities, equity, and evacuation considerations. The CMCP stakeholder working group includes representation from the City of Poway, which is intended to integrate jurisdictional priorities into the suite of solutions within the boundaries of the CMCP planning area.</p> <p>Your comment has been forwarded to San Diego Metropolitan Transit System (MTS).</p>
L125	<p>Regarding the Hwy 67, please note that the City of Poway’s General Plan Transportation Element includes a multi-use path on the west side of SR-67 (reference p. 3 <a href="http://docs.poway.org/weblink/0/doc/50446/Electronic.aspx">http://docs.poway.org/weblink/0/doc/50446/Electronic.aspx</a>). This multi-use path would include a separated two-way bike path and a fenced DG equestrian trail. The multi-use path provides a critical and safe pathway for hikers, bikers, runners, walkers, children, and equestrians. A multi-use path also creates a necessary loop between the City’s Iron Mountain trailhead and other destinations (e.g., Mt. Woodson, Lake Poway) which is also a goal within the Transportation Element. We recommend the San Vicente corridor plan is consistent with the City’s plans.</p>	<p>The San Vicente CMCP will consider all relevant and related plans and projects, in collaboration with City of Poway staff, to ensure there is cohesion and consistency between the CMCP and the communities within and adjacent to it, including active transportation considerations.</p>

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L126	State Route 67 is also designated as a scenic roadway by the Poway General Plan. As a part of the General Plan requirements, a 50-foot wide landscape open space easement is required from adjacent property owners from the ultimate right-of-way line along State Route 67 when development is proposed. This easement shall be landscaped and modified as needed to enhance the scenic quality of the area as discussed in the General Plan Transportation Element Policy B – Scenic Roadways. Providing scenic roadway elements to the design will also help the corridor be more compatible with surrounding open space. To contribute to the General Plan goals, we would suggest that the right-of-way incorporate design elements consistent with a scenic roadway (e.g., naturalized decorative solid walls, native landscaped medians and shoulders, additional landscape areas and trees where feasible, earthen berms).	The CMCP study identifies ways to improve roadway safety, enhance the urban-rural transportation interface (with special consideration given to limiting impacts on surrounding environmental habitats and wildlife), engage with tribal nations, and create greater trip reliability and efficiency throughout the study area while supporting climate action initiatives. The suite of solutions will include active transportation, clean transportation, transit, resilience and environment, right-of-way and utilities, equity, and evacuation considerations. The City of Poway is an integral member of the stakeholder working group and in the development of the CMCP.
L127	As discussed, a multi-modal transportation system provides users transportation options and choices and thereby reduces traffic congestion and GHG emissions. Regional multi-use paths have been a great asset to communities across the country. Here in San Diego, the SR-56 Bike Path is separated from the highway and is often used by runners, walkers, and equestrians. In contrast, it is uncommon to see bikers, walkers, and equestrians in a bike route adjacent to a highway (for instance, SR-76). A multi-use path is also kid friendly because of the separation from the highway and kids are often seen on the SR-56 Bike Path and not commonly seen within bike routes adjacent to a Highway. The multi-use path also accommodates a more rural aesthetic and is safer for users. Multi-use paths have become a critical component to the transportation system and are treasured by the communities they are a part of. The addition of the multi-use path along Hwy 67 is more consistent with the goals and policies of the 2050 RTP. We recommend the San Vicente corridor plan provides a separated mixed-use path throughout the full length of the corridor.	The San Vicente CMCP will consider all relevant and related plans and projects, in collaboration with City of Poway staff, to ensure there is cohesion and consistency between the CMCP and the communities within and adjacent to it, including active and multi-modal transportation considerations.
L128	Lastly, during the workshop portion for the Draft 2021 Regional Plan, workshops were provide by area (North, East, Central, etc.). Based on the mapped areas shown, Poway residents and community stakeholders were not represented as a part of any region and that outreach with appropriate comment period should be provided prior to moving forward with Draft. I'd be happy to assist you with what an appropriate outreach should be.	The virtual open house held on June 16, 2021 was titled County Unincorporated and included connections to adjacent cities, including Poway. In the future, we will be clearer about areas covered in each sub-regional workshop.

**City of San Diego**

L129	I am writing to express the City of San Diego's support for SANDAG's San Diego Forward: The 2021 Regional Plan (2021 Regional Plan). The 2021 Regional Plan is a major step towards reducing vehicle miles traveled by single occupant vehicles and greenhouse gas (GHG) emissions in the region by incorporating five transformational strategies which will be critical to enabling the City of San Diego to implement its Climate Action Plan. The City applauds SANDAG's commitment to making infrastructure and technological investments in the mobility system with a greater emphasis on accessibility, transit, bicycling, and walking as well as innovative and bold strategies to manage demand on regional roadways prioritizing safety and aligning with the City's commitments to Vision Zero. The City's General Plan is consistent with the 2021 Regional Plan as both focus on development within vibrant mixed-use village centers served by high frequency transit. The City supports the 2021 Regional Plan's intent to preserve open space from non-sustainable development. The City looks forward to closely working with SANDAG to implement the strategies described in the 2021 Regional Plan.	Thank you for your support of the 2021 Regional Plan. SANDAG looks forward to working closely with the City of San Diego to implement the strategies of the plan and achieve our shared goals.
L130	The City supports the 2021 Regional Plan's vision to improve the transportation network in the region especially the planning and implementation of a complete network of efficient, convenient, and reliable transit services that connect people from where they live to where they work or go to school. The development of a dynamic management system of traffic flow and transit services, facilities for bicycles, scooters, pedestrians, and flexible micro transit, offer an equitable approach to first and last-mile connections to transit, a vision zero strategy to address safety, and implementation of the City's Climate Action Plan.	SANDAG looks forward to collaborating with the City to implement the 2021 Regional Plan and support implementation of the City's Climate Action Plan.
L131	The City also supports the 2021 Regional Plan's development of mobility hubs throughout the region. As part of our land use planning efforts, the City is providing policies to support the implementation of mobility hubs as vibrant centers of activity where future housing and employment growth are connected by transit. The San Ysidro and Central mobility hubs are critical transportation facilities and having a direct connection to the U.S.-Mexico Border and San Diego International Airport is a vital step towards having a transit system that meets the needs of residents and visitors.	SANDAG sees the City as a key partner in developing mobility hubs, including the critical facilities at San Ysidro and the Central Mobility Hub.
L132	The City shares the 2021 Regional Plan's goal to provide better transit access and housing opportunities in employment centers. Over the past two years, the City has adopted updated Mission Valley and Kearny Mesa Community Plans to accommodate more housing and existing and future transit improvements in high employment centers. We are also in the process of updating our community plans for University and Mira Mesa (Sorrento Mesa) which include major high-tech and biotech employment centers. These plans focus additional housing opportunities along existing and planned transit lines needed to support continued economic prosperity. Downtown San Diego has experienced a high level of residential growth as well as a recent resurgence of employment growth. The success of future housing and job growth in these employment centers is predicated on the implementation of rail	SANDAG agrees that the City's work to update community plans have been critical to advancing goals of accommodating more housing near transit and employment centers. We look forward to working together on integrated land use and transportation solutions.



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	transit, managed lanes, and bicycle networks, and the technological improvements to our regional arterials. These investments into our infrastructure will also provide jobs for the region's skilled labor force.	
L133	The City strongly supports efforts to increase mobility options including the development of high frequency transit in communities of concern with increased transit infrastructure and service needed to provide convenient access to job centers. The City recommends that SANDAG identify the planning and engineering of the commuter rail (purple line) between San Ysidro and Sorrento Valley, separation of existing light rail at-grade crossings, dedicated and/or flex lanes for Rapid Bus routes within the City, as well as double tracking the LOSSAN corridor as shovel ready projects for future state and federal funding.	The 2021 Regional Plan includes the recommendations in this comment. SANDAG will continue to pursue state and federal funding for these projects.
L134	The San Ysidro and Barrio Logan communities are affected by truck emissions due to their proximity to the U.S.-Mexico border crossing and the Port of San Diego respectively. The 2021 Regional Plan addresses the needs for air, rail, and port goods movement and smarter border strategies to support trade and international commerce. The City supports San Diego Forward's goals and policies to reduced air pollution which are needed to meet federal air quality conformity requirements and improve some of our most underserved, low-income communities.	The 2021 Regional Plan includes strategies to reduce pollution exposure in disadvantaged communities. This analysis is attached to Appendix A of the proposed final 2021 Regional Plan.
L135	The City has a long history of planning together with SANDAG to creating a land use pattern and transportation network that facilitates greater mobility and increased connectivity between employment and housing. The City encourages SANDAG to continue funding the Smart Growth Implementation Program which provides needed grant funding for planning and capital projects that support the implementation of the Regional Plan. We have included additional recommendations attached to this letter for SANDAG's consideration and look forward to partnering with SANDAG on its new Housing Incentive Program to achieve the goals of the Regional Housing Needs Assessment Plan. We are committed and look forward to a continued partnership with SANDAG on the long-term implementation of the San Diego Forward: The 2021 Regional Plan.	The 2021 Regional Plan includes expanded funding for planning and capital grant programs for member agencies. SANDAG looks forward to partnering with the City on the Housing Incentive Program and other efforts to implement the Regional Plan.
L136	The City supports the planning and implementation of future rail projects identified in the 2021 Regional Plan. Appendix A, page A-15 on the note on the bottom of the page, please clarify if the purple commuter rail should be route 582 and not 581 as noted. Commuter rail route 581 as identified on page A-29, project TL-01 is Downtown to/from La Mesa projected to be in the 2050 transit network.	Thank you for this comment, this correction has been made.
L137	The future purple commuter rail connection would provide access for people throughout the communities within the southern and central portion of the City to employment centers in Kearny Mesa, University, and Sorrento Mesa. The City recommends considering alignment and station options that would serve the Mid-City communities and SDSU West at Mission Valley. We look forward to working with SANDAG in reviewing ridership information/forecasts based on different proposed alignments for the entire line including with and without stations serving the Mid-City communities and SDSU West.	SANDAG will be engaging with City staff during the advanced planning phase of the Purple Line which will finalize station locations and more ridership analysis.
L138	The City looks forward to working with SANDAG in evaluating options for grade separation of existing light rail at-grade crossings within the City.	Evaluating options for grade separations will be done in coordination with the City.
L139	The City recommends implementing near-term operational improvements such as the use of restriping for providing dedicated and/or flex lanes for Rapid Bus routes while planning for long-term capital improvements. We look forward to working with SANDAG in evaluating near-term and long-term options for dedicated and/or flex lanes for Bus Rapid routes.	SANDAG looks forward to working with the City to evaluate and implement dedicated and/or flex lanes for Rapid Bus routes. Many of the Rapid routes will be fully built in 2035 and 2050 as described in the tables in Appendix A, while some of the Rapid routes will be expedited to open sooner in 2025 with a "light version" (Phase 1). The light version of Rapid is meant to allow for a Rapid route to operate with minimal capital investment using existing bus stops. The full version of Rapid will build up the route's amenities with improved shelters, bus guideways, and/or other transit priority measures.
L140	The City recommends including the Via Las Cumbres/I-8 Interchange/Hotel Circle North & South/Fashion Valley Road project in the list of proposed projects in Appendix A. As a regionally significant project that provides freeway and active transportation connections to two light rail transit stations and the San Diego River Trail. This will support the recently adopted Mission Valley Community Plan which increasing housing opportunities near the existing light rail stations.	Interchange improvements along the I-8 corridor will be explored as part of the I-8 Comprehensive Multimodal Corridor Plan and during development of the I-8 Managed Lanes project. SANDAG will coordinate with the City on these efforts to ensure the needs of the Mission Valley community are met.
L141	While the City supports increasing the amount of Transit Priority Areas (TPAs), the City requests that the existing TPAs be maintained in the 2021 Regional Plan. The TPAs are a critical part of the City planning process for future development to help meet out Climate Action Plan goals for the reduction of vehicle miles traveled. Maintaining future transit routes and the TPAs provides consistency in our land use and mobility planning efforts.	The 2021 Regional Plan expands Transit Priority Areas (TPAs) and includes Mobility Hub areas that align with TPAs to facilitate future development that supports Climate Action Plan goals.
<b>City of Solana Beach</b>		
L142	· Mobility Hubs – Page 19 of Chapter 2 of the Draft Plan, the Sustainable Communities Strategy (SCS), describes planned "Mobility Hubs" as areas or communities in the region with "a high concentration of people, destinations, and travel choices" that "offer on-demand travel options and supporting infrastructure that enhance connections to high-quality Transit Leap services." While the SCS seems to acknowledge that these Mobility Hubs can vary both in size and transit	A map and descriptions of the five different Mobility Hub types has been added to the proposed final 2021 Regional Plan.

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	<p>availability and can “span one, two or a few miles based on community characteristics,” the SCS and the Draft Plan do not separately categorize or discuss these Mobility Hubs based on these unique characteristics despite having done so previously as well as in Appendix T (Network Development and Performance). Pages 15 through 18 of Appendix T of the Draft Plan – Network Development and Performance – contains a Propensity Analysis for both Transit Leap Services and Mobility Hubs. These analyses identified which transit routes were most likely to meet the needs of transit riders now and in the future and which communities were most suitable for Mobility Hubs. While it should be noted that Solana Beach ranked at the lower end of both (see Figures 12 and 14), these analyses resulted in the apparent establishment of five (5) distinctive types of Mobility Hubs – Coastal, Gateway, Major Employment Center, Suburban and Urban Core – with Solana Beach identified in Figure 15 as a Coastal Mobility Hub. However, the SCS contains no meaningful discussion of these distinctive and unique Mobility Hub areas referring to them only in Figure 2.5 of the SCS where projected future growth is illustrated. The dramatic difference in projected future growth for each of these distinct Mobility Hub Areas, with Coastal Mobility Hubs well below the other four Mobility Hub Areas in both the percentage of future housing and future jobs (5% and 2%, respectively), clearly demonstrates their uniqueness with respect to jobs, housing and access to high-quality transit and the extent to which each area should be relied upon (or not) to satisfy the region’s future growth.</p> <p>The adopted 2021 Regional Transportation Plan (Adopted Plan) and the SCS should contain a detailed discussion of the five (5) Mobility Hub Areas and a description of the unique characteristics and transit needs for each – both now and in the future.</p>	
L143	<p>Additionally, by virtue of the fact that the Solana Beach Train Station is within 2 ½ miles of the cities of Del Mar, Encinitas and San Diego and the County of San Diego, this regional Coastal Mobility Hub Area in the Adopted Plan should, for purposes of planning for future housing and job growth, extend into and cover the City of Del Mar and the Del Mar Fairgrounds and areas of the cities of Encinitas and San Diego and the County of San Diego immediately adjacent to Solana Beach.</p>	<p>The coverage area of each regional Mobility Hub is based on a data-informed propensity analysis carried out in parallel with Transit Leap routing assessment. The analysis leveraged Census Block Group geographies to assess which areas were most conducive to hubs based on factors including current and forecasted population and jobs, proximity to major destinations, community of concern coverage, levels of short trip-making, etc.</p> <p>While these regional Mobility Hub coverage areas have been used to model the impact Transit Leap and Flexible Fleet trips to/from these hubs have on reducing vehicle miles traveled, they do not restrict Flexible Fleets from serving neighborhoods that may be between or beyond hubs. Some Flexible Fleet services operating within regional hubs will also need to reach outlying destinations like the set of beach and shopping communities cited in this comment. There will be many opportunities for Flexible Fleets to connect to Transit Leap stops located along routes in between hubs. The same applies to improvements on Complete Corridor arterials (e.g., Lomas Santa Fe, Via de la Valle) connecting to and from hubs.</p> <p>As SANDAG collaborates with cities on Regional Plan project and policy implementation in the years to come, conceptual mobility hub boundaries will be refined while taking into consideration city corridor and land use planning goals and policies, similar to what has already begun as part of the Comprehensive Multimodal Corridor Plans (CMCP) planning and design process. More detailed network-level analysis will be needed within each Mobility Hub to finalize detailed Transit Leap routing, Complete Corridor cross-sections, Flexible Fleet pilots, and supporting technologies.</p>
L144	<p>Transit Leap Services – As noted above, the Propensity Analysis discussed in Appendix T for both Transit Leap Services and Mobility Hubs determined that Solana Beach and its Train Station were at the lower end in the region both in meeting the needs of transit riders now and in the future and for suitability as a Mobility Hub. While the City acknowledges that the presence of the Train Station in Solana Beach might make it reasonable to include as a potential future Mobility Hub in the Adopted Plan, during the recent Regional Housing Needs Assessment (RHNA) allocation process, the City also made it clear that, both now and in the near term, the Train Station does not currently provide adequate Coaster or Amtrak headways, nor does it provide meaningful connections to other transit services to be considered a Mobility Hub now. Indeed, despite the North County Transit District (NCTD) Board recently voting to increase Coaster service beginning in October 2021, such a designation is still largely aspirational. While, again, the City acknowledges that the Draft Plan and the Adopted Plan are just that – a plan for the future – Appendix A of the Draft Plan – Transportation Projects, Programs, and Phasing – appears to support this position. Table A.5 (Interstate 5 North Coastal Corridor) identifies one Transit Leap project (TL40) – Rapid 473 – for implementation in the year 2035. Similarly, Table A.9 (State Route 56) identifies one Transit Leap project (TL026) – Rapid 103 – for implementation in the year 2050. These 15 to 30-year forward-looking Transit Leap projects, while helpful for the future, do not appear to satisfy the near-term objectives of a Coastal Mobility Hub.</p> <p>In order to justify the designation of the Solana Beach Train Station as a Coastal Mobility Hub, both now and in the future, more immediate Transit Leap service connections should be considered for inclusion in the Adopted Plan.</p>	<p>Flexible Fleets are envisioned to not only provide connections to existing and future Transit Leap services but also supply seamless on-demand travel options to and from regional mobility hub areas in the near-term. Given NCTD’s interest in transitioning some BREEZE bus routes to a more on-demand service model, there will be opportunities to pilot a variety of pooled ride and micromobility options prior to longer-term Transit Leap investments. Rapid 473 is slated to be implemented as soon as 2029, and the 103 in 2040 (2029 and 2040 are Air Quality Conformity phase years).</p>

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L145	<p>Appendix B: Implementation Actions – Appendix B provides detail on commitments and key actions to implement elements and strategies of the Draft Plan. Key to this objective is the involvement of and coordination with each member agency as they are most knowledgeable of the needs of their respective communities. Indeed, Near-term Implementation Action No. 2 in Table B.1 identifies the need to partner with local governments to develop five initial Comprehensive Multimodal Corridor Plans (CMCPs). Therefore, the City requests that the following minor edits to Appendix B (page 16) under “Land Use and Regional Growth” be included:</p> <p>“The 2021 Regional Plan vision for land use focuses on development and growth in Mobility Hub areas urbanized areas near jobs to preserve San Diego’s open space and support transportation investments by reducing vehicle miles traveled (VMT). Mobility Hubs are an opportunity to provide housing to address the Regional Housing Needs Assessment. Land use authority is reserved to local jurisdictions because they are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan through understanding of the unique needs of their communities and geographies. Because land use authority is reserved to local jurisdictions, SANDAG will leverage partnerships with cities and the county through the Smart Growth Incentive Program and other grants to provide funds for transportation-related improvements and planning efforts that support smart growth in Mobility Hubs to realize this their vision for their communities. SANDAG will continue its existing grant programs, partner with member agencies on state funding opportunities, and provide data and technical support to assist local jurisdictions with land use planning efforts in line with the 2021 Regional Plan.”</p>	<p>The proposed final 2021 Regional Plan includes similar edits to Appendix B that acknowledge the importance of coordination with each member agency on land use and regional growth given that land use authority is reserved to local jurisdictions.</p>
L146	<p>Regional Housing Needs Assessment – Following adoption of the Draft RHNA allocation by the SANDAG Board in September 2020, appeals of the allocation were filed by the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach. In order that these appeals are correctly noted for the record, there are two locations in the Draft Plan to which a clarifying footnote and additional language should be added to the Adopted Plan. Specifically, the City requests the following for the Adopted Plan:</p> <p>On page 33 of the Draft Plan, after the sentence: “The SANDAG Board of Directors adopted the RHNA Plan on July 10, 2020, with the final housing unit allocation” the following footnote should be added:</p> <p>*In September 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court challenging, among other things, the Board’s adoption of the RHNA Plan. SANDAG demurred to the cities’ Petition and the demurrer was sustained by the court in February 2021. The petitioning cities have appealed the ruling on the demurrer to their Writ Petition, and that appeal remains pending in the Fourth District Court of Appeal.</p> <p>On page 14 of Appendix K (Regional Housing Needs Assessment Plan), the following paragraph should be added to the end of this page/section:</p> <p>On September 24, 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court, Case No. 37-2020-00033974-CU-MC-CTL, against SANDAG and SANDAG’s Board of Directors seeking an order requiring that SANDAG give those cities a fair hearing on their RHNA appeals and decide the cities’ appeals in a legal manner without bias and without the use of the weighted voting mechanism. Specifically, the petitioning cities asked the court to order: (1) that the final RHNA allocation approval by SANDAG be rescinded; (2) that SANDAG’s denial of the cities’ RHNA appeals be rescinded; (3) that the appeals be remanded to SANDAG for fair consideration; and (4) that SANDAG be prohibited from utilizing a weighted vote on the cities’ RHNA appeals. On February 5, 2021, SANDAG’s demurrer to the Petition for Writ of Mandate was sustained by the Superior Court. The petitioning cities have appealed the ruling on the demurrer to their Writ Petition. That appeal remains pending in the Fourth District Court of Appeal. So long as the litigation is pending, the Board’s adoption of the RHNA Plan cannot be considered final.</p>	<p>Similar language has been added to the introductory pages of Appendix K, Regional Housing Needs Assessment Plan.</p>
<p><b>Cleveland National Forest Foundation/Save Our Forest and Ranchlands</b></p>		
L147	<p>Therefore, SOFAR and CNFF urge the SANDAG Board of Directors to include a Climate, Housing, Transit Alternative in the 2021 RTP update—an alternative focused on meeting both the housing needs and greenhouse gas (“GHG”) reduction goals for a qualified land use area that have been set collectively by the State of California, the City of San Diego, and SANDAG:</p> <ul style="list-style-type: none"> <li>• 40% reduction in GHG below 1990 levels by 2030 (California AB 32 and SB 32)</li> <li>• 80% reduction in GHG below 1990 levels by 2050 (Governors Schwarzenegger and Brown)</li> <li>• 25% reduction in per capita GHG from passenger cars and trucks relative to 2005 by 2035 (California SB 375; California</li> </ul>	<p>The 2021 Regional Plan aligns with many of the elements of the Climate, Housing, Transit Alternative while meeting all legal requirements of the Regional Plan. As the 2021 Regional Plan is implemented, SANDAG looks forward to continuing to advance efforts related to climate, housing, and transit. Section 6.5.5 of the Draft EIR presents reasons why the Climate, Housing, and Transit Alternative was not evaluated in detail in the EIR. The 2021 Regional Plan proposes a land use scenario that accommodates the Regional Housing Needs Assessment and, when combined with the transportation system, allows the region to meet its SB 375 greenhouse gas reduction target. Analysis of the 2021 Regional Plan’s consistency with other California</p>

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	<p>Air Resources Control Board1)                      • 14.3% reduction in total daily VMT per capita, and 16.8% reduction in total light-duty VMT per capita, relative to 2015-2018 average by 2050 (California Air Resources Board)2                      • 50% transit, walk and bike mode share for commuters within ½ mile of a major transit stop in City of San Diego by 2035 (Climate Action Plan, City of San Diego)3                      • 150% increase in transit mode share (SANDAG’s Urban Area Transit Study)4                      • Adequately plan to meet the housing needs of everyone in the community (California)5                      • SB 743 VMT reduction goals</p> <p>Meeting these goals is not only reasonable, but also urgently required if we are going to solve some of the unrelenting challenges faced by residents of San Diego. Indeed, SANDAG’s prior RTP was found to be deficient for failing to discuss an alternative which could significantly reduce total vehicle miles traveled (“VMT”) (Cleveland National Forest Foundation v. San Diego Association of Governments. (17 Cal. App. 5th 413, 435-437 (2017))). Heretofore, the San Diego region has met these challenges with clever words, not deeds. These goals are achievable only if land use and transportation are addressed together.</p> <p>These synergies are recognized in SANDAG’s Urban Area Transit Strategy and the City of San Diego’s General Plan Housing Element which includes this goal:                      Ensure the provision of sufficient housing for all income groups to accommodate San Diego’s anticipated share of regional growth ...in a manner consistent with the development pattern of the Sustainable Communities Strategy (SCS), that will help meet regional GHG targets by improving transportation and land use coordination and jobs/housing balance, creating more transit-oriented, compact and walkable communities, providing more housing capacity for all income levels, and protecting resource areas.6</p> <p>The Climate, Housing, Transit Alternative would pick up where SANDAG’s Urban Area Transit Strategy left off in 2011.</p>	<p>greenhouse gas reduction goals as well as an analysis of alternatives to the proposed 2021 Regional Plan are included in the Draft EIR for the Regional Plan.</p>
L148	<p>Real estate developers and their allies are currently pressuring San Diego County to retain its unlawful and inaccurate thresholds for assessing VMT impacts under SB 743, claiming that mitigation for VMT impacts will make housing in more remote parts of the County unaffordable. But housing in these areas is already unaffordable when transportation costs—that is, costs of driving long distances from locations not served by transit—are taken into account. SANDAG can help facilitate a better approach through the RTP, one that encourages the County to plan for housing in areas where transportation costs are low rather than allowing developers to build in remote areas and then trying to “mitigate” for the resulting VMT.</p> <p>The answer to housing affordability is H+T affordability. It is building more housing in the H+T affordable light-colored areas and in expanding the supply of H+T affordable areas through increased transit service.</p>	<p>The area’s indicated in the figure provided are well-aligned with the mobility hub areas identified in the 2021 Regional Plan. While land use authority is reserved to local jurisdictions, the 18 cities and the County, SANDAG will work closely with jurisdictions to incentivize building of housing in the mobility hub areas. In coordination with the development of the proposed 2021 Regional Plan, SANDAG will embark on developing a housing incentive program, which will support jurisdictions in the development and adoption of policies and process improvements to accelerate housing production. The program will also look for ways to leverage funding from the State of California to provide more housing in the region and meet the goals of the 2021 Regional Plan.</p>
L149	<p>...In the past, the housing allocations have been aspirational but not enforced. The State has signaled that it plans to be more aggressive about enforcement during this cycle. SANDAG can help the municipalities achieve their housing goals by shifting all transportation spending towards transit and non-motorized (walk and bike) infrastructure. These investments, which will facilitate getting people out of the cars, will also help the region increase density without large impacts on neighborhoods.</p>	<p>SANDAG is developing a Regional Housing Incentive Program to meet the goals of the 2021 Regional Plan and assist local jurisdictions in achieving housing goals. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, and consider climate change and resiliency, availability of transit and active transportation, and consistency with the transportation improvements included in the Regional Plan. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
L150	<p>The recently-completed study concludes that the Miramar tunnel and rail line straightening would add a critical link to the LOSSAN rail corridor. See Exhibit #1 (Miramar Tunnel Feasibility Study).Critically, it finds that the feasibility criteria for the Miramar tunnel have been satisfied. Its specific findings include the following:</p> <ol style="list-style-type: none"> <li>1. The project would increase discretionary passengers by 1,300 to 1,700 per day, thereby reducing annual VMT 200 million to 240 million miles and GHG by 70,000 to 84,000 tons.</li> <li>2. The project would provide competitive travel times, including a transit system average clock time that is approximately 3% faster than the automobile.</li> <li>3. The project would be cost competitive, with transit riders cost at \$180/month versus automobile costs of \$507/month.</li> <li>4. The project has no fatal engineering flaws.</li> </ol> <p>The study further acknowledges a prior federal study that found construction of the Miramar tunnel along with other corridor improvements would reduce travel time between San Diego and Los Angeles to two hours. In short, construction of the new tunnel, which would provide enhanced access to downtown and the airport, would be a key transportation improvement for the region and the state. As the study notes, the LOSSAN rail corridor— together with the I-5 freeway – is the second-most traveled route in North America. The Miramar tunnel must be considered a key component of the Climate, Housing, Transit Alternative.</p>	<p>The Miramar tunnel is identified in the 2021 Regional Plan to support improvements to the Coaster and new commuter rail service.</p>
L151	<p>At the next level is a network of higher-speed, high frequency transit lines with separate rights of way and fewer stops. In many regions, a light rail service fills this niche, but in the San Diego region the Trolley has not filled this niche well. It</p>	<p>The 2021 Regional Plan proposes new commuter rail service and upgrades to existing light rail service, including grade separations and eliminating stops for express service.</p>



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	operates too slowly and service is not frequent enough. Improvements are needed in both these dimensions. Achieving the required level of service in this higher-speed tier will require a rethinking of the system. As part of the Climate, Housing, Transit Alternative, SANDAG should evaluate speeding up the existing lines through grade separations and eliminating stops, as well as creating new higher-speed lines.	
L152	Both the regional rail and higher-speed high-frequency tiers need to be well connected. The Climate, Housing, Transit Alternative must include an inter-modal terminal (Grand Central) connecting San Diego’s urban core, the Airport, the LOSSAN corridor, the Sprinter corridor, and the Trolley system.	The 2021 Regional Plan proposes a Central Mobility Hub to connect the urban core, the Airport, the LOSSAN corridor, Trolley system, and many bus routes.
L153	The Climate, Housing, Transit Alternative must also include efficient connections with frequent local buses (which could possibly be automated in the future). To this end, SANDAG must grapple with the first mile/last mile issue as this reflects a failure in land use and the existing transit system. While higher income travelers may have a choice of Uber-type services to solve this problem, this should not be viewed as a remedy for the average traveler.	The 2021 Regional Plan proposes an expanded network of Rapid buses and improvements to the local bus system to facilitate more frequent and longer spans of service. The proposed investments in Flexible Fleets will allow for more options to facilitate first mile/last mile connections to transit with solutions that can be customized for different communities (microtransit, ridesharing, bikeshare, etc.).
L154	Finally, the goal of a functional transit system is to serve an area-complete bike and walkable land use because no trip begins or ends on a transit vehicle. Most transit trips begin and end with a walk trip. In regions with high transit use, there are generally about twice as many walk trips as transit trips. Investments in walk and bike infrastructure should be a top priority. Consistent with the City’s Climate Action Plan, the Climate, Housing, Transit Alternative must model a 50% transit, walk and bike mode share for residents in the central core.	The 2021 Regional Plan proposes a land use pattern that focuses growth in the mobility hubs to align with transportation investments and facilitate more bikable and walkable communities. SANDAG is working closely with the City of San Diego to ensure the 2021 Regional Plan complements the City’s efforts to achieve the mode share goals of its Climate Action Plan.
L155	<p>Building a real regional transit network will require all the region’s transportation investment dollars for the foreseeable future. The Climate, Housing, Transit Alternative must not include any freeway expansion.</p> <p>The billions of dollars spent on freeway expansion the past 20 years have A) failed to reduce congestion, B) caused a substantial increase in VMT and GHG emissions, and C) resulted in a severe housing shortage. The transportation models used to justify these freeway expansion projects have been wrong on all counts. These models - both in the San Diego region and in regions throughout the U.S. – forecast dire increases in travel time if freeways are not widened, and substantial increases in travel time even if they are widened. In fact, as shown in Figure 9 (see attached letter for figures), travel time has stayed remarkably constant in the U.S. for decades. Figure 9 shows the “average time spent driving a private vehicle in a typical day.” There was an increase during the 1990s, a time when many women were joining the labor force, but since 2000 there has been little change. Time spent driving also is very similar across differently sized regions. There is evidence that people have a “travel time budget”. If travel speeds drop, they (on average) will adapt to travel a shorter distance. In contrast, if travel speeds increase, people (on average) will travel longer distances. This phenomenon is known as “induced travel”. In work for the California Air Resources Board (“CARB”), researchers at the University of California and the University of Southern California reviewed the literature on induced travel and concluded: Thus, the best estimate for the long-run effect of highway capacity on VMT is an elasticity close to 1.0, implying that in congested metropolitan areas, adding new capacity to the existing system of limited-access highways is unlikely to reduce congestion or associated GHG in the long-run. The SANDAG regional transportation model fails to account properly for induced travel although there now are newer algorithms that could address this deficiency. Senate Bill 743 establishes VMT as the appropriate metric for determining the impacts of transportation projects. This has made properly accounting for induced VMT critical in the regulatory process. The Office of Planning and Research’s (“OPR”) Technical Advisory on Evaluating Transportation Impacts in CEQA recommends: Whenever employing a travel demand model to assess induced vehicle travel, any limitation or known lack of sensitivity in the analysis that might cause substantial errors in the VMT estimate (for example, model insensitivity to one of the components of induced VMT described above) should be disclosed and characterized, and a description should be provided on how it could influence the analysis results. A discussion of the potential error or bias should be carried into analyses that rely on the VMT analysis, such as greenhouse gas emissions, air quality, energy, and noise. The National Center for Sustainable Transportation at the University of California at Davis has produced an Induced Travel Calculator to help address the deficiencies in the models. Recently, Caltrans also has issued new draft guidance on accounting for induced travel. It recommends following the OPR recommendations: Caltrans recommends using the VMT analysis approaches recommended in OPR’s advisory when evaluating the transportation impacts of projects on the State Highway System (SHS). Neither expanding freeways nor not expanding freeways will have any effect on regional congestion or average travel times. However, expanding freeways will cause significant increases in VMT and GHG emissions, and will continue to starve the transit system of needed investments.</p>	Appendix D of the 2021 Regional Plan includes an induced demand analysis (as required by the California Air Resources Board) to be factored into estimated 2035 greenhouse gas emissions. This analysis utilized the Induced Demand Calculator referenced in the comment.

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L156	<p>Given that transit in the San Diego region has been and continues to be severely under-funded and under-built compared to roadway projects, as discussed above, the Climate, Housing, Transit Alternative must exclude roadway/freeway funding and expansion. Heretofore, SANDAG's planning has arbitrarily segmented freeway and transit projects. This artificial segmentation is not only irrational, it is fatal in achieving sustainable housing goals because transit, bike, and walk mobility and auto-based mobility serve contradictory land use purposes. SANDAG's failure to historically recognize this fundamental truth is the Achilles heel of its planning and lies at the doorstep of the agency's on-going inability to deliver a plan that truly unites our community on an ecologically sustainable foundation. It is abundantly clear that SANDAG's past planning efforts have not only been deficient but have repeatedly failed to heed the ominous warnings from the courts, the public, and the planet itself. With California literally on fire due largely to climate change induced drought and high temperatures, SANDAG has failed the public by not aggressively pursuing a transportation scenario that would meet the State's GHG and VMT reduction goals. The Climate, Housing, Transportation Alternative would help achieve targets set in legislation, the California Air Resources Board's Climate Change Scoping Plan, and relevant Executive Orders.</p> <p>Similarly, with regard to the local housing crisis, it is inconceivable that SANDAG's prior RTPs have not called for a 50% transit, bike, and walk mode share alternative necessary to activate infill housing, especially since the urban core is already zoned for such housing. Here too, the Climate, Housing, Transit Alternative would facilitate this infill housing and help the City of San Diego achieve the targets set forth in its Climate Action Plan.</p> <p>Additionally, the County's continued business-as-usual approach to planning makes the need for SANDAG to strengthen guidance regarding future development in the region all the more pressing. In spite of all the talk of a new direction, the County recently unveiled a plan update for the forest community of Alpine which can only be described as a VMT and ecosystem catastrophe. This planning contradiction was noted in Shute Mihaly's comment letter on the Alpine plan. The tectonic shift in regional transit mobility mentioned in the opening paragraph of this letter must become a reality soon to avoid irreversible damage to our wild lands and a missed opportunity for the region.</p> <p>Faced with these pressing social and environmental challenges, SANDAG's new regional direction can be strengthened by following established judicial, executive, and local legislative guidelines designed to meet the housing and climate crises. The public urgently deserves to see what it would take for the region to build a world-class transit system and to develop reasonably priced infill housing. Common sense dictates that the Climate, Housing, Transit Alternative would necessarily begin with a complete, first phase transit, bike, and walk system with an inter-modal terminal connecting the Airport, the Central Core, the LOSSAN Corridor, the Sprinter corridor, and the Trolley system. It is important to note that the Climate, Housing, Transit Alternative would not only be the "environmentally superior alternative", it would also be the socio-economic superior alternative because a true transit, bike and walk system reduces both the cost and shortage of housing and the cost of driving.</p> <p>In conclusion, in the face of a severe, entrenched housing crisis endangering the public welfare and the severe climate crisis endangering the planet, SANDAG owes the public nothing less than a transit alternative that immediately meets these life threatening challenges rather than artificially prolonging them.</p>	<p>The 2021 Regional Plan aligns with many of the elements of the Climate, Housing, Transit Alternative while meeting all legal requirements of the Regional Plan. As the 2021 Regional Plan is implemented, SANDAG looks forward to continuing to advance efforts related to climate, housing, and transit. Section 6.5.5 of the Draft EIR presents reasons why the Climate, Housing, and Transit Alternative was not evaluated in detail in the EIR.</p>
<b>Climate Action Campaign</b>		
L157	<p>Transportation accounts for nearly half of the region's emissions. To remain on track to achieve carbon neutrality, as climate science says is necessary, SANDAG must go further in exceeding CARB's target. We believe a reduction from transportation by at least 30% by 2035 is achievable and needed to ensure a climate-safe Zero Carbon future, and urge SANDAG to map out the strategies needed to achieve that target.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
L158	<p>Page A-51 of Appendix A proposes "subsidies to reduce the fares paid by transit riders." Appendix A should be amended to include an explicit commitment to Youth Opportunity Passes (YOP)—no-cost transit passes for youth 24 and under—and should be implemented immediately following the adoption of the 2021 Regional Plan. SANDAG should also commit to overseeing YOP in partnership with MTS and NCTD, to ensure successful implementation by the local transit operating agencies.</p> <p>Community based organizations have been fighting for YOP for nearly a decade, as it is an essential investment in our region's youth, providing access to education and early career opportunities, while fostering the next generation of sustainable transportation riders.<sup>3</sup></p> <p>We urge you to make YOP a top priority in the 2021 Regional Plan.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
L159	<p>Attachment 6 of Appendix T (Network Development and Performance), includes the "Performance Measure Results Tables." Page T6-6 includes mode share projections for the 2021 Regional Plan for the benchmark years 2025, 2035, and 2050 for peak period work trips, all day work trips, and all trips.<sup>4</sup></p>	<p>SANDAG has provided the requested data to Climate Action Campaign.</p>



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	<p>We request this same set of projections, but specifically for Transit Priority Areas, to be able to compare Climate Action Plan’s mode shift targets with the mode shift that will be achieved through the buildout of the plan.</p> <p>For example, the City of San Diego’s Climate Action Plan (CAP) set ambitious targets for the percentage of commuters travelling by bike, walk, and transit in Transit Priority Areas (18% by bike, 7% by walk, and 25% by transit by 2035)5, and we want to ensure our regional transportation goals and local transportation targets are meaningfully aligned.</p>	
L160	<p>To maximize mode shift away from fossil fuel cars and towards bike, walk, and transit, Transit Leap timelines must be expedited, and prioritized in the early years of the plan over Managed Lanes and Managed Lane Connector, which will yield an increase in vehicle miles travelled.</p> <p>Investments in commuter rail, light rail, and bus rapid transit infrastructure should be prioritized in Communities of Concern, to increase access to sustainable mobility options and connections to the region’s job centers. The climate crisis and environmental injustice have and will impact Communities of Concern first and worst. Historically underinvested communities are exposed to the region’s most dangerously polluted air from cars and trucks, and are left with disconnected transit trips or long, expensive car commutes. As such, we support the inclusion of “Social Equity Early Action Transit Pilots” as a mechanism to streamline immediate investments in the communities on the frontlines of these crises.</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
L161	<p>Page A-26 of Appendix A states that the Del Mar tunnel will be complete by 2035. Currently, the 1.6 mile stretch of LOSSAN tracks in Del Mar is located dangerously close to the edge of the bluffs, and several bluff failures within feet of the tracks have occurred over the past 2 years alone.</p> <p>With the bluffs eroding at approximately 6 inches per year, and the ever-intensifying threat of sea-level rise due to the climate crisis, these incredibly dangerous bluff failures will only increase in severity and frequency, putting lives seriously at risk.</p> <p>Moving the tracks off the bluffs is essential to securing a long-term solution for the LOSSAN corridor, while preventing increased air pollution from shipping trucks, and ensuring economic prosperity for the region. To secure a climate-safe transportation system, we urge you to make the Del Mar tunnel a top priority, and urge for completion as soon as possible, no later than 2025-2030.</p>	<p>The Del Mar tunnel is a top priority for SANDAG. Planning work is underway with preliminary engineering and environmental phase expected to begin as soon as 2022 if funding is secured. SANDAG reviewed the timelines of other similar tunnel projects throughout North America and the 12 to 15 year timeframe is consistent with industry best practices. The 2021 Regional Plan identifies funding to kick start the environmental, design, and right-of-way phases of the Del Mar Tunnel project by 2025 with construction funding in the 2035 phase.</p>
<b>Columbus Club of San Diego, Inc.</b>		
L162	<p>Thank you for providing the public and businesses with the opportunity to comment on the draft Regional Plan. Our banquet hall is located in the City Heights community adjacent to the Webster neighborhood and along the Auburn Creek tributary of the Chollas Creek. We have been in business at this location for more than 50 years.</p> <p>The list of priority projects for our District 9 and District 4 service area are as follows:</p> <p>1. Extension of the Home Avenue Route to Market Street for Pedestrians, Bicycles and Vehicles. The Home / Market connection would provide significant economic development stimulus to the Mt. Hope and City Heights areas. It would assist in congestion relief by providing an alternate to freeway traffic on the SR 94. The Home / Market connection was originally planned but delayed for racially motivated reasons. Decades ago the 94 Freeway was the Color Line barrier. The Home/ Market connection would reknit neighborhoods that were separated by the installation of the SR94 Martin Luther King Freeway.</p>	<p>While Home Avenue is not on the Adopted Regional Bike Network, we have included the nearby and parallel Chollas Creek Bikeways: North Fork - Bayshore Bikeway to University Bikeway and South Fork - Petway Park to Market Creek Plaza in the Regional Plan which will help improve some of the connections you’ve described. The project alignment and details can specifically be found in the updated data viewer and Appendix A’s tables and maps for quick reference in the forthcoming Final Regional Transportation Plan that will be presented to the SANDAG Board of Directors for adoption this fall.</p> <p>Your comment was forwarded to the City of San Diego.</p>
L163	<p>2. Completion of the Bus Stop &amp; Pedestrian Sidewalk System on Home Avenue-East of Fairmount Avenue. Sidewalks are generally absent on the North side of Home Avenue, East of Fairmount Avenue. Pedestrians must walk in the street and are exposed to dangerous high-speed traffic. Curbs are not marked for safety and to assist the proper parking, traffic movements, and access for Buses and the Disabled. The Bicycle route is not painted and warning ramps for the visually impaired are often not in place. Please fund and work with adjacent property owners to install enhanced bus shelters and amenities, along Routes 13 and 965. Bulbing, out at key intersections, should be funded to increase pedestrian crossing safety. Please consider installation of pedestrian safety sidewalk and street lighting along Home Avenue and Fairmont. Installation of better lighting would enhance safety and could tie the neighborhoods together into a more friendly and effective neighborhood</p>	<p>We encourage you to be involved with the in-progress CMCP for this area - the South Bay to Sorrento Corridor here: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=611&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=611&amp;fuseaction=projects.detail</a>.</p> <p>The City of San Diego and Metropolitan Transit System are collaborating on that effort too and are the implementing agencies for these improvements you’ve requested. That said, our plan is a plan for the whole region, and our efforts are regional.</p> <p>Your comment was forwarded to the City of San Diego.</p>
L164	<p>3. Undersized Auburn Creek under crossings. Please fund the correction of undersized flood water under crossings at Fairmont and Federal Boulevards. The under crossings are no longer the proper size to carry the flood condition flows along Auburn Creek; because the creek has been channelized and the permeable storm water area fully developed. The</p>	<p>SANDAG consider stormwater, or urban runoff during the project development process and partners with regional transportation infrastructure owners and operators to manage stormwater from roads and highways in the region. For more information on stormwater, please see Appendix R of the 2021 Regional Plan. In</p>

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	storm water collection conduits from adjacent streets are galvanized corrugated tubing that is aging and conducts storm water directly into this listed impaired waterway and the Bay.	<p>addition, the crossings referenced in the comment above fall within the City of San Diego's jurisdiction. This comment will be forwarded onto the City of San Diego's Stormwater Department.</p> <p>Your comment was forwarded to the City of San Diego.</p>
<b>County of San Diego</b>		
L165	Land use and transportation planning in the San Diego region is evolving to better address the most pressing issues of today, including climate change, quality of life, attainable housing, and social and economic inequities. The County has several planning efforts underway which prioritize addressing these issues, including the Regional Decarbonization Framework, the Climate Action Plan Update, the Electric Vehicle Roadmap, Office of Environmental and Climate Justice, and establishment of VMT thresholds. While independent of the Regional Plan, these efforts are aligned with the goals of the Regional Plan. County staff is interested in further understanding the regional growth modeling assumptions used within the Regional Plan and alignment with these County efforts.	SANDAG looks forward to continuing coordination with the County on planning efforts that align with the 2021 Regional plan, including the Regional Decarbonization Framework, Climate Action Plan Update, Electric Vehicle Roadmap, Office of Environmental and Climate Justice, and establishment of VMT thresholds.
L166	The County represents more than 500,000 residents who live within 34 unincorporated communities throughout the region. County staff would like to better understand how the Regional Plan will address transportation options outside of proposed mobility hubs for those communities. The unincorporated community of Ramona, for example, has a population of 36,000 residents, which is a larger population than the incorporated communities of Imperial Beach, Lemon Grove, Coronado, Solana Beach, and Del Mar.	While certain types of Flexible Fleets are envisioned to converge in more dense communities (e.g., micromobility, last-mile delivery), there are also Flexible Fleet services that operate outside of Mobility Hubs including unincorporated communities. These services may include on-demand rideshare, ridehail, carshare, and microtransit services. As an implementation action of the 2021 Regional Plan, SANDAG is conducting a Flexible Fleets Implementation Strategic Plan to determine the appropriate use cases and geographic locations that are best appropriate for Flexible Fleet services including unincorporated communities of the County of San Diego. In addition, the 2021 Regional Plan includes investments in broadband connectivity that will facilitate improved access to online services and on-demand mobility services.
L167	Less than 1% of the unincorporated area is within the proposed mobility hubs, which is where transit and on-demand travel infrastructure investment will be focused. The unincorporated north and east county communities represent a significant population with higher-than-average VMT in the region. Investment in public transit and other transportation options will make it easier for people to drive less, which results in decreased GHG emissions. However, investment outside of mobility hubs appears to be limited, which would make it difficult for unincorporated residents to use new transit service.	Investments in the 2021 Regional Plan for unincorporated communities include improvements to local bus service (increased frequencies and span of service) and Flexible Fleet services. Additional detail on the improvements to local bus service has been added to Appendix A. In addition, the investments in the mobility hubs also serve residents of the unincorporated area as many residents live near a mobility hub and will be able to access the transit system within a reasonable amount of time on a Flexible Fleet service, then be able to make use of the Rapid bus, light rail, or commuter rail systems.
L168	To promote greater equity, County staff see opportunities to expand the proposed mobility hubs to include adjacent unincorporated communities. When we overlay the proposed mobility hubs with the County's VMT efficient areas (using both the unincorporated and regional averages), North County Metro, Lakeside, and Spring Valley (Attachment B) are adjacent to what appear to be proposed mobility hubs. These unincorporated communities would benefit from additional access and investment associated with inclusion in adjacent mobility hubs, as these communities have few existing alternative options to driving.	The coverage area of each regional Mobility Hub represents a general area defined through a propensity analysis (detailed in Appendix T). The mobility hubs of the 2021 Regional Plan depict a framework that will be used to guide future collaborative planning efforts between SANDAG and local jurisdictions. In reviewing the County's suggestions, SANDAG agrees that the areas identified are appropriate to consider in future mobility hub planning. The areas identified also align with Transit Priority Areas. In the proposed final 2021 Regional Plan, mobility hub maps also reflect Transit Priority Areas to be more inclusive of these areas.
L169	County staff is also interested in understanding how Regional Housing Needs Assessment (RHNA) allocations would be assigned. For the current 6th RHNA cycle, which covers 2021 - 2029, SANDAG allocated 6,700 units for the unincorporated area, with a total housing forecast in the Regional Plan of 7,419 units through 2050 for the unincorporated area. This forecast projects the County's RHNA allocation of 6,700 units being met by 2029, with an additional growth of 719 units by 2035, and projects no further growth in the unincorporated area through 2050. Based on this forecast, it appears that beyond 2035, all future housing needs in the region from RHNA cycles would be allocated to and met by growth in incorporated cities.	<p>The 2021 Regional Plan accommodates the regional housing need determined by the Department of Housing and Community Development for the 6th Cycle RHNA. That determination specifically identified additional need resulting from a low vacancy rate, overcrowding, and housing unit demolitions in the region. The remaining housing projected through 2050 is based on the January 2020 vintage of the Department of Finance population projections. As described in Appendix F, additional assumptions used in developing the forecasted housing units include a gradual increase in the region's vacancy rate to 4% by 2040, identification of vacation rentals as unoccupiable units, and a decline in household size as the population ages.</p> <p>While land use authority is reserved to the local jurisdictions, land use patterns will directly impact GHG emissions from the transportation sector. "Specifically, where and how the State population grows will have implications on distances traveled and tailpipe emissions; as well as on secondary emissions from the transportation sector, including emissions from vehicle manufacturing and distribution, fuel refining and distribution, demand for new infrastructure (including roads, transit, and active transportation infrastructure), demand for maintenance and upkeep of existing infrastructure. Conversion of natural and working lands further affects missions, with the attendant impacts to food security, watershed health, and ecosystems. Less dense development also demands higher energy and water use" (2017 Scoping Plan, California Air Resources Board, p. 77).</p> <p>Government Code section 65080(b)(2)(B) requires that the SCS "set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board." The</p>

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		<p>SCS included in the 2021 Regional Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan.</p> <p>The Regional Plan and its SCS are iterative planning documents that are typically updated every four years to account for new data, analysis, policy, and experience.</p>
L170	In order to fulfill the goals of the Regional Plan in providing access to affordable, reliable, and safe mobility options for everyone in the region, County staff would like to work with SANDAG to ensure consideration is given to future investments and incentives within the unincorporated area that would result in expanded options for transit and active transportation, and to encourage shorter and fewer automobile trips, including locations of mobility hubs, transit leap, flexible fleets, and complete corridors.	SANDAG looks forward to coordinating with the County on many areas of implementation for the Regional Plan including the Flexible Fleet Implementation Strategic Plan, Active Transportation Plan, Comprehensive Multimodal Corridor Plans, and advanced transit planning. All of these efforts provide opportunities for refinement of the Regional Plan concepts at a local level.
L171	County staff would like to continue coordinating with SANDAG to further identify Regional Plan investments in infrastructure, technology, and communication improvements for roads identified in both the County's Mobility Element and unincorporated roads included in the RAS and how these investments will further connect the unincorporated area to proposed mobility hubs, flexible fleets, or transit leaps. In addition to providing efficient movement of people and goods, these investments would increase the efficiency of evacuation routes, relay important information on evacuation conditions to first responders, and assist in getting residents safely away from hazardous conditions, all important components of resiliency planning.	The 2021 Regional Plan puts in place a regional framework for a reimagined transportation system. The plans and studies identified as implementation actions of the Regional Plan will provide opportunities for SANDAG to work closely with the County on these suggestions for applying the 5 Big Move concepts to the unincorporated areas and improving mobility options and safety.
L172	County staff appreciates the difficulty in forecasting funding and revenue sources for a regional transportation network. The Regional Plan identifies use of TransNet funds as part of the implementation, but it is not clear whether projects that have previously been planned, programmed, or awarded as part of the previous plan using TransNet would retain that funding allocation, or if there would be a reallocation of these funds as part of the Regional Plan. It is also unclear if there would be any changes to the current allocation or use of funds that local agencies receive directly for local road system improvements. The unincorporated area relies on TransNet funding to build, improve, and maintain transportation facilities that enhance roadway safety and support smart growth development, including road infrastructure to support increased transit options. Loss or reallocation of this funding could affect these projects and limit the County's ability to provide transportation services in support of our goal of reducing greenhouse gas emissions	<p>A comparison between the <i>TransNet</i> Program of Projects and the Draft 2021 Regional Plan was included in the July 7, 2021 ITOC Agenda Item #2 (<a href="https://www.sandag.org/uploads/meetingid/meetingid_5886_29414.pdf">https://www.sandag.org/uploads/meetingid/meetingid_5886_29414.pdf</a>). In addition to the report narrative, you will find in Attachment 1 the details regarding the original <i>TransNet</i> projects and how those are addressed in the Regional Plan corridor by corridor.</p> <p>The 2021 Regional Plan maintains the current allocation of <i>TransNet</i> Local Street and Road funds for local jurisdictions.</p>
L173	<p>The Regional Plan indicates that user fees would help build a transportation system that provides travelers with alternatives to driving. County staff would like to further discuss how the proposed road user charges would be developed, implemented, and applied to ensure that this funding strategy will not disproportionately burden unincorporated communities, which often have longer commutes and less access to alternative transportation options due to lack of regional planning for transit services to these communities. Revenues generated should also be allocated to support additional transportation and mobility options in unincorporated communities, while vehicle use by those with access to alternate modes of transportation should be disincentivized since their communities are receiving significant investments in public transit.</p> <p>County staff looks forward to learning more about how future funding and investment would be applied to ensure that both the benefits and the costs of the Regional Plan are equitably distributed across the region.</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
L174	The Regional Plan provides SANDAG with an opportunity to guide future investments in a way that meets smart growth objectives and reduces GHG emissions, but also guides future allocation of resources to achieve equitable outcomes. Several of the unincorporated communities, such as Lakeside, Spring Valley, and Ramona, have larger populations than some of the incorporated cities that are prioritized in the Regional Plan. In review of the proposed plan expenditures, a majority of the capital investments (55% of RTP funding) appear to go toward mobility hubs, complete corridors, and Next OS investments that	The Regional Plan considers the current and future needs of the whole region, including unincorporated communities. The reimagined transportation system offers benefits that extend through the region as residents and visitors travel outside their communities for work, recreation, school, entertainment, and accessing basic needs. The investments in Next OS, Flexible Fleets, Mobility Hubs, and programs are

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	are primarily outside of unincorporated communities. It is unclear what proportion of investment would go toward addressing mobility challenges within unincorporated communities and infrastructure investment that would provide linkages between the unincorporated areas and the proposed mobility hubs, transit leap, flexible fleets, and complete corridors. County staff is committed to working with SANDAG to further identify opportunities to equitably distribute the mobility benefits of the 5 Big Moves and further reduce GHG emissions regionwide	presented as regional investments and SANDAG intends to work collaboratively with each jurisdiction to implement the Regional Plan and customize mobility solutions for the unique needs of each community.
<b>David Alvarez, on behalf of ReConnect Logan Community Leaders</b>		
L175	<p>On behalf of the residents and community leaders of Barrio Logan and Logan Heights, we submit these letters of support for the creation of a priority not currently identified in the 2021 Draft Regional Plan. It is imperative that you incorporate a project to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego’s Barrio Logan and Logan Heights communities.</p> <p>Specifically, we request the addition of a Freeway Lid as a priority project in SANDAG’s 2021 Draft Regional Plan (Draft Plan).</p> <p>Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950’s and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know ReConnect Logan Freeway Lid will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.</p> <p>As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950’s our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children’s access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.</p> <p>Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out ReConnect Logan Freeway Lid as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:</p> <p>The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)</p> <p>Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)</p> <p>Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)</p> <p>Besides being in line with the 2021 Draft Regional Plan, ReConnect Logan Freeway Lid is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional Plan.</p>	<p>Caltrans District 11 has also expressed interest in exploring opportunities for freeway caps. In alignment with the 2021 Regional Plan, SANDAG and Caltrans District 11 are currently developing Comprehensive Multimodal Corridor Plans in coordination with agency partners and local city governments. Comprehensive Multimodal Corridor Plans (CMCPs) are data-driven plans to reduce congestion and generate transportation choices while preserving community character and creating opportunities for enhancement projects. Opportunities for freeway caps will be considered in the CMCPs.</p>
<b>Douglas A. &amp; Christine L. Evans</b>		
L176	<p>We oppose “Road User Charges” as a funding source that would be incremental/ additional to the existing fuel fees and taxes for the transportation infrastructure as outlined in the 2021 Regional Plan Transportation. We request that you oppose implementation of such Road User Charges if they are in addition to the existing fuel fees and taxes. Road User Charges for all vehicles - Internal Combustion Engine (ICE),</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation</p>



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	<p>Electric Vehicles (EVs), Hydrogen, Hybrid, etc. -- is acceptable only if the State, County and City fuel fees (\$0.389/gallon) and taxes (California -- \$0.612/gallon) 1l are eliminated. If those fees and taxes are eliminated, then implementing a Road User Charge of \$0.27 /mile, which would generate the equivalent revenue as the current fuel fees and taxes would be reasonable (calculation assumptions -- average fleet fuel economy of 37.5 miles/gallon2l and miles driven per year of 12,5243)) . If the fuel fees and taxes are not eliminated, then Road User Charges should be implemented for ICE vehicles. Such charges could be added to the non-ICE vehicle's license fee - EVs, Hydrogen, Hybrid, etc.</p> <p>Use the fuel fees and taxes (federal and state of \$1.191)) as intended by the voters instead of diverting gas fee and tax revenues into other projects. From the Los Angeles Daily News4l, "The gross misspending, waste and diversion of gas tax revenues into projects having nothing to do with roads or highways. Caltrans admits that as it tries to focus available funding on core system assets, it is simultaneously increasing our investment in bicycle and pedestrian transportation. Gov. Newsom signed an executive order in 2019 that redirected gas tax money to fund railway systems and other non-road projects. Although SB 1 raised taxes with the promise that the money would be used to repair crumbling roads and bridges, about 30 percent of the revenue raised by the tax hike is designated for other transportation priorities, including public transit, bike lanes and walk paths." From the Fresco Bee5l, another disturbing example of diverting funds from their intended purpose, Gov. Gavin Newsom issued executive order N-19-19, which obligates the state transportation agency to leverage transportation spending on projects such as strategically directing discretionary transportation investments in support of housing production near available jobs and in accordance with the state 's smart growth principles. Stop diverting funds from their intended purpose.</p> <p>If projects for transportation in addition to roads and / or other non-transportation projects are needed, then put such projects on the ballot for a vote by the citizens of San Diego County I California to approve or reject a tax for such needs. Do not use the "bait and switch" tactic on the citizens of San Diego County. Use fees and taxes for their intended purpose - PERIOD!</p> <p>Thank you for your attention to this matter. We look forward to hearing your opposition to the Road User Charges as outlined in the SANDAG 2021 Regional Plan.</p>	<p>system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.</p>

Environmental Health Coalition

L177	<p>A. ZE drayage trucks are commercially available now and also comparable in costs today along with increasingly positive total cost of ownership (TCO) in years ahead.</p> <p>1. In section 4.1 (page Y-165), it states that "Port of SD: ZE vans and trucks may be suited to accommodate demand for goods movement in the area while reducing air quality and noise impacts, given the volume of local truck trips and improvements in ZE technologies....". Data indicates that these local trips, as well as much longer drayage trips, are already feasible today with ZE drayage trucks.</p> <p>2. Per the Port of San Diego study (November 2020)1, ZE drayage trucks with a range of over 100 miles are commercially available today. The Port study explains that:</p> <ul style="list-style-type: none"> <li>a. Five different ZE drayage trucks are expected to be commercially available by the end of 2020, while another seven should become available by 2022/2023. Each has a range of over 100 miles, which is enough to complete the average drayage truck duty cycle of less than 100 miles on a single charge;</li> <li>b. The range of existing electric Class 8 trucks cap out at around a 150-mile range on a single charge;</li> <li>c. ZE drayage trucks requiring more than 150 miles will be available soon; and,</li> <li>d. Truck ranges are expected to increase as manufacturers develop longer- range batteries with the Tesla semi planned to exceed 500 miles near the 2023 timeframe.</li> </ul> <p>3. ZE drayage trucks are comparable in costs today along with increasingly positive total cost of ownership (TCO) in years ahead.</p> <ul style="list-style-type: none"> <li>a. A Lawrence Berkeley National Laboratory (March 2021)2 study concludes that a Class 8 electric truck operated 300 miles per day when compared to a diesel truck offers a roughly 3-year payback and net present savings of about \$200,000 over a 15-year lifetime."</li> <li>b. The 2035 Report 2.0: Plummeting Costs and Dramatic Improvements In Batteries Can Accelerate Our Clean Transportation Future from UC Berkeley's Goldman School of Public Policy (April 2021)3 explains that the TCO for heavy duty electric vehicle starts out as positive compared to diesel and gets substantially better through 2035.</li> </ul>	<p>SANDAG will continue to support flexibility for funding and incentives to promote private and public sector adoption of zero-emission truck technologies. SANDAG will also share information on ZE commercial vehicle availability to private sector companies and industry organizations in the region through the Freight Stakeholders Working Group.</p> <p>SANDAG will be assessing existing medium-/heavy-duty ZE fleets and infrastructure, identifying barriers, and developing near and long term strategies for transitioning to these fleets through the recently awarded California Energy Commission Blueprints for Medium- and Heavy-Duty Zero-Emission Vehicle Infrastructure grant.</p>
L178	<p>B. ZE drayage trucks (not near-zero) trucks are needed to reach air quality and climate goals.</p>	<p>SANDAG's support of private sector education will assist operators in making appropriate choices as they determine the best way for their respective businesses to adapt to new policy and regulation and mitigate the</p>

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	<p>1. EJ communities and Climate Action Plans require ZE (not near zero) trucks. However, the SANDAG report encourages and/or assumes near zero. On page Y-29, it states “.....In addition to the international gateway forecast, develop a freight forecast to 2050 for three specific urban areas of the Gateway Region that addresses emerging freight trends, such as the transition to zero/near-zero-emission freight vehicles...”.</p> <p>2. The Luskin Report (2019)<sup>4</sup> specifically warns against meeting any short-term uptick in drayage truck turnover with natural gas trucks. The report explains that if investments focus on natural gas trucks as the primary replacement, more natural gas fueling stations will be needed. Given goals to transition to zero-emission trucks, these investments will inevitably be stranded or the ZE transition will be delayed unnecessarily.</p>	<p>effects of emissions on our climate. In addition, the “zero/near-zero emission” policies found within Appendix Y reflect statewide goals, strategies, and actions identified in the California Sustainable Freight Action Plan and California Freight Mobility Plan 2020.</p> <p>SANDAG acknowledges that more work needs to be done in this area and that various climate action plans developed for the region, along with federal and state agency initiatives, are being incorporated as SANDAG’s comprehensive strategies for addressing climate change in this and future regional plans.</p> <p>SANDAG continues to partner with the California Air Resources Board, the City of San Diego, the City of National City, the Port of San Diego, and other agencies to support the implementation of their specific climate action plans.</p>
L179	<p>C. Misclassification of truck drivers needs to be explained in report.</p> <p>1. Misclassification of truck drivers in California needs to be explained in the SANDAG report. On page Y-24, it states “...A large portion of truck operators in the freight industry are independent contractors who own their own vehicles and work for larger corporations. As policies start to implement regulations that discourage the continued use of heavy-duty diesel trucks and enforce the use of zero-emission vehicles, independent truck owners will be left with outdated vehicles they can no longer use, leading to potential unemployment for these operators...”.</p> <p>2. The drayage, package delivery, and other short-haul segments of the trucking industry are home to ongoing and egregious worker exploitation.<sup>5</sup></p> <p>3. Trucking companies, brokers, and other contracting entities often illegally misclassify drivers as independent contractors (when they are employees by law) to avoid paying wages, benefits, equipment costs, taxes, and regulatory compliance costs. <sup>6</sup></p> <p>4. Misclassified drivers operate 70 to 90% of California’s drayage trucks, making misclassification the drayage segment’s dominant business model. <sup>7</sup></p>	<p>Litigation is ongoing related to the trucking industry and California Assembly Bill 5 (AB 5). Appendix Y now contains the following updated passage:</p> <p>“In 2019, AB 5 was passed to regulate the use of independent contractors in a variety of activities that also included trucking. In January 2020, San Diego U.S. District Court Judge Roger Benitez issued a preliminary injunction blocking the enforcement of AB 5 against California trucking companies that contract with owner-operator truckers. The initial lawsuit was filed by the California Trucking Association (CTA) and two owner-operators seeking to prevent the application of AB 5 to the trucking industry. In late April 2021, in a ruling from a three-judge panel of the Ninth Circuit Court of Appeals, the panel reversed the granting of CTA’s preliminary injunction. Following the Ninth Circuit’s denial of CTA’s petition for rehearing in June, CTA filed a petition for a writ of certiorari with the United States Supreme Court on August 9, 2021. At this time, the deadline for the State of California’s response is October 12, 2021.”</p>
L180	<p>D. The Freight Gateway Study should address potential impacts of climate change on goods movement.</p> <p>1. The Gateway Study did not address potential impacts of climate change on 2050 freight projections. Impacts are difficult to predict, but it would be reasonable to develop scenarios that do not assume simple linear growth in freight volumes, due to disruptions in supply chains, extreme weather events, sea level rise, and potential changes in key industries in the San Diego region such as agriculture, construction, and tourism. As overarching policy directions, the San Diego region must plan for producing critically important goods closer to home, and reducing our dependence on goods movement as an economic driver.</p>	<p>The IHS Markit Transearch data used to develop the freight forecasts for the Freight Gateway Study Update include economic considerations resulting from climate change and other possible disruptions. Section 3.1 of the study has been revised to reflect this. SANDAG recognizes the importance of resilience through disruptions and will incorporate this into future goods movement planning efforts.</p>
L181	<p>E. Additional Comments on Goods Movement Planning and the Freight Gateway Study.</p> <p>1. Appendix Y correctly notes the importance of equity for workers in the freight industry, but mentions the potential impact of automation only in passing, on page Y-5. SANDAG needs to address the challenges of automation more fully. Who makes the decisions to automate unloading, loading, or movement of freight? What opportunities are there for workers and the public to participate in these decisions? What policies are in place, or needed, to support workers whose jobs may be at risk as a result of a shift to automation? Until these questions are answered fully, SANDAG’s goods movement planning will be failing these workers.</p> <p>2. Marine Highway M-5 is mentioned briefly on page Y-8 as a potential new source of trade. Short sea shipping may be a good option for reducing GHG and truck traffic. At the same time, Portside residents need to know how this mode shift would impact air quality in their communities. Will additional ships be coming to San Diego’s cargo terminals if the project is approved? Will these ships be shorepowered? Goods movement planning requires that local impacts be identified and addressed.</p> <p>3. Urban warehouses for e-bike deliveries are mentioned as an innovative delivery option on page Y-26. It is important to be clear that if trucks will also be accessing these facilities, they do not belong in residential areas. Residents of Barrio Logan and west National City have struggled for decades to eliminate incompatible land uses such as warehouses from their communities.</p> <p>4. Regarding infrastructure needs for truck freight hauling, the report, in Section 2.1.2.1. Gaps in Existing Road</p>	<p>SANDAG understands that this topic is evolving and will continue to work with stakeholders, monitor the adoption and readiness of technologies, and engage with the community as automation technologies mature. SANDAG will stay cognizant of policy decisions to avoid unintended consequences and influence outcomes.</p> <p>In January 2021, SANDAG provided a letter of support for an application submitted by the Port of San Diego and other west coast ports for the MARAD America’s Marine Highway – West Coast M-5 Coastal Connector. SANDAG will stay engaged with the Port of San Diego, assist as needed with policy decisions, communicate, and collaborate with stakeholders and community leaders to identify and monitor local impacts.</p> <p>SANDAG will collaborate with the City of San Diego and the City of National City in the configuration of truck routes in portside communities considering potential innovations like urban warehouses.</p> <p>SANDAG continues to support progress toward an adequate electric vehicle charging infrastructure for both freight and passenger vehicles in collaboration with public agency and private industry stakeholders. This support includes planning through the Comprehensive Multimodal Corridor Plans (CMCPs) that include federally designated zero-emission vehicle corridors and commensurate charging infrastructure as well as the development of a Blueprint for Medium-/Heavy-Duty (MD/HD) ZEV Infrastructure. A SANDAG board resolution was passed to work collaboratively to establish the framework and agreement for a joint electric vehicle charging incentive program with the California Energy Commission, County Air Pollution Control District, and</p>



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	<p>Infrastructure, correctly notes the lack of dedicated truck parking, staging, and queuing facilities. Another essential piece of freight infrastructure planning: EV charging facilities for MD/HD trucks. Charging facilities must be planned and installed in readiness for the transition to ZEV trucks that is mandated in California.</p> <p>5. Regarding outbound cargo, Figure 3.14 on page Y-129: Gravel is the largest outbound cargo, by tonnage, at 3,505 tons. This is a category of commodity that also includes aggregate. Sand is also a large outbound commodity, at 1,086 tons. It appears unnecessary to develop new imports of sand, gravel, and aggregate into the region, and unlikely to produce reductions of emissions from trucks.</p>	<p>Center for Sustainable Energy as part of the Regional Vehicle Charging Program partnership program. SANDAG will continue to coordinate with Caltrans in their efforts to plan the deployment of potential medium- and heavy-duty truck charging infrastructure in conjunction with parking identified through the California State Truck Parking Study that is currently underway.</p> <p>SANDAG builds public transportation and active transportation projects and thus has an interest in the status of aggregate commodities that are available in the region. SANDAG, however, does not control regional private sector markets and will be subject to the same economically-driven market dynamics as other aggregate consumers. SANDAG continues to support maritime and highway vehicle conversion to zero emission power to further reductions in air pollutants and GHGs from these industries.</p>
<b>Friends of Rose Canyon 1</b>		
L182	<p>Our overall comment is that the 2021 Draft Regional Plan states that it proposes a bold new vision. However, it is based on a massive expansion of our highways. This includes widening many of our highways to add Managed Lanes and adding huge, elevated concrete “Managed Lane Connectors” (MLCs) where highways intersect. These MLCs will require even further highway widening to add lanes where traffic would enter and exit the connectors. In some cases these MLCs connect highways at very different elevations or with multiple other on and off ramps and bridges in the same location. Judging from just the area we focus on, these added MLs and MLCs will have huge direct and indirect environmental impacts on sensitive habitat, MSCP lands, Marian Bear Park, Rose Canyon Open Space Park, MCAS Miramar, and the Rose Creek and Carroll Canyon Creek/Sorrento Valley/Penasquitos Lagoon watersheds. Furthermore, just in the area we focus on, these MLs and MLCs will cost many hundreds of millions of dollars.</p>	<p>The 2021 Regional Plan places emphasis on maximizing the use of existing facilities to add corridor capacity to ease congestion while also trying to achieve meeting state and federal greenhouse gas and air quality targets. The proposed managed lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools and low-emission vehicles with appropriate decals. The system of managed lanes and supporting connectors support Transit Leap and high occupancy vehicles to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes.</p> <p>Decisions on where to construct proposed managed lanes connectors including defining and designing site specific elevation profiles and or structural/physical footprint construction components will be examined through more detailed operational and technical studies. These efforts are generally undertaken during the project development and environmental clearance phase which is generally carried out with public input and following the California Environmental Quality Act guidelines to evaluate proposed project impacts and identify necessary mitigation measures.</p>
L183	<p>How sure is SANDAG of those calculations? What is the course correction if we start adding all this highway capacity and the benefits are not there? Do the RTP models rest on the assumption that the projected benefits require that all the highway MLs and all the MLCs be added to achieve the projected benefits? What if we get half way into building this out and find that adding all this highway capacity is not bringing the benefits anticipated?</p>	<p>SANDAG is required to analyze induced demand impacts of the Regional Plan, which are documented in Appendix D. The activity-based model and other analyses used to inform the plan have been reviewed through SANDAG’s peer review process and documented in the technical methodology submitted to the California Air Resources Board, also included in Appendix D. Where possible, the Regional Plan proposes repurposing of general purpose lanes or shoulders to create managed lanes. The managed lane system is important for supporting the transit network and Flexible Fleets envisioned in the Regional Plan. The Regional Plan is updated every four years, providing opportunities to reflect changes in the network</p>
L184	<p>Based on what we see proposed for just the area we focus on, we see major direct and Indirect Impacts on MSCP lands, open space, habitat, native plant and animal species, wildlife corridors, creeks, and watersheds. Adding Managed Lanes and Managed Lane Connectors means bulldozing land and building extensive new concrete surfaces and retaining walls and drainage ditches, expanding direct impacts and edge effects on habitat and wildlife, increasing storm water run-off, noise and light impacts, invasive species, habitat loss, loss of wildlife connectivity and wildlife corridors, increased erosion, trash, and air and water pollution. “Mitigating” these impacts through projects done in distant mitigation banks does nothing to reduce the impacts in the areas where these impacts occur.</p> <p>While SANDAG staff have stated in meetings with the QOL coalition that they are not widening outside the highway ROWs, that does not mean there won’t be major highway widening and environmental impacts. In some cases, CALTRANS has sufficient ROW to widen by multiple lanes. And widening even within the ROW extends the damaging impacts and pushes the edge effects closer to and into sensitive habitat.</p>	<p>For direct and indirect impacts related to biological resources in the area within and extending out from the I-805/SR 52/I-5 triangle, that includes the Rose Creek watershed (Rose Canyon, MCAS Miramar, San Clemente Canyon and Marian Bear Park, and Rose Creek extending south to Mission Bay), and the Carrol Canyon, Sorrento Valley, and Penasquitos Lagoon watersheds please refer to Section 4.4 Biological Resources of the EIR.</p> <p>Measures have been identified in the EIR to implement design, minimization and avoidance measures for sensitive vegetation communities that provide habitat for special-status species during construction and operational maintenance.</p>
L185	<p>Meanwhile, the Purple Line (Commuter Rail 582) from Sorrento Mesa to the Border (a true transit project) will not be completed until 2050. In concept, we strongly support this project, assuming it is largely underground through the environmentally sensitive areas we focus on. But despite the importance of this transit project, we know little beyond the vaguest description of its route. Where might it be underground? Where might it be at grade or above grade? Why is it not being completed until 2050 while the RTP prioritizes adding so many highway MLs and MLCs?</p>	<p>The Purple Line is broken down into two phases of the 2021 Regional Plan. The first phase is planned for by 2035 and will operate between National City and Sorrento Valley. It is conceptually planned right now to be fully grade separated and operate either in tunnels or on aerial structures. At the Regional Plan level, we have not determined the exact location of the tunnels or structures. By 2050, the Purple Line would be extended between National City and the San Ysidro Border. Next Generation Rapid routes are planned along the Managed Lanes on Interstate 805 in the early years of the plan in order to build ridership while the Purple Line is being designed and constructed.</p>
L186	<p>On April 15, 2021, the Sierra Club sent the attached letter to SANDAG Director Hasan Ikhata, Director of Regional Planning Coleen Clementson, Senior Transportation Planner Jennifer Williamson, and several SANDAG BOD members. At a subsequent meeting with the Quality of Life Coalition’s Transportation Committee, Coleen Clementson stated</p>	<p>The 2021 Regional Plan includes no additional freeway widening along Interstate 805 between SR-52 and Sorrento Valley Road. The Direct Access Ramp at I-805 has been removed from the 2021 Regional Plan. There are no park and rides or Rapid stations planned for the Southwest Corner of Nobel/I-805. A bus route would</p>

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	<p>vehemently, “We agree with you.” We therefore assume and would like confirmation, that the following is not in and will not be added to the RTP for the I-805 North from just south of SR-52 to Carroll Canyon Road:                      -Any additional freeway widening beyond what has currently been built (one Carpool/ HOV lane in each direction was completed in 2016)                      -Widening of the I-805 bridge over Rose Canyon                      -Direct Access Ramps (DARs) at Nobel Drive                      -A Park &amp; Ride at the southwest corner of Nobel/I-805                      -A bus station at the southwest corner of Nobel/I-805</p>	<p>still access Nobel Drive through operational improvements, but the location of any stops could occur on street or on the north side of Nobel Drive.</p>
L187	<p>Project ID CC114 is called I-805 (Nobel Drive) - it should be deleted from the RTP                      Rationale: I-805 North should locate access to and from the Managed Lanes at La Jolla Village Drive, not Nobel Drive. La Jolla Village Drive has extensive high density employment and high density housing located between the LJVD/I-805 intersection and Genesee Avenue. At Genesee there are two trolley stations surrounded by existing and planned high density employment and housing. La Jolla Village Drive is the route BRT lines should use to enter and exit the I-805 MLs. Nobel Drive is a poor location for a BRT route to enter or exit I-805 MLs. The location is far from significant employment or housing density. Furthermore, no parking lot or bus station should be located at Nobel/805. The I-805 commute is south to north in the morning, so parking lots near the I-805 should be located in communities well to the south where commuters come from in the morning. The land at the Nobel/ I-805 intersection should be protected from any further impacts. Most of it is MSCP, and there are vernal pools and numerous documented sensitive species. That area should have no further disturbance.</p>	<p>The Direct Access Ramp at Nobel/I-805 has been removed from the 2021 Regional Plan. There are a number of constraints that limit the ability of the Rapid bus to access La Jolla Village Drive via the Managed Lanes. The current plan is to use existing ramps or operational improvements that would give the bus some level of priority to enter the existing ramps. More planning will need to occur as this project moves forward.</p>
L188	<p>The RTP should reduce the amount of highway expansion and the number of MLCs in this area. SR-52 should not be widened and the MLCs between these highways should be eliminated.</p> <p>The following projects would cause major environmental damage to MSCP lands and to the area’s critical and already highly constrained wildlife corridors.                      This area illustrates our concern about the RTP as a whole. The RTP proposes a massive expansion of highway capacity in the name of creating “Complete Corridors” that will, in theory, carry BRT lines and carpools. While it is true that some existing general purpose lanes will be converted to “Managed Lanes”, the RTP proposes an expansion of all the highways in this area to add MLs plus multiple MLCs between these highways that will further degrade the habitat and wildlife corridors.</p> <p>CC085: 2035 - MLC I-805 (SR 52) West to North and South to East CCT - \$149 mil                      This MLC will cause major environmental damage to an area with important wildlife corridors that connect MCAS Miramar, San Clemente Canyon (and Marian Bear Park) and Rose Canyon. These wildlife corridors are identified in the MSCP and in the MCAS Miramar Natural Resource Management Plans. The wildlife corridor between MCAS Miramar and San Clemente Canyon is already highly constrained at the I-805/52 intersection. In addition, the elevation change between the I-805 and SR-52 is significant. A further environmental impact will occur due to adding two MLs to SR-52 east of I-805 and one ML to SR-52 west of I-805.</p> <p>CC086: MLC I-805 (SR52) North to West and East to South (\$126 mil): More environmental impacts in this same area.</p> <p>CC003 - (by 2035) - I-5 (Pacific Highway to SR 52) 8F to 6F+4 ML (\$353 mil) (adding 1 lane in each direction to I-5)</p> <p>CC004 by 2035 I-5 (SR 52 to I-805) 8F to 6F + 4ML (adding one lane in each direction) (\$190 mil) CC028 by 2050 MLC I-5 (SR 52) South to East and West to North (\$202 mil)                      CC065 by 2050 Complete Corridor: ML SR 52 (I-5 - I-805) 4F to 4F + 3 ML (\$214 mil)                      This massive widening of SR 52, with additional width needed to build the Managed Lane Connectors between I-5/52 and SR 52/ I-805 (MLCs in all directions) will have huge negative impacts on the adjacent MSCP lands in San Clemente Canyon and Marian Bear Park and on Rose Canyon and on the wildlife corridors between</p> <p>CC066 by 2050 I-5 (SR 52) MLC - North to East and West to South (\$202 mil)</p>	<p>For direct and indirect impacts related to biological resources please refer to Section 4.4 Biological Resources of the EIR. Measures have been identified in the EIR to implement design, minimization and avoidance measures for sensitive vegetation communities that provide habitat for special-status species during construction and operational maintenance.</p>
<b>Friends of Rose Canyon 2</b>		
L189	<p>The City of San Diego’s chosen alignment for the Coastal Rail chosen between Gilman/La Jolla Colony Drive and Sorrento Valley Coaster Station should be added to the RTP and the old alignment should be deleted (Rose Canyon, “UTC” (along Judicial Drive), Roselle Canyon and Roselle St to the Sorrento Valley Coaster station). This old alignment was thoroughly studied and rejected due to multiple major problems.</p>	<p>SANDAG has worked with project partners at Caltrans to include the North Coast Bike Trail projects in the 2021 Regional Plan as part of the Adopted Regional Bike Network, this includes the completed segments referenced here.</p>

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	<p>The Draft RTP contains inconsistent and out-of-date labeling of a portion of the City of San Diego’s Coastal Rail Trail. The City is the Lead Agency for the Coastal Rail Trail in the City, and it has selected the alignment and completed final design of the alignment along Gilman Drive to UCSD.</p> <p>The City has deleted from its Bike Master Plan the old Rose Canyon, “UTC”, and Roselle Canyon alignment. The City studied that route for years and rejected it for multiple reasons. The RTP therefore needs to:</p> <ul style="list-style-type: none"> <li>• cut three planned CRT segments and trim one CRT segment</li> <li>• relabel the CRT route in the RTP to coincide with the approved Gilman Drive CRT segment, adding the UC San Diego CRT segment plus the I-5 Bicycle Corridor.</li> <li>• Amend Appendix A and Appendix L in the SANDAG RTP to be consistent with this change.</li> </ul> <p>The RTP should make the following changes summarized in the following tables (see attached letter for full tables presented by commentor):</p> <p>CRT route as presented in the SANDAG RTP:</p> <ol style="list-style-type: none"> <li>1. AT032 (CRT - Carmel Valley to Sorrento to Roselle Canyon) - Change Carmel Valley to Roselle via Sorrento by removing Sorrento to Roselle. Carmel Valley to Sorrento Remains</li> <li>2. AT036 (CRT - Roselle Canyon) - Cut</li> <li>3. AT037 (CRT - UTC to Rose Canyon) - Cut</li> <li>4. AT023 (CRT - Rose Canyon) - Cut</li> </ol> <p>The RTP needs to add the CRT route the City of San Diego has chosen for the segment from Sorrento Valley Coaster Station to the Gilman Drive/La Jolla Colony intersection</p> <ol style="list-style-type: none"> <li>1. CRT – I-5 Bicycle Corridor (Sorrento Valley to Voigt and Gilman): Already completed by Caltrans</li> <li>2. CRT - UC San Diego (Voigt/Gilman Dr. to Gilman/La Jolla Village Dr.): UC San Diego is adding major bike infrastructure improvements through the campus on this route</li> <li>3. CRT - Gilman (Gilman Dr./La Jolla Village Dr. to Gilman Dr. and I-5/Rose Creek Bike Path and La Jolla Colony Dr.): Protected bike lanes fully designed by City. Partial construction funding in SD City 2022 CIP budget.</li> </ol>	<p>Portions of the City of San Diego’s 1.63 mile Coastal Rail Trail project S00951 are already identified as the Gilman Connector in the project list in Appendix A. This will be a connector to SANDAG’s recently upgraded Rose Canyon Bike Path and newly constructed Rose Creek Bikeways to the south. Extending north, however, there remains a need for safe, direct, all ages and abilities active transportation alternatives extending into currently underserved residential (University) and employment centers (UTC, Sorrento Valley) to improve alternatives in this major transportation corridor. In order for SANDAG to stimulate the shift from personal motor vehicle use to people choosing to bike, a network of well-designed routes is essential. The City of San Diego’s project on Gilman Drive is greater than 2 miles away from, and represents just 25% of, the entire length of the projects requested to be removed.</p> <p>These projects and this alignment were first identified in the 2000 Coastal Rail Trail Project Study Report: <a href="https://www.keepsandiegomoving.com/Libraries/Transnet-doc/Coastal_Rail_Trail_Project_Study_Report_reduced.sflb.ashx">https://www.keepsandiegomoving.com/Libraries/Transnet-doc/Coastal_Rail_Trail_Project_Study_Report_reduced.sflb.ashx</a>.</p> <p>These projects were approved by the SANDAG Board of Directors In 2010 with the development of a comprehensive regional bike network - Riding to 2050: The San Diego Regional Bike Plan: <a href="https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?projectid=353&amp;fuseaction=projects.detail</a>.</p> <p>Again, these Coastal Rail Trail segments were identified as a priority project in 2013 via the Bike Early Action Program (EAP): <a href="https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=34&amp;subclassid=122&amp;projectid=497&amp;fuseaction=projects.detail</a>.</p> <p>SANDAG plans to deliver all bikeway projects proposed in the 2021 Regional Plan, and looks forward to partnering with Friends of Rose Canyon and the City of San Diego to ensure the success of these projects.</p>
L190	<p>The savings for the three old, out-of-date segments to be cut is \$53 million (Rose Canyon, UTC (Judicial Drive) and Roselle Canyon, plus any savings from trimming the route AT032 by cutting Sorrento to Roselle, a segment made unnecessary by the I-5 bike path from the Sorrento Valley Coaster Station to UCSD. Two of the three segments in the City’s chosen CRT route are either complete or funded, so it can be anticipated that almost all of the \$53 million in the RTP can be freed up for active transportation projects that address equity, for example, in Chollas Creek, South Bay, or the Midway Corridor.</p>	<p>The Chollas Creek Bikeways: North Fork - Bayshore Bikeway to University Bikeway and South Fork - Petway Park to Market Creek Plaza has been incorporated into the 2021 Regional Plan and will help facilitate all ages and abilities active transportation connections in another watershed and transportation corridor like Rose Canyon. Please see the South Bay to Sorrento, and Central Mobility Hub tables in Appendix A (and online data viewer) for specific bikeway alignments and project details for these other two corridor areas.</p>
L191	<p>The CRT route has City and Community support:</p> <ul style="list-style-type: none"> <li>• The SANDAG RTP routes do not exist in the City of San Diego Bike Master Plan. They were explicitly deleted by the San Diego City Council in December 2013.</li> <li>• The approved CRT Project route in San Diego has been selected, with the final Gilman Dr. link ready for construction and on the CIP list for 2020-2021.</li> <li>• The approved CRT route was developed and selected by a City of San Diego Public Working Group in 2013-2014.</li> <li>• The approved CRT route is supported by the Community Planning Groups: the UCPG in 2013 and 2021, and the La Jolla Planning Association in 2021.</li> <li>• The approved CRT route has been supported by the City of San Diego in 2013, 2016 and budgeted in 2021.</li> </ul> <p>The City’s approved CRT route enhances important existing connections:</p> <ul style="list-style-type: none"> <li>• With the Rose Creek bikeway open, it is a connecting link to UC San Diego from the south.</li> <li>• With the existing I-5 Bicycle Corridor, it is a connecting link to UC San Diego from Sorrento and the Coaster.</li> <li>• The completed UC San Diego Gilman Bridge over I-5 provides comfortable and safe bicycle links to the east UC San Diego Campus, industry along Eastgate Mail, and the commercial center at UTC.</li> </ul>	<p>SANDAG agrees that the infrastructure improvements listed here are all critically needed.</p>
<b>Gatzke Dillon &amp; Ballance LLP 1</b>		
L192	<p>This firm represents Lakeview 1, LLC, Lakeview 2, LLC and Moller Lakes Investment, LLC (collectively, Lakeview), owners of the approved Otay Ranch Resort Village Project (Resort Village).<sup>1</sup> On behalf of Lakeview, we have reviewed SANDAG’s Draft 2021 Regional Plan (Draft Plan) and provide the comments that follow below.</p>	<p>Government Code section 65080(b)(2)(B) provides that a Sustainable Communities Strategy (SCS) “use most recent planning assumptions considering local general plans and other factors.” It also requires that the SCS “set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from</p>

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	<p>As relevant background, the Resort Village is part of the Otay Ranch General Development Plan/ Subregional Plan approved by the County of San Diego and City of Chula Vista in 1993. Otay Ranch, portions of which have been built out, is a complete community approved for 24,000 homes; commercial/retail uses; other non-residential uses; schools and public services; parks, recreation facilities, open space and a protected biological preserve; and complementary amenities designed to be developed over a 30- to 50-year period. Consistent with the land use parameters established in 1993 for Otay Ranch, the County of San Diego Board of Supervisors, in November 2020, approved the Resort Village for 1,938 residential units, a resort, and other complementary uses (such as parks and trails, a public safety site, an elementary school, and resident-serving commercial). As a general matter, development of the approved Otay Ranch planned community—of which the Resort Village is a part—has been accounted for in regional plans and projections since 1993.</p> <p>As discussed below, it appears that SANDAG’s Draft Plan has omitted from its design assumptions the Resort Village and its approved uses, resulting in a disconnect between the Draft Plan and the legal status of the Resort Village as a fully-entitled project.</p> <p>We understand that the Draft Plan strives to transform the way San Diegans move through and about the region in an effort to address safety, traffic congestion, social inequities, air pollution and greenhouse gas (GHG) emissions. The Draft Plan includes an updated Sustainable Communities Strategy (SCS), which sets forth a “forecasted development pattern” that is designed to: (i) achieve per capita GHG reduction targets set for the region by the California Air Resources Board (CARB), (ii) accommodate the Regional Housing Needs Assessment (RHNA), and (iii) utilize the “most recent planning assumptions.” (Draft Plan, p. 19). SANDAG reports that its SCS will exceed CARB’s 2035 reduction target for the region by one percent; i.e., a 19 percent reduction is required and the SCS, if implemented, will realize a 20 percent reduction.</p> <p>We provide the following comments on the Draft Plan, including its SCS:</p> <p>1. Government Code section 65800, subdivision (b)(2)(B) requires SANDAG “to use the most recent planning assumptions considering local general plans and other factors” (italics added). In this regard, Figures F.7, F.8 and F.9 in Appendix F of the Draft Plan are in error and must be corrected to ensure SANDAG’s compliance with this statutory requirement for its SCS. Specifically, the referenced figures show approved and entitled development located within Otay Ranch—including the Resort Village—as “Vacant” on the SCS’ land use pattern maps for 2025, 2035 and 2050. This is obviously incorrect. The “Vacant” appellation is inconsistent with the County’s approval of its General Plan in 2011, the Otay Ranch General Development Plan/Subregional Plan in 1993, and the Resort Village in 2020. As such, it results in development forecasts that are incorrect and incapable of supporting the Draft Plan’s findings and objectives. Therefore, we respectfully request that SANDAG modify the referenced figures to reflect the land use densities long-approved by the County and long-recognized by its General Plan for this portion of unincorporated South County.</p>	<p>automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the 2021 Regional Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan. The Regional Plan forecasts development through 2050 consistent with projections from the California Department of Finance but does not represent buildout of jurisdictions’ General Plans. The Otay Ranch Resort Village Project had not been approved by the Board of Supervisors at the time the SCS Land Use Pattern was developed, and it was not projected for future development in the SCS. The Regional Plan and its SCS are iterative planning documents that are typically updated every four years to account for new data, analysis, policy, and experience.</p>
L193	<p>2. The Draft Plan’s forecasted development pattern will not accommodate the RHNA. Specifically, the Draft Plan—in Table F.3 of Appendix F—projects the construction of just 7,419 dwelling units in unincorporated County areas over the next roughly 30 years (through 2050). This number does not accurately represent the amount of approved, planned and reasonably anticipated growth in the unincorporated areas. For example, in the 6th RHNA Cycle, which covers the 2021 through 2029 planning period (and thus does not align with the 2035 horizon year of the SCS modeling), SANDAG assigned 6,700 dwelling units to the unincorporated areas.<sup>2</sup> Therefore, it appears the Draft Plan assumes that a mere 719 additional units will need to be built in unincorporated areas between 2030 and 2050, an assumption that is at odds with reasonable approximations of future RHNA cycles and existing market supply-and-demand evaluations for the San Diego region. The Draft Plan’s assumption of 7,419 units also is approximately 1/8th of the County’s General Plan build-out capacity of approximately 65,000 dwelling units. Thus, we respectfully request that SANDAG reevaluate the reasonableness of its forecasted development pattern by way of housing growth assumptions. It is critical to ensure that all modeling inputs are informed and reasoned, such that the SCS quantification analysis is defensible.</p>	<p>The 2021 Regional Plan accommodates the regional housing need determined by the Department of Housing and Community Development for the 6th Cycle RHNA. Government Code section 65080(b)(2)(B) requires that the SCS “set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the 2021 Regional Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan. The Regional Plan and its SCS are iterative planning documents that are typically updated every four years to account for new data, analysis, policy, and experience.</p>
L194	<p>3. It is unclear to what extent the SCS and its supporting quantification framework account for the home-to-work, interregional commute reality present in San Diego. We know that the San Diego region’s failure to provide sufficient in-County housing opportunities has resulted in the exportation of some San Diego workers who now must commute into the region from more affordable housing opportunities in Riverside County or Mexico.<sup>3</sup> The spirit of Senate Bill (SB) 375, which created the statutory framework for SANDAG’s SCS, will not be met unless and until we grapple with how land use choices made in the San Diego region affect San Diego workers. The Draft Plan must clarify SANDAG’s strategies for reducing interregional commuting. Such strategies must ensure a sufficient quantity of in-County housing opportunities exists; otherwise, home-to-work, interregional commuting will continue to be a major problem.</p>	<p>As described in Appendix F, the Regional Growth Forecast has accounted for the need to increase the quantity of in-County housing opportunities. Appendix F includes the following language: “First, the forecast assumes the region’s vacancy rate would increase to 4% by 2040. The 4% vacancy rate assumption acknowledges that the region’s vacancy rate in 2018 was estimated to be less than 2% and that both state and local housing policy has recently focused on accelerating housing production. Second, the forecast assumes that the Series 14 Regional Growth Forecast accounts for vacation rentals and second homes, which are “unoccupiable,” meaning that they are not available for year-round residence. The result of this assumption is that more housing units would need to be developed to counteract the housing units no longer available to residents for long-term occupancy. Third, data for all the counties in the U.S. show that as the population ages, household size declines, and the Series 14 Regional Growth Forecast assumes that due to the aging</p>



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<p style="text-align: center;"><b>Gatzke Dillon &amp; Ballance LLP 2</b></p>		
<p>L195</p>	<p>As relevant background, Village 14 and Planning Areas 16 and 19 are part of the Otay Ranch General Development Plan/Subregional Plan approved by the County of San Diego and City of Chula Vista in 1993. Otay Ranch, portions of which have been built out, is a complete community approved for 24,000 homes; commercial/retail uses; other non-residential uses; schools and public services; parks, recreation facilities, open space and a protected biological preserve; and complementary amenities designed to be developed over a 30- to 50-year period. Consistent with the land use parameters established in 1993 for Otay Ranch, the County of San Diego Board of Supervisors, in June 2019, approved the Specific Plan and Tentative Map for the Adara community for up to 1,119 residential units and other complementary uses (such as parks and trails, a public safety site, an elementary school, and resident-serving commercial). As a general matter, development of the approved Otay Ranch planned community—of which Village 14 and Planning Areas 16 and 19 is a part—has been accounted for in regional plans and projections since 1993.</p> <p>As discussed below, however, it appears that SANDAG’s Draft Plan has omitted from its design assumptions the Adara community and its approved uses, resulting in a disconnect between the Draft Plan and the legal status of Adara as a fully-entitled project located within Otay Ranch.</p> <p>We understand that the Draft Plan strives to transform the way San Diegans move through and about the region in an effort to address safety, traffic congestion, social inequities, air pollution and greenhouse gas (GHG) emissions. The Draft Plan includes an updated Sustainable Communities Strategy (SCS), which sets forth a “forecasted development pattern” that is designed to: (i) achieve per capita GHG reduction targets set for the region by the California Air Resources Board (CARB), (ii) accommodate the Regional Housing Needs Assessment (RHNA), and (iii) utilize the “most recent planning assumptions.” (Draft Plan, p. 19). SANDAG reports that its SCS will exceed CARB’s 2035 reduction target for the region by one percent; i.e., a 19 percent reduction is required and the SCS, if implemented, will realize a 20 percent reduction.</p> <p>We provide the following comments on the Draft Plan, including its SCS:</p> <p>1. Government Code section 65800, subdivision (b)(2)(B) requires SANDAG “to use the most recent planning assumptions considering local general plans and other factors” (italics added). In this regard, Figures F.7, F.8 and F.9 in Appendix F of the Draft Plan are in error and must be corrected to ensure SANDAG’s compliance with this statutory requirement for its SCS. Specifically, the referenced figures show approved and entitled development located within Otay Ranch—including Village 14 and Planning Areas 16 and 19—as “Vacant” on the SCS’ land use pattern maps for 2025, 2035 and 2050. This is obviously incorrect.<sup>1</sup> The “Vacant” appellation is inconsistent with the County’s approval of its General Plan in 2011, the Otay Ranch General Development Plan/Subregional Plan in 1993, and the Adara Specific Plan and Tentative Map in 2019. As such, it results in development forecasts that are incorrect and incapable of supporting the Draft Plan’s findings and objectives. Therefore, we respectfully request that SANDAG modify the referenced figures to reflect the land use densities long-approved by the County and long- recognized by its General Plan for this portion of unincorporated South County.</p>	<p>population in the region, a similar pattern will be observed. This is achieved by converging to household formation rates from the 2010 decennial census by 2035, which are held at that level through the end of the forecast.”</p> <p>The 2021 Regional Plan includes investments in a housing program to coordinate with local jurisdictions, developers, and other stakeholders to accelerate affordable housing production near jobs and transit.</p> <p>Government Code section 65080(b)(2)(B) provides that a Sustainable Communities Strategy (SCS) “use most recent planning assumptions considering local general plans and other factors.” It also requires that the SCS “set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the 2021 Regional Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan. The Regional Plan forecasts development through 2050 consistent with projections from the California Department of Finance but does not represent buildout of jurisdictions’ General Plans. The Otay Ranch Village 14 and Planning Areas 16 and 19 had not been approved by the Board of Supervisors at the time the SCS Land Use Pattern was developed, and it was not projected for future development in the SCS. The Regional Plan and its SCS are iterative planning documents that are typically updated every four years to account for new data, analysis, policy, and experience.</p>
<p>L196</p>	<p>2. The Draft Plan’s forecasted development pattern will not accommodate the RHNA. Specifically, the Draft Plan—in Table F.3 of Appendix F—projects the construction of just 7,419 dwelling units in unincorporated County areas over the next roughly 30 years (through 2050). This number does not accurately represent the amount of approved, planned and reasonably anticipated growth in the unincorporated areas. For example, in the 6th RHNA Cycle, which covers the 2021 through 2029 planning period (and thus does not align with the 2035 horizon year of the SCS modeling), SANDAG assigned 6,700 dwelling units to the unincorporated areas.<sup>2</sup> Therefore, it appears the Draft Plan assumes that a mere 719 additional units will need to be built in unincorporated areas between 2030 and 2050, an assumption that is at odds with reasonable approximations of future RHNA cycles and existing market supply-and-demand evaluations for the San Diego region. The Draft Plan’s assumption of 7,419 units also is approximately 1/8th of the County’s General Plan build-out capacity of approximately 65,000 dwelling units. Thus, we respectfully request that SANDAG reevaluate the reasonableness of its forecasted development pattern</p>	<p>The 2021 Regional Plan accommodates the regional housing need determined by the Department of Housing and Community Development for the 6th Cycle RHNA. Government Code section 65080(b)(2)(B) requires that the SCS “set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board.” The SCS included in the 2021 Regional Plan projects development that would achieve the state-mandated GHG emissions reduction target when integrated with the transportation investments, programs and policies in the Plan.</p> <p>The Regional Plan and its SCS are iterative planning documents that are typically updated every four years to account for new data, analysis, policy, and experience.</p>

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L197	<p>by way of housing growth assumptions. It is critical to ensure that all modeling inputs are informed and reasoned, such that the SCS quantification analysis is defensible.</p> <p>3. It is unclear to what extent the SCS and its supporting quantification framework account for the home-to-work, interregional commute reality present in San Diego. We know that the San Diego region's failure to provide sufficient in-County housing opportunities has resulted in the exportation of some San Diego workers who now must commute into the region from more affordable housing opportunities in Riverside County or Mexico.<sup>3</sup> The spirit of Senate Bill (SB) 375, which created the statutory framework for SANDAG's SCS, will not be met unless and until we grapple with how land use choices made in the San Diego region affect San Diego workers. The Draft Plan must clarify SANDAG's strategies for reducing interregional commuting. Such strategies must ensure a sufficient quantity of in-County housing opportunities exists; otherwise, home-to-work, interregional commuting will continue to be a major problem.</p>	<p>As described in Appendix F, the Regional Growth Forecast has accounted for the need to increase the quantity of in-County housing opportunities. Appendix F includes the following language: "First, the forecast assumes the region's vacancy rate would increase to 4% by 2040. The 4% vacancy rate assumption acknowledges that the region's vacancy rate in 2018 was estimated to be less than 2% and that both state and local housing policy has recently focused on accelerating housing production. Second, the forecast assumes that the Series 14 Regional Growth Forecast accounts for vacation rentals and second homes, which are "unoccupiable," meaning that they are not available for year-round residence. The result of this assumption is that more housing units would need to be developed to counteract the housing units no longer available to residents for long-term occupancy. Third, data for all the counties in the U.S. show that as the population ages, household size declines, and the Series 14 Regional Growth Forecast assumes that due to the aging population in the region, a similar pattern will be observed. This is achieved by converging to household formation rates from the 2010 decennial census by 2035, which are held at that level through the end of the forecast."</p> <p>The 2021 Regional Plan includes investments in a housing program to coordinate with local jurisdictions, developers, and other stakeholders to accelerate affordable housing production near jobs and transit.</p>

Good Neighbor Project San Diego

L198	<p>My family has lived in Barrio Logan/Logan Heights for over 100 years I'm a retired school teacher and founder and Exec Dir of the Good Neighbor Project SD my home and office is located at 2215 Logan Ave. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities. Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan (Draft Plan)</p> <p>Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know Re-Connect Logan Freeway Lid will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.</p> <p>As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans and while we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.</p> <p>Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, it is appropriate to identify and call out Re- Connect Logan Freeway Lid as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:</p> <p>The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)</p> <p>Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)</p> <p>Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)</p> <p>Besides being in line with the 2021 Draft Regional Plan, Re-Connect Logan Freeway Lid is also pursuant to Appendix H in</p>	<p>Caltrans District 11 has also expressed interest in exploring opportunities for freeway caps. In alignment with the 2021 Regional Plan, SANDAG and Caltrans District 11 are currently developing Comprehensive Multimodal Corridor Plans in coordination with agency partners and local city governments. Comprehensive Multimodal Corridor Plans (CMCPs) are data-driven plans to reduce congestion and generate transportation choices while preserving community character and creating opportunities for enhancement projects. Opportunities for freeway caps will be considered in the CMCPs.</p>
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	<p>relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional Plan.</p>	
<p><b>Harvey Levine</b></p>		
<p>L199</p>	<p>I need to preface my comments by expressing my admiration for the product that SANDAG has produced and for the investment that has been made in developing a potentially ideal transit-based solution to the environmental and density challenges with which we are faced in this remarkable county. The professionalism and quality exhibited in the published works are of the highest rank and served me well in my quest to understand the goals of the RTP and the methods to achieve them. It is indeed a visionary expression of a world-class system for a future population. I recognize the seriousness of the challenges and I fear for the future of the planet. I applaud the bold and creative efforts to meet these challenges head on, to work to meet state and federal mandates, and to qualify for state and federal funding and subsidies where available.</p>	<p>Thank you for reviewing the draft Regional Plan and for your compliments on this report.</p>
<p>L200</p>	<p>In my consulting practice I have often been engaged to perform due diligence on business cases for major programs and for proposals for new business initiatives. As I became deeply interested in the 2021 RTP, I couldn’t help seeing items that sounded alarms and triggered reality checks. As I have seen all too often, the search for the ideal has surpassed the practicalities of what is reasonable and achievable. I also am concerned that the sponsors may have based their assumptions on a best case or “wished for” values rather than a most likely set of scenarios. This plan begs for a responsible investigation and evaluation of the RTP by members of the SANDAG board who will carry the responsibility for this investment in the future. There is actually more at risk than an investment. The county appears to be committed to facilitate and mandate a radical change in the culture and behavior of a vast populace whose lifelong belief is that having a personal vehicle to go anywhere, at any time, is an inalienable right. The board is not voting for a transportation plan. It is voting to mandate a change to the very foundation of our lifestyle. They better get it right. We need to do something that will work.</p>	<p>Starting in 2019, the Board discussed the development of the Regional Vision for the draft 2021 Regional Plan. The Board will be asked to take action to adopt the proposed final 2021 Regional Plan in December 2021.</p> <p>For more information regarding the Board of Directors meeting, and staff reports pertaining the Regional Plan, please visit: <a href="https://sdforward.com/about-san-diego-forward/staff-reports">https://sdforward.com/about-san-diego-forward/staff-reports</a>.</p> <p>Please note that both federal and state transportation planning law require RTPs to be revenue-constrained and capable of implementation, and the 2021 Regional Plan has been prepared consistent with these requirements.</p> <p>Appendix M of the 2021 Regional Plan describes the progress SANDAG has made on actions from the 2015 Regional Plan and 2019 Federal Regional Transportation Plan.</p>
<p>L201</p>	<p>Actually, there are two huge hurdles. One is the nature of people to resist paradigm shifts. Cultures cannot be mandated. They exist by will of the people. The 2021 Regional Plan makes assumptions of colossal culture change that cannot be reasonably presumed. This is a fact of life that governs what can be accomplished, no matter how “good” it is for the people and for the planet. For example we need only look to our current COVID-19 crisis. The only way out of the pandemic is via vaccination. The science is certain. The data is monumentally supportive. Yet, a major portion of the population refuses to do what is good for them and for the nation. Has this artifact of human nature been given adequate consideration in the plan?</p> <p>The second hurdle, which has led to the demise of even the most seemingly foolproof plans, is the failure to consider the potential downside of the business case. In every plan there is a range of possible outcomes. We can look at the case through three lenses; the optimistic, the most likely, and the pessimistic. Where things fall apart is when exuberant support for the “optimistic” case causes the sponsor to downplay the “most likely” and to ignore the “pessimistic, and the associated risks.”</p> <p>The pessimistic case fully considers risks. It creates alternate models representing the potential downside. The downside can happen. Even the most infallible plans have collapsed, leading to total failure of the venture, because of the reluctance to use assumptions that consider potential events and conditions that are not of the sponsor’s liking.</p> <p>Here in San Diego, even in SANDAG, we have a history of inflated assumptions. We have seen it in the forecast of pension funding and in the projection of tax revenues. We have also seen it in the estimates of transit ridership. What assurances can you give the public that the 2021 Regional Plan is not based on inflated assumptions of income, ridership, or even the level of acceptance of change by the public?</p> <p>Where are the models that represent a lesser level of expectations and what that would mean to accomplishment of the goals? I see a presentation of the ideal. Where is the picture of the realistic?</p>	<p>The 2021 Regional Plan addresses transportation and mobility challenges we face: safety and traffic congestion, social inequities, and complies with state and federal requirements to reduce greenhouse gas (GHG) emissions and air pollution, among other requirements. A compliant Regional Plan is needed for the San Diego region to receive federal and state funding for transportation projects, programs, and services and housing programs.</p> <p>Appendix S documents the transportation demand modeling tools and off-model calculators used to analyze performance of the Regional Plan. Appendix F describes the Regional Growth Forecast and Sustainable Communities Strategy Land Use Pattern, including projected population, housing, and job growth.</p>
<p>L202</p>	<p>Director Ikhtrata boldly declares that it is the plan’s intention to pressure the public to change its wasteful use of personal motorized vehicles as a response to environmental concerns of growing proportions, as well as to meet various government mandates. He talks about incentives. But when queried about how the change in behavioral culture will come about, he repeatedly brings up “pricing”. He says “it will work if we price it right.” Of course “pricing” is a code word for “fees.” Using a euphemism cannot disguise what it is.</p>	<p>Thank you for your comment. SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. The initial phase of this study will focus on calculating the true cost of driving, and better understanding what sources of existing revenue are funding different parts of the system and how different populations are impacted by existing revenue mechanisms. This foundational understanding will help</p>

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	<p>Invoking new fees, to use what has been considered to be something already covered by our taxes and DMV fees, is not an incentive. It is a penalty. The plan openly sets out to punish the public for doing what has been considered one of its most appreciated freedoms – the ability to get places, in the comfort and convenience of our own vehicles, on a timetable of our own choosing. SANDAG would have us give up this sacrosanct right and has set about to force the changes upon a recalcitrant public.</p> <p>The pricing scheme is so devious that it not only imposes fees and taxes (a penalty, not an incentive) to force people to stop doing what is considered an inalienable right, but then directs the funds it collects away from what is wanted by the public (highway improvements). What kind of incentive sets out to punish rather than reward?</p> <p>Let us not forget or ignore the penalties already inflicted on the driving public and the failures of previously imposed taxes to deliver what was expected or were diverted to other initiatives. For example I submit my motorcycle registration fee of \$233, which would cost me \$13 in NY. Or the income from the ½ percent TransNet sales tax that was grossly underestimated and is slated to be diverted from the highway projects it was supposed to support.</p>	<p>SANDAG to design a road usage charge program that is more fair than current transportation funding sources.</p> <p>The study will also assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no particular group, such as those driving fuel-powered vehicles, are paying more than their fair share.</p>
L203	<p>Now, looking at some of the initiatives in the RTP, there are data that belies the expected results. Director Ikhata was asked if he could provide an example of where MANAGED LANES was implemented. Oddly I-15 was used as an example. However, the design calls for Managed Lanes for I-5 and CA-78/56/52 without adding new lanes (except for repurposing shoulders), whereas the I-15 project created four additional lanes for HOV or toll-payer use. Unless all of the lanes are contiguous (which they are not) and narrow bridges are widened, the periodic merging of lanes would create new bottlenecks and backups. So would any breakdowns, public safety vehicles, or emergencies that would impact the travel lanes in the absence of shoulders. Is this really safe or practical? How would traffic control (police radar and traffic stops) operate? What happens in a medical emergency or when a vehicle has a mechanical problem, a flat tire, or runs out of gas or battery power? How is congestion reduction alleviated when a lane is isolated for busses? This model of managed lanes is more like a game of whack-a mole. I am apprehensive of drivers' attention being diverted from the road by a system of signs and signals directing them to a particular managed lane that changes with traffic conditions.</p> <p>How effective would the Managed Lanes concept be if it doesn't involve increased reliable capacity? SANDAG projects an increase in use of mass transit (at peak commuting times) from about 3% to 11.2% (in 2035). Will this be enough to sufficiently impact the carbon reduction goal? SANDAG is also projecting a population growth of 15.2% by 2035. It would seem that the movement of commuters to transit will not be enough to offset the growing demand for roadways. How do we significantly reduce congestion (a key goal) without increasing capacity? Do we gain enough to justify the cost and inconvenience of construction and repurposing plus the imposition of user fees?</p>	<p>The Managed Lanes concept is envisioned in the 2021 Regional Plan. They provide a system of managed lanes allowing the opportunity to dynamically manage the lanes based on real time conditions, time of day, and vehicle occupancy, to make all lanes more efficient and provide benefits to the system as a whole.</p> <p>Public safety impacts of the proposed Project are discussed in section 4.16 of the Draft Environmental Impact Report, specifically impact TRA-3, which analyzes any increases in hazards due to design features.</p>
L204	<p>On the other hand, there are other conditions that might represent a reduction of emissions-producing vehicles. Among the important forecast values that we must consider for the RTP is the impact of electric vehicles. All manufacturers are making massive investments and commitments to have a majority of their output be EVs, within a decade. Governments are equally committed to replacing petroleum-fueled vehicles by 2035. Are we likely to gain more in the real goal of reduced greenhouse gases through the mandated and incentivized move to EVs?</p> <p>When the shift to EVs is added to the impacts of more workers not having to drive to an office every day, potentially offsetting the population growth, the expense and "pricing" of the full managed lanes solution may not be warranted. Not if the justification is the reduction in the production of GHG. As an aside, we have to learn not to justify massive, expensive projects because there is government funding earmarked for such programs. Yes, I am thinking of California High-Speed Rail. These programs always end up growing extensively beyond the original (misrepresented) scope and cost, causing the agencies that thought that they were getting a free lunch to bleed real cash.</p>	<p>Thank you for your comment. The 2021 Regional Plan commits SANDAG to making investments to support the region's transition to electric cars, trucks, and buses. To achieve GHG reduction targets, the 2021 Regional Plan relies on both the transition to electric vehicles and managed lanes.</p>
L205	<p>Let's get back to the "incentives" to get drivers to shun their cars. The "right" pricing essentially means making it painful to pay the VMT (vehicle miles traveled) fees. What I am hearing now is a charge of two cents per mile for the state plus two cents per mile for the county. So a highway trip from Rancho Bernardo to downtown and back would cost about two dollars. That is enough to make people angry, but not enough for them to use other means for travel. If they don't meet the HOV criteria, it's either pay additional fees or be limited to what are designed to be slower lanes. In the latter case, how does that help relieve congestion? It just pushes lower income drivers to use the most congested lanes. How does that support the stated "equality" goals?</p> <p>The "right" pricing – that is; fees that will cause drivers to shun the controlled highways – may eventually lead to drivers eliminating such trips altogether. That may help the goal of easing congestion. But there will be offsetting penalties if the cancelled trips lead to people not shopping, eating out, or going to entertainment venues. This, in turn, will reduce income from sales taxes as well as impact the bottom line of these businesses (more tax losses). Has this been factored</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>As usage-based fees are further studied, SANDAG will complete an Interstate 15 Operational Study to build</p>

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	<p>into the equation? When combined with other initiatives, such as reducing or completely eliminating parking in many areas, both business and residential, the campaign against car owners becomes draconian. The thinking is that if people are using MASS TRANSIT and local connection options there will no longer be a need to own a personal vehicle. So whether you're going out to the mountains to go hiking, or over to Costco to load up on groceries and a 30-roll package of toilet paper, can you say that you really don't need a car?</p> <p>Sure! Hey guys! Let's grab our beach chairs and umbrellas, the cooler, our cornhole game and a couple of surf boards and take the bus over to Cardiff State Beach (from Green Valley in Poway). And we'll stop off for dinner in Rancho Santa Fe on the way home, toting all our stuff. Currently, there is no reasonable mass transit to support that (according to MTS trip planner). The software did come up with a solution that would take four hours just to get to the beach, using four busses and the Sprinter (plus some walking) and told me to start 90 minutes earlier than I had specified. Is better coverage in the works? Would the group be able to make the trip in one day? Could they manage with all their gear?</p> <p>So let's stop dreaming about a world without cars. Can we be practical and come up with ideas and real incentives to cut down on VMT?</p> <p>Furthermore, as an "incentive" to dump your car or truck, the plan calls for charging for parking spot use and even to pull over to the curb. Yes, it's in the plan – see page 40 "Parking and curb pricing." Pricing is the term that is used for "fees."</p> <p>With the estimate of only 11.2% of commuters using mass transit (and less for the general public) what we need is more parking. We shouldn't need to drive around looking for parking spots or hang out at the curb with the motor running. If you want to change behavior, do it with rewards, not with penalties. While there are some interesting ideas in this plan, I predict that the overall result will be to nickel and dime car owners in multiple ways without actually achieving the results that are expected.</p>	<p>upon the success of the managed lanes currently operating in the region.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
L206	<p>The concept of MOBILITY HUBS is interesting. Providing flexible transit in selected concentration areas would be sensible and likely take care of some of the "last mile" issues that hinder the practicality of using mass transit. Here again, there are disconnects between wishful thinking and practical outcomes. The mobility hubs may be considered to be frequent destinations for the public. But what do people do on the other end (their origination point) when it's not in a mobility hub area. I reside about 1 ½ miles from the eastern edge of the Rancho Bernardo mobility hub (92128). About half of my family travel is to points within that hub. But how do I get to that hub without a car? (I do use my e-bike for some of this, but not if I am shopping or if I have to cross hazardous intersections, such as the I-15 ramps.) The expectation that businesses will all of a sudden relocate to properties within a mobility hub is speculative, at the most. Where is the evidence? Furthermore, if the new model is for these businesses to not have parking then the people will choose to take their business elsewhere. In the end, SANDAG may achieve their goal to reduce VMT. The public will do their shopping on-line. They'll enjoy their own cooking at home. And the biggest accomplishment will be a local business decline and more tax losses. The roads will be wall to wall with gas-guzzling Amazon vans.</p>	<p>The regional network of Mobility Hub areas overlaps with communities that already feature higher concentrations of people, places, and trip-making. As SANDAG partners with cities, transit agencies, and additional entities to deploy Flexible Fleet solutions these services will not only help people travel within a hub but also to places beyond and between hubs. Please refer to Figure 2.4 in the plan which illustrates how Flexible Fleets expand coverage to neighborhoods beyond the mobility hub areas. In areas outside of mobility hubs, Flexible Fleets such as shared, electric, and eventually autonomous shuttles would be available on-demand, ready to take you where you need to go. Today, services like on-demand rideshare, microtransit, and vanpool already provide a convenient travel option in areas where traditional fixed transit may not work well.</p> <p>The 2021 Regional Plan does not assume existing businesses would relocate to mobility hub areas. Rather, these are areas where future growth can be focused to accommodate projected population, housing, and job growth in the San Diego region. Since our region is approximately 90% built out, the plan assumes some growth in populations and jobs can occur in the mobility hub areas. However, there's no expectation for sudden re-location as the plan's transformational transportation system has been designed to better connect where jobs are already situated. Some infill can occur in employment centers such as what's happening in communities like Kearny Mesa.</p>
L207	<p>Bringing usable, frequent mass transit services to San Diego is something that we can all appreciate. But assuming that the car culture will significantly change because of the transit improvements is pie in the sky. No amount of disincentives will remove the need for highways and parking. From a personal perspective (I live in 92128), I see little that serves my needs or interests. This area and adjacent Poway and places east are hardly served (except for a snippet of the RB mobility hub). The proposed Rapid bus is the same as now, except with improved frequency. But the transit stations are not easily accessible except by car. With all the plans for commuter rail and light rail, the I-15 corridor is ignored. That is; except for the ghost of the California High-Speed Rail, which surprisingly shows up on Figure 2.3 – the Transit Leap map. I suspect that most of San Diego will have fallen into the Pacific before this foolhardy venture reaches any place where people live, let alone stretching south of I-10. Placing it on the Transit Leap map doesn't help to generate any confidence in the rest of the plan.</p>	<p>Thank you for your comments and your interest in mobility in our region. We encourage you to stay engaged by visiting <a href="http://SDForward.com">SDForward.com</a>. Public engagement will continue until the Board is asked to adopt the 2021 Regional Plan in December 2021.</p> <p>Regarding the I-15 corridor, the I-15 Corridor is difficult to serve with rail because of the development patterns which resulted in widely spread out communities. This area is served by Rapid bus routes which will be expanded in the future with more services.</p>
L208	<p>In regard to this Bakersfield/Fresno/Merced rail, I hear horrifying stories of issues with acquiring land rights. Have the experiences from that venture been factored into the land acquisition needs for transit and mobility hubs? If land</p>	<p>The implementation of the proposed 2021 Regional Plan will be a truly collaborative effort between SANDAG, local jurisdictions, transit agencies, private developers, and employers. While land acquisition may be considered for certain projects, land use decisions are reserved to local jurisdictions. Innovative public-private</p>

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	acquisition is an issue in the sparsely populated SR-99 corridor, have we honestly considered the challenges in coastal San Diego? Is this a deal killer?	partnerships can be forged to fund, design, and implement various aspects of mobility hubs including stations, complete corridors improvements, and other mobility hub amenities.
L209	Back to my personal travel habits and needs. I recently purchased an e-bike and use it almost daily. I take it to the tennis courts on week days – just less than a mile and with no major intersections. I love the ride and am happy to not use my gas engine vehicles for such short trips. But the e-bike is not practical for most errands and my primary use is for exercise and recreation. There are several areas where I cannot ride because of poorly maintained bike lanes or unmarked bike lanes in high-traffic streets and intersections. The nearest formal bike trail (I-56) is about a ten mile ride over a treacherous, unmaintained bike lane on Carmel Mountain Road in Rancho Penasquitos. The money available for biking would be better spent on improving these impediments than in uprooting city streets to make us look like Holland. Also, I would not be able to use the e-bike with mass transit because the bike is too heavy to put on the bike carriers. (Does anyone ever use these? I never see a bus with a bike. I also never see a bus with more than two passengers.)	As an early action out of the Regional Plan, SANDAG will be developing a new Active Transportation Plan. The plan will take a fresh look at the network and the options to make it safe and comfortable to use active transportation.  Your comment was forwarded to the City of San Diego.
L210	I have not addressed the practicality of the proposed high-speed coastal rail or other light rail expansions due to lack of details. Shouldn't we be looking at a set of alternatives, rather than a single plan? On the LOSSAN corridor segment, I'd like to see figures for a solution based on upgrading the Coaster system, rather than assuming that a new high-speed system is needed to meet our goals. The benefits of a high-speed train tend to be grossly overstated when one considers that the actual rail time is just a small portion of the overall door-to-door trip time. Doubling the speed of a locomotive may equate to a 5% to 10% improvement in trip time. Increasing distances between stations makes the use of high-speed rail less convenient and may add additional time to last-mile segments. Frequency (less waiting time) may contribute more to shortening trips than high speed. It is good to see this in the plan.	The Regional Plan identifies investments in the LOSSAN corridor to improve capacity, speeds, safety, frequency, and significantly reduce travel time primarily due to higher-speed realignments with the Del Mar Tunnel and Miramar/UTC Tunnel. In 2020, SANDAG began work on a Regional Rail Alternatives Alignment Study ( <a href="https://www.keepsandiegomoving.com/Libraries/Lossan-PDFs/SAN-LOSSAN-DMB-FactSheet_LongTermAlignment_11-10-2020.sflb.ashx">https://www.keepsandiegomoving.com/Libraries/Lossan-PDFs/SAN-LOSSAN-DMB-FactSheet_LongTermAlignment_11-10-2020.sflb.ashx</a> ) that identifies incremental higher-speed upgrades to the LOSSAN corridor to meet the goals in the Regional Plan.
L211	<p>On a final note, I am compelled to comment on some disturbing issues relative to the relationships and behavior between the agency (SANDAG), the SANDAG Board of Directors, and the public. There is no way that we can accept the response by Director Ikhata to criticism voiced by board member Rodriguez (Oceanside), at the 5/21/21 SANDAG presentation. Obviously dismissing the board member's right to question the RTP, Ikhata interrupted to say "We are the experts." It is this attitude that highlights the importance of the Board exercising its responsibility to provide oversight and leadership for this important agency.</p> <p>We must further question the intent of Director Ikhata to influence the recent Supervisor election, and hence the selection of board members by making a political contribution to a likely supportive candidate in opposition to a candidate that voiced resistance to the developing RTP. How these two incidents can go unchallenged is beyond belief. Where is the oversight?</p> <p>As I began to follow the RTP, the early news headlines consistently noted the sense that the Board was heavily leaning toward support for the emerging RTP. It appeared to represent a desire to take strong action to deal with the very real concerns regarding global warming and to address how re-envisioned transportation models can contribute to a viable solution.</p> <p>Politically, it seemed sound to jump on the band wagon. However, as the details of the RTP were meted out to the public, there has been virtually unanimous rejection of the Plan. The public is saying that they do not favor the RTP and cannot see it as something that will produce the stated goals. One comment: "This is NUTS!" The board needs to listen.</p> <p>As a concerned voter in San Diego County, it is my expectation that our representatives on the SANDAG Board of Governors will ask the type of questions that I highlighted here and to make certain that the RTP is based on honest assessments and assumptions. Due diligence requires that proposals consider a range of outcomes, based on an open-minded assessment of risks and variables. Common sense requires that we fully consider human factors and culture. Transparency should come with honest language that does not sugar-coat the burdens to be placed on the public to gain compliance.</p> <p>I ask the SANDAG Board of Directors to provide intelligent oversight of SANDAG and the RTP, and to recognize the voice of the people in questioning the rationale and achievability of the proposal.</p>	Thank you for your comment.
L212	High-speed Rail: Going from 60 MPH to 120 MPH will not deliver a great time savings if distances between stops are greater and time from station to destination is increased. The easiest and most economical way to make train-based travel faster is actually to have stops closer to the "last-mile" and to up the frequency so that travelers don't have to spend the projected time gained waiting for the next train. Commuter rail, with short distances will not gain much from doubling the top speed. Electrification will help acceleration times and reduce GHG emissions. Can we modify what we already have and still achieve our goal -- faster and cheaper? Urban/suburban rail should run every four minutes in peak travel times and every eight minute at other times. At the least a ten minute interval would free travelers from needing	Thank you for your comments and your interest in mobility in our region. We encourage you to stay engaged by visiting <a href="http://SDForward.com">SDForward.com</a> . Public engagement will continue until the Board is asked to adopt the 2021 Regional Plan in December 2021.  The 2021 Regional Plan proposes increased frequencies, longer spans of service, grade separations, and express service on the existing transit system in addition to an expanded transit network with new higher speed commuter rail in the highest demand corridors.



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L213	<p>to use timetables. Stations should be closely spaced and easily accessible by walkers and bikers as well as personal vehicles. Adequate parking will be needed. Express trains can be added to accommodate longer distance riders.</p> <p>Managed Lanes: The biggest cause of highway congestion is the intermittent loss of a traffic lane. You can see that every day in places like I-15 northbound as it approaches the Bernardo Center Dr. and Rancho Bernardo Rd. interchanges. In this very short distance, the main highway loses one lane (due to narrow overpasses) and the traffic will back up at times of heavy use. Other causes of backups are vehicle breakdowns, police activity, and accidents. There MUST be space for vehicles to pull to the side of the road without losing a traffic lane.</p> <p>The maximum capacity of any highway is determined by the capacity at its most constricted point. The plan calls for increasing capacity on limited access highways, such as SR-56, by utilizing shoulders. SR-56 would increase from four lanes to seven lanes. However, the inner shoulders are only four to eight feet and they do not continue at the six locations where the highway goes over a bridge. It seems that this would require adding lanes on the existing divider and building six new bridges at the overpasses to accommodate the three additional traffic lanes. Without this, the bottlenecks would nullify any gains from the added lanes.</p>	<p>Managed lanes are meant to be flexible based on the needs of the corridor at different times of the day by using real-time data through the Next Operating System (Next OS). In the event of a breakdown or accident lane designations can shift to accommodate emergency vehicles while managing traffic flow.</p> <p>SANDAG and Caltrans are currently preparing several Comprehensive Multimodal Corridor Plans which aim to create a comprehensive set of safe, sustainable, and equitable transportation solutions that are tailored to the needs of the corridor. The design and operation of the managed lanes network will be further assessed through these Plans and other detailed engineering studies.</p>
L214	<p>Rapid Bus Plazas: These will have to be considerably upgraded if Rapid Bus is to be a principal component of a four-fold increase in mass transit patronage. As I look at the plaza closest to my residence, Rancho Bernardo, I see some major issues. Parking would have to be significantly increased, since the planned Flexible Fleets in Mobility Hubs will not reach all users. Plazas would likely need to be enlarged. Where will we find the land for this?</p> <p>Also, at Rancho Bernardo, the transit plaza is not accessible from the east side of I-15. Walkers or bikers cannot readily get to the plaza. This can be remedied by building a pedestrian/biker structure from the east side of the I-15 bus ramp, over the northbound lanes of I-15 to adjacent Iberia Pl. This would provide easy access to the downtown business area of RB and several residential neighborhoods that do not have that access now. For me, the walk or ride would be 1.2 miles, rather than 2.6 mi via dangerous route and 3.0 miles via safer route.</p>	<p>Flexible Fleet services can extend beyond Mobility Hubs to get travelers to and from their origin, destination, and fixed transit stations. SANDAG will work closely with local jurisdictions and transit agencies to design transit stations and stops to meet the needs of the surrounding community. We encourage you to stay engaged by visiting <a href="http://SDForward.com">SDForward.com</a>. Public engagement will continue until the Board is asked to adopt the 2021 Regional Plan in December 2021.</p> <p>Your comment was forwarded to agencies that oversee these facilities.</p>
L215	<p>Biking: I have recently joined the population that is using bicycles for short trips, as well as recreation. Mine is an e-bike and I can easily do round trips of up to 30 miles, even with the hills in my area. What I can't do is to make these trips in safety. The city and SANDAG are hyping their support for biking to alleviate some of the pollution and congestion caused by motor vehicles. But they can't even maintain the bike paths that we already have. Also, to use bikes for commuting (SANDAG is counting on at least a tripling of biking to work) we need well marked bike lanes and paths that are contiguous. Many of the areas are interrupted by stretches of missing or unmaintained bike lanes. We need more consistent riding paths and much improved driver education and awareness. The recent efforts to use green paint for bike lanes and to add a buffer between the bike lane and car lane need to be expanded as rapidly as possible. Adding a well-marked bike lane at left turns would be a welcome safety addition. I have seen this only at one place, the intersection of Carmel Mountain Rd. and Rancho Carmel Dr (next to Costco).</p> <p>With 12 deaths to bikers in seven months, more has to be done promote safety. Countless injuries are awaiting bikers that are forced to ride on unmaintained bike lanes, opening up municipalities to large law suites.</p>	<p>The 2021 Regional Plan aims to create safe and well-connected routes for bicyclists and pedestrians. The intention of the network in this Regional Plan is a framework which facilitates trips associated with regional purposes designed to enhance neighborhood connections to schools, employment centers, and other everyday destinations. The regional network will not include details regarding the types of bicycle and pedestrian facilities for specific projects are not yet determined and will require future planning and coordination with local jurisdictions, community members, and other stakeholders.</p>
L216	<p>Reducing Carbon: The RTP aims to reduce GHG emissions, primarily by penalizing travel with cars and trucks. However, as I interpret the plan, the methodology is aimed at generating new income from road usage fees. The plan bemoans the loss of gas tax income from drivers of EVs. Instead of providing incentives for driving EVs, the plan requires that EV owners pay a fee to cover the gas tax losses and then, adding insult to injury, earmarks that revenue for mass transit.</p> <p>Would it not make more sense to offer payments to gas and diesel car and truck owners to turn in their cars and get them off the road? Couple this with rebates to exchange their petrol cars for EVs.</p> <p>California registration rates are backwards. The fees should be based on weight and gas mileage, not property value. A Chevy Tahoe produces more wear and GHG than a Porsche 911. But the Porsche owner pays way more for registration. The owner of a BMW K1600 motorcycle pays more than for a Ford Fiesta. The latter weighs more than three times as much and uses twice the gas, but pays less for the registration. EV owners, with vehicles that are emission free and have less aggressive tires should get a break.</p> <p>This may be extreme, but if you really want to cut GHG you can go to fuel rationing. There is a direct relationship between the fuel burned and the amount of emissions. But this would not work in the face of a model which is designed to generate usage fees, rather than cut emissions. It would also cut revenue from gas taxes. This may be an underlying factor in a model that is designed to generate income from fuel burners while the goal is to reduce the use of fuel. It is more likely to build the fee income than to achieve the stated goal.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target is achieved by a number of strategies, including reducing per capita VMT.</p> <p>The GHG Inventory (Appendix X) analyzes emissions from all sources and the projections account for state and federal legislation currently in place, as well as strategies within the 2021 Regional Plan. The 5 Big Moves will result in people having more travel options and operating solutions, reducing per capita VMT, and the local jurisdictions can identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.</p> <p>The Regional Plan supports investments in the electrification of cars, trucks and buses and their supporting infrastructure (e.g., EV charging stations and hydrogen fueling stations). These electric vehicle investments are one of the ways SANDAG is working to reduce regional GHG emissions and improve local air quality. Appendices A (Table A.17) and B show SANDAG's proposed EV commitments such as regional electric vehicle and charging infrastructure incentive programs. Innovation and advanced technologies will be critical to meeting regional GHG reduction goals in 2035.</p>

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<b>Jacumba Community Sponsor Group</b>		
L217	On page 10, the plan states that in 2019, greater than 90 percent of CA-MEX trade was moved by truck across the international border. A great fact to know, but where does your regional plan address and mitigate for the smoggy trucks registered in Mexico that are hauling those goods? Will the plan only regulate the emissions of vehicles registered in San Diego County (or California) while out-state and out-of-country (Mexican) vehicles get a “free pass?”	<p>In California, regulation of vehicle emissions is managed by California Air Resources Board (CARB). CARB conducts inspections of heavy-duty trucks traveling in California including those registered out of state and from foreign countries. At border ports of entry CARB inspects heavy-duty trucks for excessive smoke, and engine certification label compliance. SANDAG partners with CARB and the San Diego Air Pollution Control District on air quality conformity (see appendix C) and emission reduction strategies across the region.</p> <p>In addition, SANDAG is committed to the following actions:</p> <ul style="list-style-type: none"> <li>• Pursue programs and projects to further policies focused on electrification of fleets, and Executive Order N-79-20 related to sales of zero-emission personal and medium/heavy-duty vehicles.</li> <li>• Plan for goods movement strategies that reduce border congestion that exacerbates emissions resulting from vehicle delay.</li> <li>• Continue coordination on strategies identified in the 2021 California-Baja California Border Master Plan.</li> </ul>
L218	On page 12, the plan states: “from 2016 to 2050, nearly 60 percent of population growth will be among those who are 75 years and older.” Will this aging population (60 percent who are projected to be people of color), feel physically safe while using public transit (buses, trams, trolleys) during evening/night time? Will they all have smart phones and be able to navigate a smart phone application that gives them a choice of transportation modality based on a variety factors including CO2 emissions?	<p>SANDAG has a long history of working closely with senior community members, social service providers, non-profits and community-based organizations to develop and fund specialized transportation services geared specifically towards the needs of seniors. The Regional Plan network includes a variety of modes that work together seamlessly to provide all San Diego residents, regardless of age or ability, access to multiple travel choices. Flexible Fleets are an example of an option that is particularly well suited for the senior population. Flexible Fleets options like ridehail, rideshare, and microtransit, offer a range of mobility options and vehicles that can accommodate many types of trips and meet the needs of various users. They can make it easy for seniors to access medical appointments and other basic needs without relying on a car. Flexible Fleet vehicles and services are adaptable in nature and can offer personalized accommodations, such as wheelchair lifts, door-to-door services, and other options for people with physical limitations. SANDAG has conducted outreach and will continue to engage with seniors to ensure their mobility needs are met. In addition, SANDAG is developing a Flexible Fleets Implementation Strategic Plan that will address potential barriers to accessing Flexible Fleets, ensuring options for people without smartphones or internet, providing education about how to access Flexible Fleets, and more.</p> <p>SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, MTS has reprioritized security funding from fare enforcement to safety improvements.</p>
L219	On page 15, the plan states that if the 2021 plan was implemented, “By 2050, this could result in 13 percent of commuters using transit (up from 3 percent today) and that there would be a substantial decline in commuters driving alone to work (from 80 percent today to 62 percent in 2050). Those figures do not reflect any significant behavioral changes regarding transportation choices given that this plan would greatly expand mass transit frequency and routes. In 2021, many city busses are carrying just two to three passengers while trolleys carry more passengers depending on their routes. How realistic are the 2021 plan’s predicted increases? Were urban residents asked about factors that would actually make them leave their cars and use mass transit instead? Was the current trend of working remotely from home factored into these calculations? What if the public perceives that it is not in their best interests to share a bus or a trolley with a group of strangers who may or may not be healthy? What happens when the next pandemic impacts our region and mass transit shuts down for public safety reasons? Clearly more studies on the current trends in mass transit usage must be analyzed before the predictions contained in this plan can be validated. Also, additional studies on post-COVID mass transit usage figures are critical. Analysisists should avoid using the data from any month when all mass transit ridership fares have been waived, as they will skew the data. (This will happen in September 2021.)	The performance of the 2021 Regional Plan is based on the best available data at this time. It will be important to continue to monitor trends and impacts to travel behavior as the Regional Plan is implemented and updated in the future. Priority Implementation Action 10 is to advance a data science program to better understand travel behavior in the region, update travel demand modeling tools, and improve transparency and reporting on program effectiveness and project delivery.
L220	On page 25, the 2021 plan calls for providing a variety of transit riders with reduced fares (seniors, low-income, students, youth and the disabled). This is fiscally untenable. What is the actual cost per passenger mile on a bus, trolley, or light rail? Appendix A predicts that in 2020 dollars, transit fare subsidies in 2035 will be \$982 million dollars and in 2050, subsidies will be \$4 BILLION dollars which means that the answer to the previous question about the cost per passenger mile must be too high to print!!! This plan cannot seriously contemplate spending \$4 billion dollars to possibly achieve a 13 percent increase in mass transit ridership.	Yes, the Regional Plan envisions a public transportation system that is cheaper to ride than in the past. By offering these lower fares, more residents, especially those in disadvantaged communities, will be able to afford transportation freedom. SANDAG has prioritized equity in San Diego Forward: The 2021 Regional Plan (2021 Regional Plan) more than ever before. Promising a system that is faster, fairer, and cleaner, the planning efforts intend to uplift people who have been historically faced with social injustice.
L221	The 2021 plan which seeks to “reimagine” regional transportation strategies appears to be a huge and costly wish list of programs and government regulations directed primarily at changing residents’ driving behavior at a tremendous loss of personal freedoms. It envisions spending millions of dollars to create an expanded bike network with corridors by	Build out of the Regional Bike Network along with investments in complete streets and Vision Zero programs are components of the 2021 Regional Plan that advance goals related to reducing greenhouse gas emissions, improving safety for all users, and advancing public health.



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	2050. Again, where is the data that shows that kind of expenditure will get more people out of their cars and onto bicycles? A recent case in point: the removal of 400 parking spaces along the business district on 30th Street in the North Park area so that bike lanes, that are rarely used to commuting to and from work, could be installed. Not only are the merchants upset about the loss of customer parking and business, but delivery trucks are now blocking bikes lanes to make their deliveries and handicapped parking has become confusing for those who need it. The 2021 plan will greatly expand on that unpopular and costly transportation strategy.	
L222	Under this plan, transportation in and around mobility hubs or areas of concentrated development (cities) would be highly regulated with curb management regulations/fees based on the time of day parking rates, and ride-hailing opportunities. Ride-hailing at mobility hubs is described as offering people on-demand vehicles for short and long-distance trips, possibly subscription-based services which would “allow people to reserve a vehicle that best serves the needs of their trip.” So, it is okay to rent/drive a vehicle but just not to personally own a vehicle?	Flexible Fleets are shared, electric, mobility services that provide greater options for making trips around the region. Different vehicles allow you to pick the service that best meets your needs and provide an option for people to rent a vehicle or share a ride as that can be more convenient and affordable than owning a personal vehicle.
L223	On page 32, the plan states: “In the San Diego region, almost half of all trips are three miles or less, and most everyday trips are made within neighborhoods using local streets.” Where is the data to back up this statement? This page also states: “On average, one person is killed or seriously injured in traffic violence everyday in the region.” Everyone understands the safety risks that they take when they drive a car and they believe those risks to be acceptable. Again, no driving statistics are referenced, and of course, the plan does not provide data on the numbers of people who are mugged walking down the region’s streets or at trolley stations, etc.	The SANDAG travel demand model is the data source for the region’s daily trip making estimates. Person trips, travel behavior characteristics, and related decisions are based on empirical data collection efforts conducted by SANDAG, Caltrans, and the federal government. Out of more than 13 million daily trips completed by residents, more than 6 million of those trips are 3 miles or less.
L224	Everyone agrees that climate change is real. On page 34, several climate strategies are listed. The blue pie chart at the top of the page lists “collecting rainwater” as one viable climate mitigation strategy. Why doesn’t this 2021 plan identify more impactful strategies such as building new reservoirs/expanding existing ones or building additional desalinization plants? It should be noted, that even if the 2021 plan is implemented, it will not stop the sea levels from rising.	The Venn Diagram on page 34 of the 2021 Regional Plan, is illustrative in nature, offering graphics to accompany the definitions for mitigation, adaptation, and resilience. The local jurisdictions and other public agencies, including water authorities, can and will identify climate strategies beyond what is included in the 2021 Regional Plan. New transportation infrastructure projects will be engineered to integrate adaptation strategies that consider the best available science, tools, and technology to make them, and the region’s transportation network, more resilient to the impacts of climate change, such as sea level rise.
L225	This plan would require employers and developers to provide transportation benefits and on-site amenities to encourage people to use sustainable transportation choices. Does the County want even more businesses to flee California for a friendlier business climate? Employers can figure out how to use flexible work schedules and tele-work options to attract and sustain their workforce without unnecessary government intervention/regulation.	The 2021 Regional Plan proposes a Transportation Demand Management Ordinance that would require employers over a certain size to provide transportation benefits and amenities that encourage sustainable transportation choices. These types of TDM ordinances exist in other regions across the state. A near-term implementation action would be to complete a Transportation Demand Management Ordinance Policy Analysis. This policy analysis would detail the employers that the ordinance would apply to and mechanisms for implementation and enforcement.
L226	Of course, of the 2021 plan’s proposed transportation management “strategies” come at a huge cost (\$163 billion dollars). The plan identifies \$90 billion dollars that will come from local funding sources: sales taxes, impact fees, fuel taxes, roads tolls, increased passenger fares, general funds, housing revenue, ride-hailing fees, value pricing, and road user charges also called vehicle miles travelled (VMT). Road usage fees or VMT, which have yet to be implemented through legislation, are needed to offset the reduction in gasoline taxes as more electric vehicles (EV) use our roadways. Under this plan, VMT fees would come on top of the existing federal, state, and local gasoline taxes, and they would unfairly penalize the drivers of gas-powered vehicles, who frequently are the low-income residents who live in the rural areas of the County. (VMT would not be collected on out-of-state vehicles.) Under the 2021 plan, fees of all kinds would be raised, including variable road tolls based on the time of day (congestion), fees for solo drivers using carpool lanes, and fees for ride-sharing services like Uber. The fees and regulations imposed by this plan will disproportionately impact low-income residents, while the plan claims to promotes social equity. They are the ones who will not be able to afford to park/drive their own private vehicles while transportation choices of more affluent residents will not be affected.	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.</p>
L227	Figure 3.3 on page 50 shows the 2021 Regional Plan Expenditures with an estimated total of \$163 billion in 2020 dollars. There needs to be a similar pie chart within the 2021 plan that shows how much money will be spent on each	As noted in the comment, this information is available in Appendices A and U of the 2021 Regional Plan.

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	<p>transportation category: Transit Leap (mass transit), mobility hubs, complete corridors, bicycle network, highway improvements etc. Although there may be appendices that lists all the funding for a specific category, it is unlikely that most people will wade through all of them to find that important information.</p>	
L228	<p>On page 53 of the 2021 Regional plan is a list of a priority implementation actions. Number 1 on the list is “Apply the Social Equity Planning Framework”. Number 10 on the list is: “Advance a data science program to better understand travel behavior in the region.” These priorities should be reversed. You can’t apply a framework until you have solid, valid, and recent (post COVID) data!</p>	<p>Each of the 10 priority implementation actions have both near-term and continuing actions. Implementing the 2021 Regional Plan will require coordination across all 10 priorities.</p>
<p><b>James Brown, Bread &amp; Salt and Public Architecture</b></p>		
L229	<p>I have been a Logan Heights business owner for over 12 years. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego’s Barrio Logan and Logan Heights communities. Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional Plan (Draft Plan)</p> <p>Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950’s and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know ReConnect Logan Freeway Lid will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the 1-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.</p> <p>As mentioned, the construction of the 1-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950’s our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that 1-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children’s access to neighborhood schools. It is time for our community to heal - a freeway lid is the answer.</p> <p>Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out ReConnect Logan Freeway Lid as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are: The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)</p> <p>Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)</p> <p>Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)</p> <p>Besides being in line with the 2021 Draft Regional Plan, ReConnect Logan Freeway Lid is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional Plan.</p>	<p>Caltrans District 11 has also expressed interest in exploring opportunities for freeway caps. In alignment with the 2021 Regional Plan, SANDAG and Caltrans District 11 are currently developing Comprehensive Multimodal Corridor Plans in coordination with agency partners and local city governments. Comprehensive Multimodal Corridor Plans (CMCPs) are data-driven plans to reduce congestion and generate transportation choices while preserving community character and creating opportunities for enhancement projects. Opportunities for freeway caps will be considered in the CMCPs.</p>
<p><b>Martha Zapata</b></p>		
L230	<p>I have been a Logan Heights resident for 34 years. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego’s Barrio Logan and Logan Heights communities.</p> <p>Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional</p>	<p>Caltrans District 11 has also expressed interest in exploring opportunities for freeway caps. In alignment with the 2021 Regional Plan, SANDAG and Caltrans District 11 are currently developing Comprehensive Multimodal Corridor Plans in coordination with agency partners and local city governments. Comprehensive Multimodal Corridor Plans (CMCPs) are data-driven plans to reduce congestion and generate transportation choices while</p>

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	<p>Plan (Draft Plan)</p> <p>Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know ReConnect Logan Freeway Lid will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.</p> <p>As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.</p> <p>Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out ReConnect Logan Freeway Lid as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:                      The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)</p> <p>Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)</p> <p>Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)</p> <p>Besides being in line with the 2021 Draft Regional Plan, ReConnect Logan Freeway Lid is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.</p>	<p>preserving community character and creating opportunities for enhancement projects. Opportunities for freeway caps will be considered in the CMCPs.</p>
<p><b>North County Transit District</b></p>		
<p>L231</p>	<p>Regional Capital Project Prioritization and Implementation</p> <ol style="list-style-type: none"> <li>1. NCTD seeks clarity on the status of specific projects that were included in the constrained TransNet funding plan but are at risk due to lack of funding. NCTD is seeking information on how much of the estimated \$160 billion proposed plan estimate is allocated to complete these unfunded TransNet projects on a project-level basis. NCTD is seeking more detailed information that expands upon the corridor-level information included in Appendix A: Transportation Projects, Programs, and Phasing of the Plan.</li> <li>2. NCTD seeks clarity on the project phasing proposed within the Plan. Specifically, NCTD is seeking to understand the timing of implementation of unfunded TransNet projects related to new projects presented within the Plan. To support this, NCTD is requesting that SANDAG input the information requested in Table 1 (Attachment B).</li> <li>3. NCTD seeks clarity on the assumptions related to the completion of major capital projects, including the assumed percentage level of federal and state match funding required to implement the projects envisioned in the Plan. To support this, NCTD is requesting that SANDAG input the information requested in Table 1 (Attachment B).</li> <li>4. NCTD seeks specific data on the proposed 200 miles of rail service contemplated in the 2021 Draft Regional Plan. To support this, NCTD is requesting that SANDAG input the information requested in Table 3 (Attachment D)</li> </ol>	<ol style="list-style-type: none"> <li>1-2. A comparison between the <i>TransNet</i> Program of Projects and the Draft 2021 Regional Plan was included in the July 7, 2021, ITOC Agenda Item #2 (<a href="https://www.sandag.org/uploads/meetingid/meetingid_5886_29414.pdf">https://www.sandag.org/uploads/meetingid/meetingid_5886_29414.pdf</a>). In addition to the report narrative, you will find in Attachment 1 the details regarding the original <i>TransNet</i> projects and how those are addressed in the Regional Plan corridor by corridor.</li> <li>3. The Regional Plan relies on a host of revenue sources with various matching requirements and funding eligibility constraints. Once projects reach the programming stage, specific funds are identified from specific sources in order to include those projects into the Regional Transportation Improvement Program (RTIP). With regard to <i>TransNet</i> projects, there are projects that remain on the <i>TransNet</i> extension list of projects that are being reimagined in the draft 2021 Regional Plan as part of a regionwide system. A report on these projects was brought to the SANDAG ITOC on July 7, 2021, which explains what <i>TransNet</i> projects have been completed, what projects remain, and the approach to provide multimodal solutions in these remaining corridors as part of an integrated systems approach. This report is available here: <a href="https://www.sandag.org/uploads/meetingid/meetingid_5886_29414.pdf">https://www.sandag.org/uploads/meetingid/meetingid_5886_29414.pdf</a>.</li> <li>4. Both the Batiquitos Lagoon Double Track and Carlsbad Village Trench projects are included in the 2021 Regional Plan. These projects will complete LOSSAN double tracking within the City of Carlsbad in generally</li> </ol>

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L232	<p>Operational and Financial Assumptions</p> <ol style="list-style-type: none"> <li>1. NCTD seeks specific data on the proposed dedicated source of funding to be used to provide reduced or free fares within the region. NCTD believes that it is important that SANDAG identify a source that is not sales tax based to mitigate impacts to service levels during economic downturns. The source of funding should also match increases in operating costs.</li> <li>2. NCTD seeks specific data on the proposed level of funding that is proposed to be dedicated to transit operations, preventative maintenance, and state of good repair maintenance and replacements, respectively.</li> <li>3. NCTD seeks specific data on the assumed transit service frequencies throughout the duration of the plan, and specifically as it relates to local transit bus operations. To support this, NCTD is requesting that SANDAG input the information requested in Table 2 (Attachment C).</li> <li>4. NCTD seeks specific data on plans and funding that will be allocated to support road, technology, and other infrastructure improvements to advance faster, frequent, and more reliable transit service.</li> </ol>	<p>the same alignment. Some segments of the LOSSAN corridor and will likely include fencing will remain at grade with fencing.</p> <ol style="list-style-type: none"> <li>1. Fare subsidies may be attached to sales tax measures but could be paid for by other sources as they become available.</li> <li>2. Systemwide Operations Costs are shown in Appendix A in Table A.16.</li> <li>3. Additional data on transit frequencies and span of service has been added to Appendix A as Attachment 2.</li> <li>4. Local streets and roads funding can be found in Appendix A in Table A.18. Next OS operating funds which will support transit optimization and other features to prioritize transit is shown in Table A.15.</li> </ol>
L233	<p>Customer Research Questions</p> <ol style="list-style-type: none"> <li>1. NCTD seeks clarity on the transit customer research conducted as part of the Central Mobility Hub planning process, either as part of the Draft 2021 Regional Plan development process or the Central Mobility Hub Comprehensive Multimodal Corridor Plan (CMCP) process. NCTD is specifically seeking information on transit user experience impacts related to the relocation of transit service from Old Town Station to the proposed Central Mobility Hub.</li> <li>2. NCTD seeks clarity on the transit customer research conducted as part of the Sorrento Mesa spur planning process, either as part of the Draft 2021 Regional Plan development process, SD-LOSSAN Rail Corridor Realignment Study process, or South Bay to Sorrento CMCP. NCTD is specifically seeking information on transit user access and user experience impacts related to the relocation of transit service from the existing Sorrento Valley COASTER Station to a proposed Sorrento Mesa location.</li> </ol>	<ol style="list-style-type: none"> <li>1. The Central Mobility Hub (CMH) and Connections CMCP included planning level concepts for a transit center at the Navy's Old Town Campus and the Intermodal Transportation Center site adjacent to Washington Street and Pacific Highway. These concepts incorporate local and regional busses, Trolley, COASTER, future Transit Leap services, Amtrak, and a direct transit connection to San Diego International Airport with connections to active transportation, Flexible Fleets, and pick-up/drop-off facilities. The concepts looked to minimize walk distances and provide easy transfer opportunities for transit users. The CMH is envisioned to also include transit serving amenities such as retail and dining establishments, ticketing facilities, and public restrooms. Additional locations and refinements of the initial concepts included in the CMCP will be examined in the CMH environmental process.</li> <li>2. SANDAG did not conduct transit customer research specifically related to Sorrento Mesa. A detailed data analysis was conducted on how to optimize our primary connections to Tier One employment centers, including Sorrento Mesa. The spur line is designed to provide a direct connection to the heart of the employment center while still allowing for freight and Amtrak to operate on the main line. It is envisioned that customer access and user experience will be enhanced by having a station that is located within walking distance of many of our region's largest employers.</li> </ol>
<p><b>Oceanside Bicycle and Pedestrian Committee</b></p>		
L234	<p>Our Committee has reviewed the draft 2021 Regional Plan and wishes to submit several comments for SANDAG consideration. First, as a general statement, the Committee appreciates the Plan's significant shift in how people move about in the region, as proposed through the "Five Big Moves" and interrelated projects and programs. We concur with SANDAG's conclusion that the imperative of responding to the climate crisis requires such a significant shift from previous Regional Transportation Plans. We also strongly agree with the statement on page 1 of Appendix L: Active Transportation, that: Active Transportation is a key element interwoven through the 5 Big Moves; it connects people to all kinds of destinations and defines the infrastructure needs to make the system work for everyone. With this statement in mind, we have specific input regarding several of the key Active Transportation projects which affect Oceanside, as listed in Appendix A, Page A-35, as follows:</p> <p>AT031 – Coastal Rail Trail Oceanside – Broadway to Eaton– This project appears to be off-street from Vista Way/Broadway to Broadway/Eaton (using the railroad right-of-way), then on-street on Eaton to Hwy 101. The existing portions of the Coastal Rail Trail north and south of Cassidy Street in this area are sub-standard (see photo) – the usable width of the trail in this section is only about 7 feet wide and does not provide sufficient space for cyclists to pass walkers safely without nearly coming to a stop. In addition, in preliminary City discussions with the Buena Vista Audubon Society, the possibility exists that the Society might allow development of the trail through their property south of the end of Broadway Street, connecting to the improved trail on Coast Highway. This would provide a safer and traffic-free connection rather than putting trail users directly on Eaton and Coast Highway. For these reasons, the City of Oceanside, with Committee support, submitted a Caltrans Sustainable Transportation Planning Grant request in February 2021, seeking funding for a "Coastal Rail Trail Morse-Vista Way Improvement Study". Please see our attached January 27, 2021 letter on same. We await word on the outcome of this grant request. Accordingly, we recommend that SANDAG include the potential for widening the trail in this area and connecting it through the Audubon Society property as part of Project AT031 and revise the budget accordingly</p>	<p>We appreciate the input from Oceanside's Bicycle and Pedestrian Committee members. The bike network shown in the plan is the Adopted Regional Bike Network, which was adopted in 2010. As an early action out of the Regional Plan, SANDAG will develop a new Active Transportation Plan which will look at adding in a number of new connections like these you have mentioned. Even sooner, I'd encourage your organization to be involved with the efforts of the North County CMCP if you are not already: <a href="https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;subclassid=83&amp;projectid=609&amp;fuseaction=projects.detail</a></p> <p>SANDAG prioritizes community engagement and will develop these connections in partnership with the community so that we can make sure the routes take people where they want to go.</p>



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	<p>AT049 – Inland Rail Trail Oceanside – This project is intended to cover the entire Inland Rail Trail segment within Oceanside, from Melrose to west of I-5. The Committee strongly supports this project – completion of the Inland Rail Trail and the Coastal Rail Trail within Oceanside are the two top-priority projects in Oceanside’s adopted Bicycle Master Plan. The Committee’s concern about this project is SANDAG’s listed “Year Built” of 2035. Completion of the Inland Rail Trail has been an adopted goal of the north county communities it travels through since 1995, through a Memorandum of Understanding (copy attached). In that MOU, the corridor agencies adopted the following vision 25 years ago: NCTD and the sponsor agencies desire to create a multi-modal transportation facility which will help these communities achieve a higher quality of life by promoting alternative transportation opportunities, reducing automobile trips, improving air quality, reducing congestion, providing recreational opportunities, and increasing access to desired North County destinations. This trail has also been identified as a priority project in the SANDAG Ride to 2050 Plan and is key in promoting bike commuting in the region. The only nearby alternative to completing this trail in Oceanside is to ride on Oceanside Blvd., which is very challenging if not outright unsafe for cyclists given its narrow bike lane widths, complete disappearance of the bike lane at major intersections, high traffic speeds, and heavy truck volume. Simply put, the citizens of Oceanside should not have to wait 40 years for their portion of the IRT to be completed, when the communities across North County made it clear in 1995 that completion of this trail was a priority. This delay is not fair to Oceanside on a general basis and is further exacerbated by equity considerations – Oceanside is home to a significant minority population (52% composition) whereas other North County coastal cities have majority white populations ranging from 74% to 90%.</p> <p>The proposed SANDAG Regional Plan includes a significant “Focus on Equity”, including the statement, In developing and implementing the 2021 Regional Plan, SANDAG has a responsibility to listen to the communities we serve, prioritize equitable solutions in the transportation system, and analyze the burdens and benefits of this system for historically underserved communities<sup>2</sup>. While Escondido and San Marcos had all or portions of their IRT constructed by 2008, and Vista’s segments are completed, in design, or under construction now, the Oceanside segment is not even in preliminary planning at this time. Given the frequent mention throughout the Regional Plan of the importance of bike trail improvements to the overall success of the Plan, and the Focus on Equity, we implore SANDAG to move up the completion of this segment of the IRT commensurate with its importance to the Adopted Regional Bike Network. We believe that this project could be completed in roughly five years if it was prioritized, as follows: -18 months for alignment definition and design                      -18 months for any necessary permitting, approvals, and right-of-way acquisition                      -24 months for construction</p> <p>AT074 – Coastal Rail Trail Oceanside Segment 1 ALT – According to the materials provided by SANDAG staff, this segment of the Coastal Rail Trail at the northern connection with the San Luis Rey River Trail would become just an on-street bike lane on Pacific Street, from just west of the railroad tracks underpass to west of the Oceanside Transit Center. This alternative does not appear to take advantage of the currently-built off-street segment adjacent to the tracks from under I-5 to Neptune Way (see photo). Why not incorporate that portion as part of this segment before returning to on-street status?</p> <p>AT113 – San Luis Rey River Trail Extension – This project proposes to extend the east end of the San Luis Rey River Trail from where it returns to surface streets at Andrew Jackson Street near Polk Street, all the way out to Old Hwy 395, mostly adjacent to the river. It should be noted that the proposed alignment does not make use of the already-constructed segment from Tyler Street to Via Manos at Hwy 76. In addition, there may also be City easements along the farmland adjacent to Highway 76, leading from Via Manos to the next neighborhood to the east. There, another already-constructed trail segment circumnavigates the residential neighborhood, coming out right across the street from Mission Vista High School on Melrose. All of these segments, if linked together, offer the opportunity to create a significant trail extension in the near future at very little cost. We urge SANDAG to consult with long-term Bicycle and Pedestrian Committee members who have extensive historical background on trails in this area.</p> <p>Additional Proposed Project#1 - SANDAG should consider an improved connection between the Vista Way shopping area east of I-5 and the Oceanside communities west of I-5. Currently, due to the topography of the alternative East/West routes, the freeway is a significant barrier to this community having access to the large shopping area on Vista Way east of I-5. Riding from the shopping center, west to the coast, requires riding up a very steep hill at the back of the shopping center and another one on Cassidy Street. They are both difficult climbs, especially with groceries. Such a project would likely entail a bridge overpass of I-5, in the vicinity of Kelly Street. Travelling East, once the Active Transportation user is past I-5, the optimum route would probably follow the least-elevation-change path, which would entail a turn to the south. We found that there is a similar bridge in Cupertino, over I-280, on Mary Avenue, that cost only \$8 million, approximately 13 years ago.</p>	

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	<p>Additional Proposed Project #2 - SANDAG should consider the Oceanside Coast Highway Corridor Study Road Diet and Incentive Zone, as approved by Oceanside in August 2019 between Harbor Drive and Morse, to be an Active Transportation Project. The project would convert this portion of the road, which is now mostly avoided by the Active Transportation Community, to be one that is safe and desirable. This “complete street” transformation would provide more room on the road for all roadway users, fewer signalized intersections, and reduced speeds. It would maintain good traffic flow, by having roundabouts at most arterials and a turning lane for streets and driveways between arterials. It would have a desirable mixed-use, smart-growth ambiance, with designated bike lanes, wider sidewalks, community-oriented commercial developments, upscale housing, and shade trees. This project is on the historical Route 101. The street is two blocks East of the Oceanside Transit Center, where new developments are planned. The City Library, a Community Center, and City Hall are on this street, just blocks from the Transit Center. The Bicycle and Pedestrian Committee has been urging Oceanside to expand its Climate Action Plan (CAP) by giving its City employees a car-parking system that encourages use of alternative modes to driving alone. This complete street project would help City employees get to work without driving.</p>	
<p><b>Peace Resource Center of San Diego</b></p>		
L235	<p>The PRC Board of Directors agrees that all San Diegans should have access to safe high-quality transportation and economic mobility. After consultation with our partner organizations and members, we submit the following recommendations to improve mass transportation to meet the needs of all our residents in the region. These recommendations also support our critical task of reducing carbon emissions.</p> <p>PRC Recommendations for amendments and changes to Appendix A of the 2021 Regional Plan:</p> <p>A. Prioritize funding to institute no-cost transit passes for youth ages 24 and under when Transit Fare Subsidies are allocated.</p> <p>Many of our members have children dependent on mass transit. No-cost transit passes for all youth encourages a culture of lifelong transit riders independent of cars. As part of a long-term strategy to build a greener and equitable San Diego, invest in youth no-cost transit passes. This and subsidies for elder travel will also stimulate the region’s equitable economic recovery. This works in other cities, and it is time San Diego MTS offers youth passes to connect our youth to our region.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
L236	<p>B. The proposed RTP will only achieve a 20% reduction in GHGs by 2035. San Diego needs a climate plan which exceeds this, and strives for 30% reduction. The overall system must live up to the promise to give a public transportation alternative that is as fast or faster, and less expensive, than private automobiles. There is concern that the proposed RTP will fall short of this promise.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. The SB 375 reduction target must be achieved by reducing per capita VMT.</p> <p>The 5 Big Moves will enhance connectivity and result in people having more travel options and operating solutions, reducing per capita VMT. Local jurisdictions can and will identify GHG reduction targets and measures to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
L237	<p>The lack of transit coverage of the “last mile traveled” is a large problem for both riders and our Climate. This is especially an issue for transit-dependent seniors who shop by bus in East County. Aggressive implementation of “flexible fleets” at the neighborhood/community level is vital, especially to achieve transportation equity. In addition, buses need more space for bags to ensure that transit riders can shop &amp; ride! Why aren’t shelves also put above the seats, allowing for more storage area of shopping bags, etc.</p>	<p>The deployment of Flexible Fleets such as e-bikes, shuttles, or ridesharing is envisioned as part of the 2021 Regional Plan to provide convenient and affordable options in different communities. SANDAG is developing a Flexible Fleet Implementation Strategic Plan to identify near-term opportunities for Flexible Fleet pilots that support mobility, equity, and sustainability goals.</p>
L238	<p>C. Ensure public safety of all passengers through community oversight of security training and reduce aggressive policing at transit stops.</p> <p>Ensure appropriate training of transit security - whether private or in partnership with local law enforcement. The training must include restorative practices as practiced by the county law enforcement, de-escalation tactics and bias-recognition studies. Members of the PRC Board have witnessed unacceptable targeting by transit security of young people, young women, people without housing, young men of color, and other residents. These interactions too often result in fines and/or arrests. They are terrifying for all who watch these aggressive tactics. Involve community groups in oversight of transit security training.</p> <p>Remove the practice of the infamous Lemon Stops from transit security practices. The Lemon Drop is when a team of local law enforcement from different agencies sweep through transit stops, using intimidation and illegal detention of people for questioning based on bias.</p>	<p>SANDAG, MTS, and NCTD believe that more can be done to improve the safety on and near transit and are working to make those improvements now and in the future. For example, funding at MTS for security is being diverted from fare enforcement to safety improvements.</p>



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	<p>In addition, the Green Line frequently ends trips at Gillespie Field without warning. MTS claims this is due to schedule needs, if the trolley is running later than expected. Too often, women are told to leave the trolley at Gillespie, a deserted un-patrolled transit stop in El Cajon. This can result in dangerous encounters, especially in the evening. Plans should include longer trips during rush hour and later, to stop this practice of leaving people on a platform with no services or security.</p>	
L239	<p>D. The PRC supports the Recommendations from the Transportation Equity Working Group:</p> <ol style="list-style-type: none"> <li>1. An Environmental Justice Centered RTP</li> <li>2. Improve the Bus System Now: Develop a bus system that is fast, frequent, reliable, and accessible by increasing frequency on popular lines, especially overcrowded ones. More clarity in Appendix A: Transportation Projects, Programs, and Phasing that provides a list of specific improvements to the bus system. Bus improvements are one of the most affordable ways to immediately increase connectivity, reduce toxic air pollution and greenhouse gas (GHGs) emissions in the region.  At the same time, SANDAG must stop approving freeway expansions and also charge for “full cost of parking”. Too often, parking is subsidized by either private or public entities, a perk for car owners who don’t have to pay the full price of parking. History has shown that dependence on individual cars only leads to continued congestion. Solutions to congestion must be through public transit (rails, bus) and transit-housing hubs so that people who need transit can get to it easily. Focus on transit, affordable housing near transit centers. We must reduce VMT to have a decided impact/reduction on climate gas emissions.</li> <li>3. Blue Line Express: Fund the planning, environmental, engineering, and capital for the additional Blue Line track that allows express, 24-hour service, and additional frequency enhancements. Rail-grade separations should only move forward with the addition of a third track that eliminates conflict between the Blue Line and freight. The information listed needs to be clarified. It is unclear if the double/third tracking included in Appendix A refers to an additional track that will provide express connectivity from the border to downtown San Diego.</li> <li>4. 24-Hour Service by 2025: Provide 24-hour service on popular transit routes to connect late night and early morning workers to their jobs by 2025. Participants of the Elevate SD 2020 community engagement efforts ranked this as their highest priority. The information listed needs to be clarified. Appendix A includes local bus route enhanced frequencies to ten minutes in key corridors but does not state if that would result in 24-hour service. Simultaneously, Chapter 2 includes all-day services from 20-22 hours per day for rail and rapids, but it excludes local bus routes and a clear implementation schedule.</li> <li>5. Purple Line Serves Central City Heights: Fund the planning, environmental, engineering, and capital for the Purple Line as a rail line that connects EJ communities in central City Heights and South Bay to Sorrento Valley.</li> <li>7. Electrify Bus Fleet by 2030: Fund the implementation of California’s Innovative Clean Transit rule to accelerate the electrification of the bus fleet ten years before mandated by the California Air Resources Board.</li> <li>8. Identify Anti-Displacement strategies: Fund anti-displacement efforts to protect vulnerable communities living near transit corridors by developing an anti-displacement strategy that includes affordable/low-income housing and preservation of naturally occurring existing affordable housing, community ownership, and tenant protections.</li> <li>9. Bathroom network much needed!!! Develop a bathroom access plan and provide MTS with funding for a clean and accessible bathroom network open at all major transit stations. State-of-the-art bathrooms are mobility and key to a successful transit system.</li> <li>10. Emergency Ready Transit System: Fund the planning and implementation of a transit emergency response strategy to provide safety particularly to EJ communities during community-wide emergencies. EJ residents are more likely to live in proximity to hazardous land uses that frequently result in fires and neighborhood emergencies. Simultaneously, frontline communities are also most vulnerable in the face of climate disasters.</li> </ol>	<ol style="list-style-type: none"> <li>1. The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</li> <li>2. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. The 2021 Regional Plan is not proposing any new highway expansions or addition of highway general purpose lanes but rather is focusing on a regional network of managed lanes that uses existing infrastructure by converting shoulders or general purpose lanes. In regard to parking management, SANDAG is looking into various parking and curb management strategies to encourage alternative modes of travel, including parking/curb pricing and reduced parking requirements.</li> <li>3. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</li> <li>4. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</li> <li>5. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</li> <li>7. The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</li> <li>8. Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan.</li> </ol>

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	<p>The PRC joins with our partners to urge you to take bold action to build a greener, healthier, prosperous, and just future in San Diego.</p> <p>Please amend the Plan to include Youth Opportunity passes as a priority.</p> <p>Thank you, and please feel free to contact us to discuss any of the recommendations outlined above.</p>	<p>SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p> <p>9. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p> <p>10. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p> <p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
<b>Philip R. Kern</b>		
L240	<p>The 2021 Regional Plan is a significant departure from previous approaches in several regards, principally that it would be exorbitantly expensive to the region at a cost \$163B should it be implemented. By way of illustration, every one of the 3.3M residents of San Diego County in 2016 could be provided with a \$49,000 electric vehicle for less cost than implementing the proposed Regional Plan, without even allowing for tax incentives.</p>	<p>This line of thinking is shortsighted. While the distribution of electric vehicles (if possible) would generate short-term benefits, it would not address long term transportation needs. The Regional Plan invests in lasting transportation projects that will serve existing populations and the generations that will follow.</p>
L241	<p>Also by way of comparison, the entire Transnet program will generate \$15B through the 40 year life of the program from 2008-2048, less than 10% of the cost of the proposed 2021 Regional Plan.</p>	<p>The Regional Plan relies on over 30 sources of revenues, not just <i>TransNet</i>.</p>
L242	<p>The funding model for the 2021 Regional Plan is also a departure from previous efforts. Where in the past a transportation charges returned a defined benefit (i.e. improved roadway maintenance or the privilege of driving in a less congested Managed Lane), no such pretense is offered with this cost model. Per mile VMT “user fees” (which could be considered by many as taxes or penalties on autos) charged to use a private vehicle on a public roadway are mostly diverted to transit improvements, operations, maintenance, subsidies, and other programs rather than returned to the user in the form of a benefit. Many will view area roadways as bought and paid for with their and their parent’s tax dollars, not as a government-owned resource carrying a toll to be charged back to motorists. Given that the gas tax will not only remain, but most likely escalate, and be piled on to other fees and taxes, including VMT costs passed through by companies transporting daily goods, the situation does not promote equity or provide affordability to San Diego’s working families.</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system. The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all.</p>
L243	<p>The track record of SANDAG and its partners (principally Caltrans, MTS and NCTD) in delivering major transportation programs for the San Diego region within budget and on schedule has not been stellar, particularly when transparency on the real costs of the programs is factored into the equation. MTS’ Mission Valley East Trolley Extension (or “Green Line”) was pushing 50% over the original budget (\$361M vs. \$506M) and even that did not approach inclusion of all the</p>	<p>The Mid-Coast Trolley project is being delivered on time and within budget. More details of the project can be found here:  <a href="https://www.keepsandiegomoving.com/Mid-coast/midcoast-intro.aspx">https://www.keepsandiegomoving.com/Mid-coast/midcoast-intro.aspx</a></p>

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	<p>costs required for the expansion of the system. Although delivery methods, and consequently cost and risk management, appear to have improved with the Mid-Coast Trolley Extension, no easily accessible “dashboard” or other record of construction Contract Change Orders could be found on SANDAG’s website for the project.</p>	
L244	<p>Several other major programs that were supposed to be included in the original Transnet authorization (extensions of State Route 76 and State Route 52, for example) were delayed over a decade with the commensurate increases in cost of the programs, traffic congestion, delays and emissions. The same pattern of deferring promised capital projects (particularly roadways) ad infinitum appears to be repeated in the 2021 Regional Plan. Assuming adoption of the Regional Plan by 2025 it appears highly unlikely given previous efforts that environmental, design and construction for any of the major transportation programs will be completed and ready for revenue service by 2035. Very few, if any, major local highway or transit projects in the region have gone from inception to ribbon cutting in a decade. The Mid Coast Trolley extension will end up taking over twenty years from inception to revenue operations. Accountability in this area is a serious issue.</p>	<p>This Regional Plan has been developed to prioritize different goals from previous efforts in order to provide a faster, fairer, and cleaner transportation system. The Managed Lanes system envisioned will help provide access to alternative modes, not facilitate boundless solo vehicle travel.</p>
L245	<p>The single most costly element of the 2021 Regional Plan is the proposed “high speed rail” (HSR) network. Aligning local high speed rail (HSR) facilities underground is not a panacea for avoiding environmental, right of way, utility, acquisition, and relocation costs related to development of a high speed transit network, nor will relying on tunneling technologies that are yet to be developed (and which may ultimately be proprietary) substantially reduce the risk or cost, or automatically render an economically infeasible transportation system more feasible once it goes underground. Tunneled alignments carry a whole new set of risks and costs, all of which come in to play when you elect to use the earth as a structure supporting your transportation system or the infrastructure above it. Fire and life safety, geologic conditions, surficial settlement, faulting/seismicity, HVAC needs, groundwater, subsurface environmental conditions, and other factors all have the ability to exponentially increase the cost and risk of below grade facilities, as well as kill the project outright. Proposing an underground (and under water) alignment parallel to the eastern shore of San Diego Bay under unstable Bay Mud, with the specter of future sea level rise and across a fault zone would range from ill-advised to sheer lunacy.</p> <p>Elon Musk’s The Boring Company (TBC) estimates current tunnel costs can range from \$100M to \$1B per mile. Their ultimate goal is to reduce costs to 10% of the low-end figure, or \$10M per mile, to be truly feasible on a large scale and today they are not even close to approaching that figure. TBC recently complete a 1.7 mile “bare” tunnel (no vehicles, track or infrastructure) in the sandy soils under the Las Vegas Convention Center at a cost of \$52.5M, or over \$30M per mile.</p> <p>The cost of a fully functioning surface high speed rail system including track, systems, vehicles, stations and support facilities can be expected to be at least \$200M per mile in</p> <p>2020 dollars, not allowing for more expensive tunneled alignments. The best data points are recently constructed and nearly completed projects, including Mission Valley East and Mid-Coast Trolley extensions. Published per mile costs for several recent programs in the western U.S. are shown in the table below, confirming the roughly \$200M per mile plus escalation is the going rate for a high speed, grade separated, electrified surface rail system in an urban setting.</p>	<p>The costs for the Commuter Rail include not only tunnel construction costs, but track and guideway construction, professional services, environmental, mitigation, right-of-way, and a 30% contingency on top of everything.</p>
L246	<p>A major factor in the selection of underground alignments will be the availability of expertise and resources with the San Diego region to prosecute a large-scale tunneling program. With the exception of a very short section of “real” tunnel (as opposed to a “cut and cover’ installation) on MTS’ Green Line, regional design and construction experience/expertise on passenger-carrying tunnels is essentially non-existent.</p> <p>Importing consultants and contractors is always an option, but never a good one as it does little for local hiring and talent development, or the ability to favorably negotiate contracts on behalf of the region when there is only one game in town (or worse yet, coming in from out of town). Decades of experience have been developed in the region developing the LRT system, this needs to be leveraged in a local High Speed Rail program.</p>	<p>To the extent possible, local expertise will be used, however, national and international expertise may be needed for the planning and engineering. SANDAG is committed to using local labor as much as possible</p>
L247	<p>Another question mark in the development of the Regional Plan is that the proposed high speed rail alignments generally parallel existing transportation corridors (whether you are talking freeways or LRT) but propose entirely new alignments. This is the worst of both worlds. It is far less expensive to increase capacity by (re)constructing new facilities within existing transportation corridors than by pioneering new alignments. New alignments require connecting infrastructure to be reconstructed and have the potential to introduce new environmental impacts (and mitigation) to areas not previously exposed to transportation activities, which also factors into the environmental justice arena. The entire San Diego Trolley system could be reconstructed as a high(er) speed rail system for a fraction of the cost of a new underground HSR system with the bonus that the same vehicles could be used regionally to phase out the diesel powered DMUs used on the Sprinter. Trolleys can run at 55 mph, how fast do you want to go? On modern transit systems travel time is dictated more by the number of stops rather than the top speed of the vehicles.</p>	<p>All services included in the Regional Plan include operations and maintenance assumptions, including the cost to purchase transit vehicles.</p>

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	<p>Also, to be fair and transparent to the region, the costs for the local HSR and other systems need to account for all costs attributable to the development of the system, rather than the classic “just get program past the point of no return, then they will have to pay for it” approach. In addition to trackways, systems, vehicles, modifications to the existing system and other capital costs, the program needs to account for such esoteric items as new maintenance shop space, technicians, and training as well as specialized equipment required to operate and maintain the new rail vehicles. Adding yet another type of transit vehicle requiring its own maintenance infrastructure to the regional fleet would be violating the first rule of fleet management: maximize commonality.</p> <p>The “per-mile costs” outlined above should also serve as a yardstick to determine the financial feasibility of the system at a glance, i.e. if you cannot deliver a transportation network by 2050 for less than \$500M per mile (\$200M per mile escalated 30 years at 3%), you need to seriously consider other alternatives. At costs exceeding \$500M per mile the 2021 Regional Plan proposal does not pass the “sniff test” on the high speed rail issue. The planners need to go back to the drawing board on this element to provide better alternatives.</p>	
<b>Quality of Life Coalition</b>		
L248	<p>To secure a healthy, safe, and equitable future, SANDAG must embrace an outcomes-driven RTP and identify priority outcomes aligned with those values. Below are seven key outcomes the Quality of Life Coalition urges SANDAG to prioritize in the 2021 Regional Transportation Plan:</p> <p>1. Improve public health in disadvantaged communities and prioritize transportation and environmental justice by:</p> <ul style="list-style-type: none"> <li>• Reducing transportation related pollution levels in disadvantaged communities.</li> <li>➤ AB 805 requires SANDAG to identify which communities to prioritize in their efforts to reduce pollution levels in this RTP.</li> <li>➤ SANDAG must use CalEnviroScreen 3.0 to identify these communities; we recommend defining disadvantaged communities as those in the top 30% of census tracts countywide, but also acknowledge that there are historically underinvested communities in San Diego County that are not adequately represented on this tool.</li> <li>➤ Any new transportation vision that successfully reduces pollution levels in disadvantaged communities must include significant reduction in Vehicle Miles Traveled (VMT) and rapid electrification of the bus fleet.</li> </ul>	<p>The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. To make this information more accessible, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. The AB 805 analysis included communities ranking in the top 25% of CalEnviroScreen 3.0 scores and an additional analysis for the top 50% scoring census tracts with the understanding that there are communities in the region with varying levels of vulnerability. The 2021 Regional Plan significantly reduces per capita VMT, however, total VMT increases through the life of the plan at a slower rate than population growth. Electric vehicle programs in the plan include investment in zero emission buses and associated charging/fueling infrastructure.</p>
L249	<ul style="list-style-type: none"> <li>• Providing infrastructure that: <ul style="list-style-type: none"> <li>➤ Encourages increased physical activity from active transportation</li> <li>➤ Reduces the risk of traffic related fatalities and injuries for all modes</li> </ul> </li> <li>• Analyzing health outcomes that are affected by the regional transportation system in each alternative, such as asthma, cardiovascular and pulmonary disease, lung cancer, type 2 diabetes, physical activity and obesity rates, by demographic group.</li> </ul>	<p>Response: The 2021 Regional Plan includes investments in the Regional Bike Network, complete streets in mobility hubs, and a Vision Zero program to fund grants and technical resources for local jurisdictions to pursue Vision Zero.</p> <p>Section 4.3 of the Draft EIR addresses the impacts of the 2021 Regional Plan on Air Quality. The EIR analyzes the exposure of sensitive receptors to toxic air contaminants (TACs) and the health risks of both cancer and noncancer hazards.</p>
L250	<p>2. Align with and exceed cities’ CAP transportation mode shift targets.</p> <ul style="list-style-type: none"> <li>• SANDAG’s plan needs to support those local plans in order for our cities to be able to hit their targets and support transportation alternatives to driving, such as mass transit.</li> <li>• Further, AB 805 – the new state law to reform SANDAG – requires that SANDAG align the RTP with local climate action plans.</li> </ul>	<p>The 2021 Regional Plan (Appendices A and B) contains Supporting Policies and Programs to support local climate action planning. Over one billion dollars is envisioned to go towards programs to support climate action planning, provide climate adaption and resilience, and promote electric vehicles and infrastructure (see Table A.17 of the Appendix A). The GHG Section 4.8 of the Draft EIR documents how the 2021 Regional Plan is consistent with local climate action plans and identifies specific investments as mitigation, including a new Climate Action Plan grant program.</p>
L251	<p>3. Achieve a 30% or more per capita GHG reduction from transportation by 2035.</p> <ul style="list-style-type: none"> <li>• SB 375 requires a minimum of 19% reduction by 2035; however, SANDAG Executive Director Hasan Ikhata has identified a 30% target as feasible, and SANDAG should pursue the maximum feasible reduction to adequately address the threat of climate change.</li> <li>• VMT reduction and mode shift through land use, housing, and transportation planning decisions must play a significant role in GHG reduction.</li> <li>• As evidenced by Governor Brown’s Executive Order B-55-18 to Achieve Carbon Neutrality by 2045, and SB 32 and EO S-3-05, which set statewide emissions reductions targets at 40% below 1990 levels by 2030 and 80% below 1990 levels by</li> </ul>	<p>The 2021 Regional Plan exceeds the SB 375 target of 19% reductions of per capita GHG by 2035 and the Board of Directors Resolution goal of a 30% reduction of GHG emissions from all on-road transportation by 2035. Please see Section 4.8 of the Draft EIR for analysis and discussion of the Plan’s effect on GHG emissions. Section 4.4 of the Draft EIR analyzes the 2021 Regional Plan’s consistency with state climate goals. It also includes Mitigation Measure GHG-5c, which calls for SANDAG to implement a nature-based climate solutions program to increase rates of carbon sequestration.</p>



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	<p>2050, the State of California continues to move towards decarbonization. SANDAG should align with these statewide goals in the next RTP.</p> <ul style="list-style-type: none"> <li>• When vegetation is destroyed for transportation facilities the resulting loss of carbon sequestration and storage capability should be counted as a loss in future GHG reduction tabulations.</li> </ul>	
L252	<p>4. Create a rate structure that increases ridership and expands access to mobility.</p> <ul style="list-style-type: none"> <li>• The regional transportation system must include Youth Opportunity Passes, which are no-cost transit passes for students and youth 24 years old and under.</li> <li>• It must also include strategically-priced fares that maximize transit usage in all income brackets to increase use of public transit, improve public health, lower greenhouse gas emissions, and enhance social equity.</li> <li>• Finally, it must be easier for seniors, people with disabilities, and Medicare users to obtain the discounted passes they are entitled to by making them available online and at more in-person sites.</li> </ul>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
L253	<p>5. Ensure that public transit is safe, comfortable, convenient and competitive with automobile travel.</p> <ul style="list-style-type: none"> <li>• Public transit must be competitive with driving in terms of time, cost, predictability, and convenience.</li> <li>• Prioritize urban core and transit-dependent communities, who are frequently low-income communities of color.</li> <li>• Provide 24-hour service and immediate improvements to bus service, including amenities such as restrooms at transit stations.</li> <li>• Ensure safe and comfortable bike and pedestrian first and last mile access to transit through funded, comprehensive, low-stress bikeway networks connected to mobility hubs, as well as adequate accommodation for bicycles on transit.</li> <li>• Prioritize new rail transit that connects underserved communities with job centers such as the blue line express and a purple line alignment through City Heights while evaluating the impacts on communities that are being displaced and gentrified.</li> <li>• Prioritize relocation of public transit corridors that are vulnerable to erosion and sea level rise, rather than armoring in place.</li> <li>• Ensure rural communities have access to quality, convenient, sustainable travel options that offer alternatives to fossil-fuel vehicles.</li> </ul>	<p>The 2021 Regional Plan proposes an expanded public transit network including commuter rail, light rail, Rapid bus, and local bus services. The network was developed to be a comfortable, convenient option to the automobile. The Regional Plan includes funding for amenities such as restrooms at new rail stations and a study to improve bathroom access for existing transit stations. Funding for complete streets in mobility hubs supports safe access for people biking and walking to transit. The commuter rail service connects the highest demand trip areas between residents and employment centers. The purple line alignment through City Heights is being studied in the South Bay to Sorrento Comprehensive Multimodal Corridor Plan currently underway. Funding for the relocation of rail on the Del Mar Bluffs to a tunnel is prioritized in the 2021 Regional Plan. The Plan includes investments in Flexible Fleets, expansion of broadband, investment in zero emission vehicles, and improvements on rural corridors. These benefit rural communities with improved access to mobility options via technology, increased safety on hazardous roads particularly during emergency situations, and advanced deployment of zero emission vehicles.</p>
L254	<p>6. Ensure transportation projects are creating high-quality careers in construction in our region through a Project Labor Agreement.</p> <ul style="list-style-type: none"> <li>• Major cities including Seattle and Los Angeles have employed project labor agreements to promote their commitment to labor stability, joint labor-management apprenticeship and a diverse, local workforce.</li> <li>• Encourage construction employment and training opportunities in ways calculated to mitigate the harms caused by geographically concentrated poverty and unemployment in economically disadvantaged areas and among disadvantaged workers.</li> <li>• Adopt a Community Workforce Policy that is implemented through a Project Labor Agreement with the Building Trades to create career pathways for a skilled and trained workforce for residents of our local communities.</li> </ul>	<p>Chapter 1 of the Regional Plan notes that AB 805 requires use of a skilled and trained workforce. In addition, on July 23, 2021, the SANDAG Board of Directors authorized staff to begin negotiations with the San Diego County Building and Construction Trades Council to execute a Community Benefits Agreement.</p>
L255	<p>7. Preserve Biodiversity, Natural Habitat, and Open Space</p> <ul style="list-style-type: none"> <li>• Ensure transportation projects protect the integrity and contribute to successful implementation of existing and planned multiple species conservation plans (MSCPs) including avoiding sensitive habitat areas within the City of San Diego’s Multi-Habitats Planning Area and County of San Diego’s Pre-Approved Mitigation Area and consistency with MSCPs rules.</li> <li>• Ensure transportation projects preserve natural habitat and other ecologically sensitive lands not covered by regional MSCPs including: urban canyons, waterways, waterbodies, ecological linkages, and ecologically important greenfields.</li> <li>• Direct transportation projects away from remote or rural natural lands and into existing developed communities and urban areas.</li> <li>• Ensure habitat mitigation land related to transportation projects is protected and managed for that ecological benefit.</li> </ul>	<p>The proposed land use pattern of the 2021 Regional Plan concentrates growth and development primarily in the mobility hub areas, which allows for preservation of open space and natural habitat in the San Diego region. Environmental mitigation funding for transportation projects is accounted for in the cost estimates of the Regional Plan. Section 4.4 of the Draft EIR discusses the impacts of the 2021 Regional Plan on biological resources, including the regional habitat conservation plans such as the MSCP. Mitigation has been identified to avoid and reduce biological resources’ impact on the future construction of transportation and land use projects.</p>
<p><b>Quality of Life Coalition: Friends of Rose Canyon</b></p>		
L256	<p>Several duplicate comments were submitted by Friends of Rose Canyon via the Quality of Life Coalition letter.</p>	<p>All comments from the Friends of Rose Canyon included in the Quality of Life Coalition letter were also received directly from the Friends of Rose Canyon. Comments and responses are provided under “Friends of Rose Canyon.”</p>

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<b>Quality of Life Coalition: Karl A.</b>		
L257	“The 2021 Regional Plan reduces per capita GHG emissions from cars and light duty trucks to 20% below 2005 levels by 2035, exceeding the region’s state mandated target of 19%. The 2021 Regional Plan also meets federal air quality conformity requirements” - This means our 29 year plan is barely ambitious enough to meet our insufficient state mandate. SANDAG should independently acknowledge the need to act on climate instead of stating from the outset that they are mandated to do so, and therefore meet the bare minimum with no margin for error. Less than 2% change annually is in the realm of noise in measurement. We need more bold commitment to change.	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.
L258	Projected emissions from GHG of Natural Gas use doesn’t assume a reduction in use by 2050 but instead assumes unabated use. Appreciate that it’s pessimistic and not optimistic, but these numbers will be very inaccurate, given changes in building code for 2022. (Table X.16) Wanted to visualize the numbers from table X.3 better. Note that methane gas is the second highest contributor after 2025, and it becomes 20% of the emissions by 2050, with no expectations of abatement.	The methodology used to calculate GHG emissions from Natural Gas in Appendix X: 2016 Greenhouse Gas Emissions Inventory and Projections for the San Diego Region is based on the best available data, including building standards through the 2019 Edition of California Title 24. Without a CEC California Energy Demand Forecast beyond 2030, more conservative building codes were assumed so as to not overestimate reductions. Future changes in building standards and related forecasts will be incorporated into future emissions inventories and related natural gas calculations.
<b>Quality of Life Coalition: San Diego County Bicycle Coalition</b>		
L259	Several duplicate comments were submitted by the San Diego County Bicycle Coalition via the Quality of Life Coalition letter.	All comments from the San Diego County Bicycle Coalition included in the Quality of Life Coalition letter were also received directly from the San Diego County Bicycle Coalition. Comments and responses are provided under “San Diego County Bicycle Coalition.”
<b>Quality of Life Coalition: Sierra Club of San Diego</b>		
L260	The ever-increasing urgency to prevent a climate catastrophe demands fast action to reduce greenhouse gas emissions. One of the most significant ways to do that is to quickly reduce driving. In light of this, projects that fail to reduce vehicle miles traveled (VMT) must be deferred until the vehicle fleet has mostly been replaced by zero-emission vehicles. Otherwise well-intentioned projects like HOV to HOV connectors will actually increase VMT by reducing travel times, encouraging more people to drive and pay whatever fees are required to use the HOV lanes. Vehicles powered only by internal combustion engines must be banned from any form of managed lanes.	The 2021 Regional Plan proposed managed lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools and low-emission vehicles with appropriate decals to achieve meeting state and federal greenhouse gas and air quality targets. The Regional Plan also supports investments in the electrification of cars, trucks and buses and their supporting infrastructure. Appendices A (Table A.17) and B address SANDAG’s proposed EV commitments. For light duty vehicles, SANDAG plans to invest \$45 million by 2025 and a total of \$270 million by 2050 for EV charging station incentives.
L261	There is no need to expand freeways when it is clear that driving must be reduced. Managed lanes must replace existing general purpose lanes. Adding lanes for any reason is unacceptable while driving is the largest source of GHG emissions.	The 2021 Regional Plan places emphasis on maximizing the use of existing facilities to add corridor capacity to ease congestion while also trying to achieve meeting state and federal greenhouse gas and air quality targets. The proposed managed lanes network uses existing infrastructure by repurposing shoulders and general purpose lanes to offer priority access to transit, carpools, vanpools and low-emission vehicles with appropriate decals. The system of managed lanes and supporting connectors support Transit Leap and high occupancy vehicles to create a seamless systemwide network that will provide people with transportation options, reducing the need to add new highways or general purpose lanes.
L262	Realignment of the LOSSAN segment through the University Community to a tunnel between Rose Canyon and Sorrento Valley would improve rail efficiency and travel times by avoiding Miramar Hill and would improve connections to other public transportation with a station at University Town Center. Realignment of the LOSSAN segment through Del Mar to a tunnel under Del Mar Heights between Sorrento Valley and the Del Mar Fairgrounds would also improve rail efficiency and travel times, improve public access to the coast, and accommodate managed retreat from eroding bluffs by avoiding the unsustainable current alignment on the delicate bluffs of Del Mar.  Sierra Club generally supports realignment of the two segments of the LOSSAN rail corridor to the extent that the new alignments and tunnels are located and constructed in a manner that fully minimizes impacts and maximizes preservation and restoration of natural habitat, open space, and wildlife corridors in Los Penasquitos and San Dieguito lagoons, Carroll Canyon, Crest Canyon, Rose Canyon, and Torrey Pines State Natural Reserve Extension.	Thank you for your support of these improvements to the LOSSAN rail corridor.
L263	Protect & restore Los Penasquitos & San Dieguito lagoons  · Realigned track across or near Los Penasquitos Lagoon should be located as close as possible to old Sorrento Valley Road and I-5 and, if located in the Lagoon, should be on an elevated bridge across the entire Lagoon to protect and maintain lagoon hydrology. An existing hill portion of Carmel Valley Road between Caminito Pointe Del Mar and Portofino Drive should be lowered as necessary to accomplish these goals.  · The Project should not impede tidal flow in Los Penasquitos or San Dieguito lagoons.	The 2021 Regional Plan includes major investments in the LOSSAN rail corridor. The San Dieguito Double Track and Special Events Platform project replaces a single track wooden trestle bridge with a new double track concrete bridge within existing NCTD right-of-way increasing tidal flow to wetlands. The Del Mar Tunnel project would include double tracking through the Los Penasquitos Lagoon in an alignment to be determined. Double tracking across that Los Penasquitos lagoon would be designed to increase tidal flow. The Del Mar Tunnel would undergo environmental review and permitting from the appropriate federal and state regulatory agencies.



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L264	<p>· The Project should include maintenance of open Los Penasquitos and San Dieguito lagoon channels to the ocean.</p> <p>Remove old track infrastructure &amp; restore lagoons &amp; native habitats</p> <p>· Old track infrastructure should be fully removed and restored to wetlands, coastal bluff scrub, coastal sage scrub, and other location-appropriate native habitats and vegetation. Removal of old track infrastructure includes removal of all Del Mar bluff stabilization structures to allow for natural bluff erosion, removal of all berms and bridges across Los Penasquitos Lagoon, and removal of all tracks, berms, trenches, and retaining walls in Carroll and Rose Canyons[1] and in Sorrento Valley.</p> <p>· Fill soils in the berm across Los Penasquitos Lagoon may have originated from the Del Mar bluffs and should be returned and incorporated into restoration of the old track cut on the Del Mar bluffs if soils are appropriate.</p> <p>Protect and restore wildlife corridors</p> <p>· Realigned track should be below grade in a tunnel or covered trench capped with native vegetation to protect wildlife movement in and between the Crest Canyon Preserve and San Dieguito Lagoon.</p> <p>· Realigned track above Carmel Valley Creek and Carmel Valley Road should not restrict deer and other wildlife movement in and between Torrey Pines State Natural Reserve, Los Penasquitos Lagoon, and Carmel Valley (under I-5).</p> <p>· Realigned track should emerge in Sorrento valley from the tunnel under the University Community elevated on a bridge over Carroll Canyon Creek.</p> <p>· Old track infrastructure should be removed and berms and slopes should be recontoured and planted with native vegetation to restore a wildlife connection between MCAS Miramar and Carroll Canyon and Sorrento Valley.</p>	<p>The 2021 Regional Plan is a high-level, programmatic document. Specific details regarding impacts and mitigation are not known at this time but will be covered when these future projects go through project level environmental review.</p>
L265	<p>Establish a Del Mar bluffs park</p> <p>The old LOSSAN right-of-way on the Del Mar bluffs should include a linear park with a public walkway and connections to the beach. However, park and beach access infrastructure should not interfere with natural bluff erosion and managed retreat.</p>	<p>SANDAG recognizes a need to improve connectivity to the coastal resources in Del Mar. SANDAG, NCTD, and the City of Del Mar have partnered together to jointly conduct a planning study to identify coastal access connections along the Del Mar Bluffs. In the long term, NCTD is the owner of the railroad right-of-way and they will determine what to do with the space once the tracks are realigned in a tunnel.</p>
L266	<p>Protect existing preserves and open space</p> <p>Tunnel vents should not be located in Crest Canyon Preserve, Torrey Pines State Natural Reserve Extension, or any University Community open space.</p> <p>Control invasive non-native plants</p> <p>The Project should bar deliberate planting of invasive non-native plants and provide for long-term control of any colonizing invasive non-native plants.</p>	<p>The 2021 Regional Plan is a high-level, programmatic document. Specific details regarding impacts and mitigation are not known at this time but will be covered when these future projects go through project level environmental review.</p>
L267	<p>Retain and improve pedestrian and bicycle infrastructure</p> <p>The Project should retain and improve pedestrian and bicycle infrastructure and connections including between Sorrento Valley Road and Carmel Valley Road, the San Dieguito River Park Coast to Crest Trail, and between the Coast to Crest Trail and Crest Canyon.</p>	<p>The currently underway Coastal Connection Pedestrian Access Study is an opportunity to begin facilitating improved connections in this vicinity. Longer term, the Coastal Rail Trail Del Mar project (AT028) will be coordinated to create a significant corridor-level improvement for people walking, biking, or using other micromobility modes.</p>
L268	<p>Many of the Active Transportation projects listed are from the Early Action Plan that they adopted in 2013 and were supposed to be completed within 10 years. There was \$200 million allocated for these bikeways, most of which are yet to be fully built. I'd like to understand if this is new funding and the timing of when these projects that are already in the works are supposed to open. It seems a bit like double dipping and now the build date is 2025 at the earliest but some say 2035, which is unacceptable</p>	<p>The commitment by the SANDAG Board of Directors for the Early Action Program was a programmatic high-level budgeted dollar amount and was always intended to be supplemented, for example as a "match" for additional grant funding to fully complete this list of projects. Funding additionally comes from different sources and financing mechanisms, including the commercial paper bonding approved by the SANDAG Board of Directors in 2020. Of note, there is a near-term goal to increase the percent of <i>TransNet</i> funding committed to the Bicycle Pedestrian, and Neighborhood Safety (BPNS) portion of local funds, this is a consistent source for the EAP projects. The commitment to funding the EAP projects has been steadfast, and the 2021 Regional Plan reflects the latest estimates. The cost estimates were initially a planning-level determination for designing and building a specific number of projects with unit costs for infrastructure elements according to bikeway facility type. Construction costs (see Caltrans Cost Index) and specific bikeway facility types have been further refined in the planning, design, or construction phases for these specific</p>

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		<p>projects and are highly variable, with many changes made since 2012 as the projects were refined through those phases.</p> <p>The date EAP bikeways will be Open to Public is specific to each project. There is significant mileage which is in the “No Build” phase, and the majority of EAP projects are estimated for opening within the 2025 phase. Additionally, the remaining EAP projects will be built sooner than 2035 but are simply aggregated into that 2035 “Phase Year” for the Appendix, consistent with other modes and presentation as a network for the table and maps.</p>
L269	I only see mention of the San Ysidro and Central Mobility Hub specifically. Is Table A.14 in reference to those or amenities for mobility hubs for all of the other new lines? We need a commitment to ensure transit accessibility for those on foot and bikes.	Table A.14 summarizes investments in Mobility Hub amenities and Flexible Fleet travel options across all 31 regional Mobility Hub areas as depicted on the map in Chapter 2, Figure 2.4. Given that planning has already commenced for Central Mobility Hub and San Ysidro communities, Transit Leap investment costs have been included as project-specific line items in Tables A.1 and A.2.
L270	Where is the habitat funding? We need a strong commitment to a regional funding source for habitat.	To assist the region to meet its habitat conservation goals, the proposed final 2021 Regional Plan has identified \$2,087 million for an enhanced habitat conservation, management, and monitoring program. These funds are complemented with a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (See Climate Adaptation and Resilience programs). In addition, future mitigation of the transportation projects included in the 2021 Regional Plan will result in an additional \$300-\$500 million of land acquisition and restoration for habitat mitigation (incorporated in project costs presented in Appendix A).
L271	The Regional Plan must include a strong commitment to provide adequate funding for the Habitat Conservation Plans.	To assist the region to meet its habitat conservation goals, the proposed final 2021 Regional Plan has identified \$2,087 million for an enhanced habitat conservation, management, and monitoring program. These funds are complemented with a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (See Climate Adaptation and Resilience programs). In addition, future mitigation of the transportation projects included in the 2021 Regional Plan will result in an additional \$300-\$500 million of land acquisition and restoration for habitat mitigation (incorporated in project costs presented in Appendix A).
<b>Quality of Life Coalition: Southwest Wetlands Interpretive Association</b>		
L272	Page 9. The brief description of this region’s natural resources, biodiversity, cultural history and other unique assets should be expanded and include a short description of the relationship of the regional transportation planning and multiple species conservation planning and permitting. This could be simply done by adding a short summary from Appendix AA.	Chapter 2 has been revised with this discussion.
L273	In the early 2000’s, SANDAG and the state/federal wildlife agencies entered into unique agreements linking regional conservation commitments with expedited transportation project permitting (and mitigation). How does this plan continue and support those agreements and commitments?	<p>Implementation of the proposed Plan would comply with the provisions of all approved local, regional, state, and federal regulations, policies, ordinances, and finalized conservation plans (HCP/NCCP, specifically the MSCP and MHCP and their respective subregional plans). In addition, the role of SANDAG as the regional planning agency and its commitment in its development of a Sustainable Communities Strategy will provide new opportunities to fulfill the promises made during the adoption of the region’s various regional habitat conservation plans.</p> <p>SANDAG, through its innovative EMP, has provided a successful stopgap measure to partially fill the regional funding needs over the last 15 years. However, the larger acquisitions under the EMP have been completed, and the EMP does not have the capacity to assist the region with all the necessary funding for management. SANDAG will need mitigation for impacts from future transportation projects outlined in the 2021 Regional Plan. This mitigation will allow those projects to move forward and will also help the region preserve wildlife species and their habitats; however, it does not replace the need for regional funding of the acquisition, management, and monitoring of lands as identified in the regional habitat conservation programs.</p>
L274	Page 13. Provide more description regarding how the anticipated increases in peak period transit use from 3% (2020) to 13% (2050) will result in a reduction in solo commuter vehicle use from 80% (2020) to 62% (2050); what are the expected contributions from other mode shifts required to achieve this goal? Add a summary table (or cross reference an existing table) that shows all mode shifts (carpool/rideshare, active transit, etc.) for 2025, 2035 and 2050. In addition, the plan’s performance metrics must include tracking of the (housing) density and transportation infrastructure improvements in smart growth areas as well as what actual/calculated GHG reductions are occurring compared to what was projected. Also briefly introduce and describe the plan’s adaptive management approach for triggering and implementing measures to correct failings in meeting the plan’s goals.	Detailed mode shift performance data is documented in Appendix T. Tracking of the share of new housing units in smart growth areas is included in the list of Performance Indicators for the 2021 Regional Plan (Table 3.1). Priority Implementation Action #10 is to advance a data science program to better understand travel behavior in the region, update travel demand modeling tools, and improve transparency and reporting on program effectiveness and project delivery. SANDAG will be implementing the 2021 Regional Plan, monitoring performance, and updating the plan every four years to incorporate the latest data, policies, and incorporate corrective measures.
L275	Page 13. The plan states that it is expected to exceed the current vehicle-based per capita GHG emissions requirement for 2035, but as annotated in the list of state GHG emission reduction legislation/executive orders on Page 14, aggressive	The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375.

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	overall GHG emission reduction targets have been established for 2030, 2040 and 2050. Provide explanation of how the plan will continue to contribute to reducing vehicle per capita (and overall) GHG emissions to complement the overall GHG emission reduction goals after the 2035 target date. [As noted in our comment on Appendix D (Page D-4), the plan's post-2035 contribution to reducing GHG emissions remains flat after 2035, implying that the current measures will not contribute substantially to those higher GHG emission reduction targets.	Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan. As described in Chapter 2, implementing the 2021 Regional Plan, while also facilitating the development and implementation of local climate action plans across the region will help the State, SANDAG, cities, and other public agencies achieve their climate goals.
L276	Page 23. The plan states that, to the extent feasible, it will stay within rights-of-way to minimize impacts and would produce other environmental benefits (water quality, air quality, reduced flooding, etc.). How does the infrastructure system that is proposed in the 5 Big Moves compare to the transportation infrastructure system that was anticipated in 2004 when the original RTP and MSCP agreements were established?	While a majority of <i>TransNet</i> extension ordinance projects have been started or built, there are projects that remain on the <i>TransNet</i> extension list of projects that are being reimagined in the 2021 Regional Plan as part of a regionwide system. These are detailed in a report to the <i>TransNet</i> Independent Taxpayer Oversight Committee on July 7, 2021: <a href="https://www.sandag.org/index.asp?meetingID=5886&amp;fuseaction=meetings.detail">https://www.sandag.org/index.asp?meetingID=5886&amp;fuseaction=meetings.detail</a> .
L277	More specifically, because SANDAG agreed to mitigate (and has mitigated?) for expected upland and wetland habitat impacts in advance of projects impacts – based on a previous set of projects/infrastructure, will the new infrastructure have new impacts that are beyond or not mitigated by the previous agreements? For example, adding many connectors among the freeways and expanding some state routes could directly and indirectly impact habitat and wildlife corridors in excess of what was anticipated in the initial agreements. If so, how will the plan ensure no net losses of habitat acres, functions and values (including to movement corridors)?	Near-term Action 3a is to update <i>TransNet</i> ordinance and associated Board policies to reflect projects and priorities included in the 2021 Regional Plan. The <i>TransNet</i> Environmental Mitigation Program will be evaluated as this action is implemented and these questions will be considered in that process. In response to this comment, a study related to EMP has been added under action 9a.  For direct and indirect impacts related to biological resources for projects within the 2021 Regional Plan, refer to Section 4.4 Biological Resources of the EIR.
L278	Page 25. The plan has the potential to produce and encourage environmental benefits (climate change mitigation, air and water quality improvements) as summarized in this section. Include more discussion about the plan's commitments to meet or improve upon the longstanding habitat and conservation agreements (e.g., NCCP/HCP permits), avoid new/unpermitted impacts to habitat/species, and mitigate for any significant unavoidable impacts.	Chapter 2 has been revised with this discussion. In addition, Appendix AA also includes discussion of environmental benefits of SANDAG's Nature-Based Climate Solutions Program that will promote natural infrastructure that uses or mimics natural processes to benefit people and wildlife. SANDAG will prioritize resilience and innovative solutions in transportation infrastructure, Comprehensive Multimodal Corridor Plans, and consistent regional planning and implementation of the Sustainable Communities Strategy actions, emphasizing both nature-based and technological climate solutions. There are also further opportunities to expand upon ongoing efforts to assess the amount of carbon storage and sequestration potential of open space lands and the co-benefits from preserved open space, land management, and restoration activities.
L279	Page 27. To assist the public's understanding of the essence of the plan, add several figures to show the relationships (by time period) among transportation infrastructure, mobility hubs, and smart growth/increased housing density areas). More specifically, provide a set of diagrams to illustrate – at the system/regionwide perspective - which projects are to be completed by 2025, 2035, and 2050 and which mobility hub/ Smart Growth areas they serve. Because Smart Growth areas are expected to increase their housing densities, the plan must provide justifications and demonstrable commitments (e.g., policies, funding, incentives) that support the presumptions that the cities and county will make those density increases in step with the basic transportation improvements (transit leap, active transportation, mobility hubs, complete corridors).	Appendix A includes detailed maps for transportation projects planned for during each phase of the 2021 Regional Plan. Appendix F includes figures demonstrating areas for future growth. In addition, SANDAG has made this information available in its online data viewer: <a href="http://www.sdforward.com/envision">www.sdforward.com/envision</a> .
L280	Previously, SANDAG produced a short list/explanation of its incentives for smart growth ( <a href="https://www.sandag.org/uploads/publicationid/publicationid_1187_5188.pdf">https://www.sandag.org/uploads/publicationid/publicationid_1187_5188.pdf</a> ), but it is unclear how effective those incentives have been. How does the plan improve on those incentives?	Information on effectiveness of the smart growth incentive program is available online: <a href="https://keepsandiegomoving.com/SmartGrowth/smartgrowth-intro.aspx">https://keepsandiegomoving.com/SmartGrowth/smartgrowth-intro.aspx</a> .  The 2021 Regional Plan includes action 8b to update evaluation criteria and provisions of SANDAG grant programs.
L281	Page 31. Goods movement comprises a relatively small part of the region's GHG emissions (Appendix X), but its associated on-road use by heavy trucks and allied freight rail access/rail car storage – especially through/near disadvantaged communities and the Port District terminals – creates significant impacts to local transportation, air quality and quality of life. The RTP/SCSs transportation infrastructure system improvements must be fully integrated with the Port's implementation of its proposed maritime operations strategy and additional actions to relocate (to the extent feasible) truck parking and freight rail car storage away from the coastal area.	SANDAG collaborated with the Port of San Diego (Port) on the strategies identified in the 2021 Regional Plan and will continue to partner with the Port on implementing these projects. SANDAG is also working with partner agencies and local communities to ensure that projects identified in the Assembly Bill 617 Portside Environmental Justice Neighborhoods Community Emission Reduction Plan and the Port's Maritime Clean Air Strategy are implemented. SANDAG also recently signed a memorandum of understanding with the Port and Caltrans to coordinate closely on implementing projects near the Port's Working Waterfront that improve accessibility, sustainability, economic vitality, and community health.
L282	Pages 32-33. The essence of the plan's sustainable communities strategy is expressed in the introduction to the region's growth and development: "The 2021 Regional Plan envisions a regional pattern of growth and development that reflects smart growth, transit-oriented development, preserving natural resources, and building communities that are resilient to the consequences of climate change and other environmental changes. Ensuring social equity and the availability of housing that is affordable for everyone are also top priorities." Those goals will only be achieved when the cities and county, which constitute SANDAG, fully acknowledge the necessity to amend their general plans to accommodate and implement the identified changes.  The forecasted concentration of jobs and housing (and population) in the urban areas that are necessary to implement	While land use authority is reserved for local jurisdictions, SANDAG will work closely with local jurisdictions to implement the land use pattern proposed in the 2021 Regional Plan. Near-term and continuing actions listed under Priority Implementation Action 8 related to land use include: 8b) update evaluation criteria and provisions of SANDAG grant programs to encourage planning and capital projects that allow for high-density and mixed-use development within Mobility areas and/or transit priority areas; 8c) launch a regional housing incentive grant program to fund local plan updates in Mobility Hub areas that can lead to more housing in transit-rich areas with infrastructure, services, and jobs; and 8h) utilize the intergovernmental review process to evaluate consistency of development projects with the Sustainable Communities Strategy.

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	<p>the plan would create a more efficient, livable region that supports the proposed transportation system. It would also alleviate pressure for development in the unincorporated county, reduce impacts on the natural landscape, and lessen the risks from wildfire to people and structures.</p> <p>If the plan is approved, then how are the cities and county proposing to commit to implement those changes? What ramifications are there to the plan – and for a jurisdiction’s ability to benefit from the transportation system improvements – if a jurisdiction does not make those needed general plan changes?</p>	
L283	<p>Pages 34-35. The global threat from continued GHG emissions and unique threats, conditions, and opportunities to reduce GHGs within our region are recognized in this plan. The GHG inventory and calculation of anticipated reductions by sector illustrate how the plan would be able to meet and exceed the region’s SB 375 GHG emission reduction target for 2035. As noted in preceding comments, achieving that goal requires significant cooperation from each of SANDAGs member jurisdictions through changes to their general plans (especially land use/zoning) as well as how their Climate Action Plans support and augment the RTP/SCS.</p> <p>While this plan demonstrates that it could meet/exceed the mandated GHG emission reduction target for 2035, the projected emissions out to 2050 in Appendix X suggest that the region will be far from “carbon neutrality by 2045.” That is not a region-by-region requirement, but it is critical that this plan incorporate goals and policies - and at least propose possible actions/projects – that would put the region on a more aggressive GHG emission reductions pathway post-2035.</p>	<p>Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan. As described in Chapter 2, implementing the 2021 Regional Plan, while also facilitating the development and implementation of local climate action plans across the region will help the State, SANDAG, cities, and other public agencies achieve their climate goals.</p>
L284	<p>Decisions pertaining to which and when to initiate projects should balance the basic GHG emission reduction priority and their effectiveness in promoting the more broad actions (i.e., specific local jurisdiction actions) to optimize system buildout. However, as noted on Page 14 of the plan, SANDAG has a specific requirement to identify disadvantaged communities, include strategies to reduce pollution exposure in those communities, and use of a skilled and trained workforce (via the RTP/SCS). So, the “balancing” decision must have a larger frame of reference than just GHG emission reductions.</p>	<p>Thank you for your comment.</p>
L285	<p>Page 44. The plan should clarify that the region’ projected population growth will result in continued – albeit slowing - total VMT, but implementing the plan will result in a significant net reduction in VMT/capita that is consistent with the requirements of SB 375.</p>	<p>Information on estimated VMT performance of the 2021 Regional Plan is included in Appendix T.</p>
L286	<p>Page 45. As described, there are real constraints on the allowable uses (types of project investments) and timing (when available) of the known and reasonably anticipated funding sources. Our prior comments (e.g., Pages 19, 27, 32-33) raised concerns about how the RTP/SCS will ensure concurrent and effective linking of the growth in the mobility hubs (smart growth areas) with the transportation infrastructure. This is particularly of concern because growth in the mobility hub areas may occur – based on local jurisdictions’ requirements and needs - even if the transportation infrastructure and operational improvements are not able to be funded concurrently. How will the RTP/SCS ensure (and measure/monitor) that the housing/jobs/transportation linkage will occur as needed?</p>	<p>Priority Implementation Action #10 is to advance a data science program to better understand travel behavior in the region, update travel demand modeling tools, and improve transparency and reporting on program effectiveness and project delivery. SANDAG will be implementing the 2021 Regional Plan, monitoring performance, and updating the plan every four years to incorporate the latest data, policies, and incorporate corrective measures.</p>
L287	<p>Pages 45-47. The projected costs to implement the revised transportation infrastructure and operations, combined with SCS strategies, will require SANDAG to evaluate and adopt new revenue funding sources. The plan does not provide sufficient descriptions of how SANDAG will evaluate the effectiveness of implementing the identified potential new revenue sources. For example, charges for Managed Lane use and a general Road User Fee potentially overlap costs for drivers; paying the premium for managed lane access may induce more VMT as well as be cost-prohibitive to lower income populations; there is no discussion about how local jurisdictions could/should adopt parking cost strategies to both promote transit (reduce vehicle use) and increase revenues that can be then incorporated into their local funding share.</p>	<p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being</p>



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		considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, fair to all.
L288	Page 50. Successfully implementing the regional plan will require cooperation with and incentives for participation by the member jurisdictions and cooperating agencies that comprise SANDAG. The plan needs to provide more description of how SANDAG's current incentives programs ( <a href="https://www.sandag.org/uploads/publicationid/publicationid_1187_5188.pdf">https://www.sandag.org/uploads/publicationid/publicationid_1187_5188.pdf</a> ) will be augmented and prioritized to ensure that the necessary infrastructure and operational investments correspond to the projected growth (e.g., location of new housing and jobs)	Appendix B describes the actions SANDAG will take to update and initiate new incentive programs for member agencies. These are detailed under Priority Implementation Action number 8.
L289	Page 53. The plan proposes a reasonable list of priority implementation actions. One item that is not discussed in the plan but is referenced in Item 9 is to expand nature-based climate solutions. As recommended in our prior comment on Page 9 of the plan, it should provide more description about the regional environment, which would then establish the context for "nature-based solutions." Though the assessment/analysis of what those solutions are and how they advance the goals of the RTP/SCS will be part of the subsequent CEQA EIR, this document needs to better describe (at a general level) what this action involves.	Nature-based climate solutions are described with more detail in Appendix B. More detail on the natural environment and nature-based solutions has been added to Chapter 2.
L290	Pages 54-55. Monitoring must address both implementation and performance. The proposed performance indicators align with the regional plan's goals and would collate/integrate relevant existing measurement/data and reporting sources. But the corresponding implementation monitoring needs to be better described and some additional monitoring considered. As noted in our comment on Pages 13, 27 and 32-33, the plan does not effectively illustrate how the key components are expected to integrate. Specifically, the plan needs to monitor and report (and provide simple illustrative mapping) how the actual growth in housing/jobs within the mobility hubs/smart growth areas and the associated transportation infrastructure/operational improvements are in alignment and how they are advancing compared to their anticipated advancement per this plan. This type of implementation tracking and reporting is essential and it does not appear to be covered by the proposed performance indicators in Table 3.1.	These comments will be considered as SANDAG implements Priority Implementation Action #10 to advance a data science program to better understand travel behavior in the region, update travel demand modeling tools, and improve transparency and reporting on program effectiveness and project delivery.
L291	General Comment. This appendix is essentially a matrix of SB 375, AB 805 and other legislative/legal requirements and a compilation of past documents that were used to prepare specific components of the RTP. Providing a conformance matrix of those requirements and what is in the RTP does not explain how the RTP comprises a sustainable communities strategy. At a minimum, this appendix should provide a short (a page or two) summary of how the plan integrates critical elements or summarize sections from Chapter 2 in the main body of the RTP/SCS where an explanation of that integration (the basic strategy) is provided.	Chapter 2 of the 2021 Regional Plan is the Sustainable Communities Strategy (SCS). Appendix D is SCS Documentation and Related Information.
L292	<p>Page D-4. While the state does not set a 2050 target for GHG emissions reduction and the MPOs are not required to produce an official GHG reduction target for 2050, the projected regional reduction of 20.3% from the 2005 baseline is alarming. That is only 0.3% below the 2035 regional reduction, which implies that all of the anticipated new GHG reductions within the region "max out" their effectiveness by 2035. One can assume that between now and 2035 there will be additional regulations and technologies that will force/enable the region to improve upon that projected 2050 reduction. In that vein, this document should include more extensive discussion about how and what future iterations of the RTP/SCS will commit to doing to continue to identify relevant GHG reduction options for the region. Presenting this number and then not providing further discussion about how SANDAG will be addressing what appears to be a "stalled" GHG reduction effort post-2035 is neither sufficient nor acceptable. The relevance of this concern is clearly illustrated by the data provided in Appendix F (Figure 1) regarding the projected population growth, which is estimated to be 437,000 between 2016 and 2050 –about a 13% increase. Even if the region added only roughly 100,000 people from 2035-2050, absent a more aggressive RTP/SCS that is initiated well before 2035, the region would be totally incapable of attaining the state's "target reduction" of 80% below baseline by 2050 or the more recently cited statewide goal of net zero by 2040. The RTP/SCS should, at the least, provide a discussion about how future versions of the document will be addressing post-2035 GHG emission reductions.</p> <p>Page D-20. The legend for this figure should be revised to "Existing and Proposed/Potential San Diego Region Habitat Conservation Lands."</p>	<p>SANDAG is required to update the Regional Plan every four years to incorporate the latest data, policies, population projections, and technology assumptions. SANDAG will consider additional strategies to reduce GHG emissions in future iterations of the Regional Plan.</p> <p>The legend for this map has been updated.</p>
L293	This appendix provides only a minimal level of information and it is unclear when the appropriate level of detail necessary to implement the performance monitoring will be developed and made available. The types of issues subject to monitoring (e.g., Health and Environment; Energy and Water; Housing; Quality of Life; and Transportation Planning) address issues relevant to SB 375 and other mandates, and the Indicators and Sources of Information seem reasonable. But the appendix does not provide any discussion or examples of how the indicators will be used. For example, which components of "Air Quality" are to be used, what are the relevant standards, etc. When a general indicator is to be used	A performance monitoring report using the indicators from Appendix E is developed halfway between each 4-year regional plan cycle. The report is shared with the SANDAG Board of Directors to provide a high-level status update on critical areas across the region. This information helps inform the Board of Directors in their development of regional goals for the subsequent regional plan. The indicators use available observed data which also informs how each indicator is calculated.

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	(e.g., Percentage of households with housing costs greater than 35% of income), what is the RTP/SCS intending to do with that number?	
L294	For all Indicators, one presumes that there is a threshold or trigger point (for when the plan is failing to meet an objective) at which the plan would be required to begin to initiate actions in response to reaching the trigger/threshold. Or conversely, if the threshold indicates that the plan has successfully achieved a goal, what if any additional effort is required?	There are no targets or thresholds associated with the indicators in the performance monitoring report. The indicators serve to inform the planning process and decision makers on trends and changes for the region.
L295	The RTP/SCS performance monitoring plan will likely have to be periodically updated to reflect new requirements (e.g., air quality standards may change), new technologies may allow for improvements to the current indicators, and conditions may warrant changes in the types of issues relevant to the plan and/or the identified indicators may need to be revised or replaced. Regardless of that reality, the public, stakeholders and jurisdictions/agencies that will be reporting, evaluating and relying on the performance monitoring to determine how the RTP/SCS is functioning must be provided a more complete description of the performance monitoring plan.	The Regional Plan performance indicators are reviewed for changes with each regional plan. Updates to the indicators are often from changes in policy direction and data sources. Past Regional Plan Performance Monitoring Reports, which include detailed methodology, are available at: <a href="https://www.sandag.org/index.asp?classid=12&amp;projectid=309&amp;fuseaction=projects.detail">https://www.sandag.org/index.asp?classid=12&amp;projectid=309&amp;fuseaction=projects.detail</a> .  Air quality conformity, which addresses federal Clean Air Act requirements, is covered in Appendix C.
L296	Pages F-10-12 (Tables F.1-3). While there appears to be a similarity in the relative growth in population, jobs and housing among the jurisdictions, the Unincorporated County's projected population growth (0.9%), jobs growth (23.2%) and housing growth (4.3%) seem to be noticeably different. In particular, there is a very high projected growth in jobs compared to population and housing. How does that seeming disparity in jobs growth with population and housing growth (which has implications for transportation to housing) impact transportation planning? Are there other jurisdictions for which the "disparity" in projected population, jobs and housing pose challenges to the RTP/SCS's 5 Big Moves approach?	Forecasted job growth in the region is a result of the size and age/race/ethnicity/sex composition of the projected population as well as higher projected labor force participation rates in the future. Population, housing unit, and job data were all incorporated into the development and implementation of the 5 Big Moves. Job and housing growth are both concentrated in the Mobility Hubs in order to ensure that current and future residents will be able to access future jobs in the area.
L297	Page F-15 (Figure F-5) – Five areas that appear to support significant jobs but are outside of mobility hubs are Camp Pendleton, MCAS Miramar, Pt. Loma and North Island (military employment) and East Otay Mesa. How are SANDAG and the military services planning to address this?	Military job growth is concentrated on current sites of military employment because of the unique characteristics of military jobs. This job growth will be outside of Mobility Hubs unlike other private employment in the region. Additionally, during the development of the Mobility Hubs, staff ensured that each military installation is located near a Mobility Hub so that military personnel have access to transit and other amenities offered on Mobility Hubs.
L298	Page AA-1. The introductory paragraph – or a new second paragraph - should include a brief description of the relationship of SANDAGs existing TransNet program, the regional Multiple Species/Multiple Habitat Conservation programs and regional funding for habitat conservation and preserve management. Any significant differences in the proposed RTP/SCS from previous versions should be discussed later in this appendix.	The text includes a discussion of the history of regional funding for habitat conservation, the role that SANDAG has played in the past, and the potential future role SANDAG could play as part of the implementation of the 2021 Regional Plan.
L299	Page AA-3. Figure AA.1. Recommend the map title be revised to "Existing and Proposed/Potential San Diego Region Habitat Conservation Lands" and change the legend to conform.	The title and legend has been updated.
L300	Page AA-6. The Regional Habitat Conservation Vision presumably applies across all of the lands within the SANDAG member agencies. Because the local jurisdiction and agencies have their own General Plans/Open Space Element, Climate Action Plans, and other planning processes that would have direct effects on a regional vision, please provide more discussion regarding how this vision is expected to be integrated into the local jurisdictions' and agencies' plans. Such as, will SANDAG add staff to coordinate this effort, what new policies and projects would this require, will additional funding be identified and provided, etc.	The 2021 Regional Plan indicates that the region must come together to take on implementation of the completion of the regional habitat conservation plans that were started in the 1990s. SANDAG has served as a forum for these discussions in the past and can be again. Implementation of the Vision would be made after adoption of the 2021 Regional Plan.
L301	Page AA-6. The Regional Funding section should add more information. We recommend adding more to the introduction of this issue. Begin the section with a new introduction: "A functioning and adequately funded set of regional habitat preserves is essential to this region's overall capability to address climate change. The benefits from habitat preserves range from meeting regulatory requirements associated with future development and ongoing operations and maintenance by the local jurisdictions; improving/enhancing the long-term potential for rare/threatened species and their habitats to adapt to climate change; providing for movement by species and vegetation communities as a response to climate change; and serving as a carbon sink. While these conserved and managed lands are part of the "baseline" condition relative to GHG emissions, they are valuable because natural areas remove CO2 and eliminate development potential." Also, revise the last part of this paragraph to state: "A regional funding source was proposed as part of a ballot measure (that failed) in 2016 to help offset the preserve implementation costs to local jurisdictions. Without a new regional funding source, securing crucial land acquisitions and long-term management and monitoring, which are essential to the success of these plans to protect species and their habitats from extinction, falls into question. In 2011, the estimated unfunded regional cost to ensure implementation of the regional habitat conservation plans was \$3.0 billion. SANDAG will work with the member agencies to develop and promote the establishment of the regional funding source that complements the infrastructure and operations components of the 5 Big Moves."	The text in Appendix AA has been updated to reflect the sentiment of the recommendation.  To assist the region to meet its habitat conservation goals, the proposed final 2021 Regional Plan has identified \$2,087 million for an enhanced habitat conservation, management, and monitoring program. These funds are complemented with a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (See Climate Adaptation and Resilience programs). In addition, future mitigation of the transportation projects included in the 2021 Regional Plan will result in an additional \$300-\$500 million of land acquisition and restoration for habitat mitigation (incorporated in project costs presented in Appendix A). SANDAG is committed to working with its regional partners to identify funding to fulfill this commitment.
L302	Page AA-6. Recommend revising the sentence "Connect habitat areas through wildlife corridors and linkages and connect people to local species and San Diego's natural habitats." to "Connect habitat areas through wildlife corridors	The text in Appendix AA has been updated to reflect the sentiment of these recommendations.



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	<p>and linkages, and enhance peoples' access, where appropriate, to natural habitat areas.”</p> <p>Page AA-7. Recommend adding a sentence to the end of the paragraph: “It is essential that the remaining habitat conservation plans be completed, which will then establish the necessary core habitat areas and key connections across the region.”</p> <p>Page AA-8. Recommend revising the following sentence “In addition to acquiring more properties to connect wildlife, in the following years, San Diego’s North County will complete their MSCP, which will prioritize acquisitions that establish critical connections for high-risk species that reside in North County communities.” To state “In addition to acquiring more properties to connect wildlife, in the following years, when the North and East County MSCPs are completed, they will prioritize acquisitions that establish critical connections for high-risk species that reside in North/East County as well as connections to preserve lands in Orange and Riverside counties.”</p> <p>Page AA-10. The paragraph that describes regional funding should reference - or reiterate - our recommended new statement (Page AA-6) regarding SANDAG’s commitment to work with its member agencies to develop and establish a new regional funding source for habitat conservation.</p>	
<b>San Diego County Bicycle Coalition</b>		
L303	Several projects that were in the Early Action Plan appear in Appendix A. How do the projects in the EAP differ than the projects here?	In September 2013, the SANDAG Board of Directors approved \$200 million in local transportation funding, intended to be leveraged for and supplemented with grant funding, to implement the Regional Bike Plan EAP. Since that time, SANDAG has been working on public outreach, environmental review, design, and construction to complete the EAP projects and in this process has more specifically defined the EAP projects which are now capital improvement projects.
L304	In general, the dollar amount spent on managed lanes rather than mode-shift is concerning. More funding and increased timelines for active transportation & transit leap projects should be prioritized.	A better transit system is a fundamental component of this Regional Plan. Revenues to fund the transit projects don't come in all at once but dollars that are available are applied to ensure that the best transit projects are initiated first and that those projects address social equity considerations. The investments in Managed Lanes will support high speed transit service to ensure time competitive trips as compared to the auto.
L305	Page A-14, Section TL58 How does the San Diego - Coronado Military Ferry connect to the Central Mobility Hub?	The airport transit connector is envisioned to have a station at the East Basin near Harbor Island that would provide a connection to a new ferry terminal that would serve Naval Air Station North Island.
L306	Page A-42, Table A.13 In general, the Arterials section neglects to mention active transportation and public transportation facilities along arterial corridors. If SANDAG wants to get San Diegans out of their cars, then arterial streets need to prioritize pedestrians, bicycles, and public transportation over cars.	The arterials portion of Appendix A are projects from the various cities through the RTIP programming process (using Local Streets and Roads funding). The inclusion of complete streets and active transportation elements would be outlined in each of those projects' descriptions by “TIP ID” in the RTIP.
L307	<p>Page A-42, Project CB04B This intersection’s bike lanes are in need of protection and better visibility for drivers. NCTD Bus 309 stops at this intersection as well, is SANDAG planning on providing any infrastructure improvements for bus and pedestrian connectivity?</p> <p>Page A-42, Project CB22 SANDAG should prioritize building safe active transportation infrastructure to and from the Carlsbad Poinsettia Station along this corridor. Sidewalks and bike lanes heading north disappear at the station, and this project makes it appear that SANDAG isn’t planning on including those elements. SANDAG should not widen Avenida Encinas from Palomar Airport Road to Embarcadero Lane. Instead, SANDAG should keep the current configuration and build wide sidewalks and protected bicycle facilities.</p> <p>Page A-42, Project CB31 The bike lane along this segment of El Camino Real is often subject to vehicle intrusion. SANDAG should add protection to the bicycle facility here to keep cyclists safe.</p> <p>Page A-42, Project CHV69 SANDAG must include in this project upgrades the existing bicycle connection to the North Island Credit Union Amphitheatre. The currently existing Class II lanes on Heritage Road are often subject to vehicle intrusion.</p> <p>Page A-42, Project CNTY14A</p>	<p>The 2021 Regional Plan aims to create safe and well-connected routes for bicyclists and pedestrians. The intention of the network in this Regional Plan is a framework which facilitates trips associated with regional purposes designed to enhance neighborhood connections to schools, employment centers, and other everyday destinations. The regional network will not include details regarding the types of bicycle and pedestrian facilities for specific projects are not yet determined and will require future planning and coordination with local jurisdictions, community members, and stakeholders such as your organization. SANDAG looks forward to working with you on these project details in the future.</p> <p>The misspelling pointed out in project O22 on page A-43 has been updated in our documentation.</p> <p>Your comment was forwarded to agencies that oversee these facilities.</p>

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	<p>SANDAG must build Class IV protected bike lanes in addition to pedestrian safety improvements along this corridor to improve connectivity to the Sprinter and NCTD Buses 305 &amp; 332.</p> <p>Page A-43, Project CNTY21 Additional pedestrian safety measures are needed for the Overpass at SR-67, including bulb-outs and more visible crosswalks.</p> <p>Page A-43, Project CNTY34 SANDAG must be specific about what bike facilities are planned for the Dye Road Extension in Ramona.</p> <p>Page A-43, Project CNTY98 The current condition of Otay Lakes Road has Class III bike facilities. What facilities are planned for this project?</p> <p>Page A-43, Project ESC04 SANDAG has forgotten to include what happens to the currently-existing Class II buffered bike lanes with this project. Bicycle lanes should be included in the bridge design over Escondido Creek.</p> <p>Page A-43, Project ESC08 SANDAG should include safe bicycle facilities in this project.</p> <p>Page A-43, Project ESC24 What intersection improvements are planned? How will SANDAG maintain or upgrade the existing bicycle facilities? In addition, Mission Road is misidentified. The street becomes Mission Avenue after it crosses I-15.</p> <p>Page A-43, Project NC01 SANDAG should include safe bicycle facilities in both Phase II and Phase III of this project.</p> <p>Page A-43, Project O22 The street Avenida de la Plata is misspelled here. SANDAG should add protected bicycle facilities along this corridor.</p> <p>Page A-44, Project SD34 SANDAG has forgotten to include what happens to the currently-existing Class III sharrows with this project. Bicycle lanes and sidewalks should be included in the design to connect to future planned bus service at Via de la Valle.</p> <p>Page A-44, Project SD70 What bridge is SANDAG planning on replacing? These bridges are extremely busy and bicycle facilities should be protected Class IV, not Class II.</p> <p>Page A-44, Project SM19 The six-lane arterial street from Craven to Grand Avenue must include safe, protected bicycle infrastructure to provide a complete network. The intersection of Craven Road and Discovery Street should be redesigned to close the slip lane and provide safe crossing for cyclists and pedestrians.</p> <p>Page A-44, Project SM24 SANDAG should add protected bicycle lanes along this project, and include a safer pedestrian crossing under SR-78.</p> <p>Page A-44, Project SM31 The proposed widening of Discovery Street from Via Vera Cruz to Craven Road must include safe, protected bicycle facilities and pedestrian infrastructure.</p> <p>Page A-44, Project SM32 This project must include safe, protected bicycle facilities and pedestrian infrastructure to provide network connectivity.</p> <p>Page A-44, Project SM42 This project must include safe, protected bicycle facilities and pedestrian infrastructure to provide network connectivity to CSU San Marcos.</p> <p>Page A-45, Project SM48</p>	

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	<p>This project's bike path should not meander, but provide clear connectivity along the route to promote bicycle commuting.</p> <p>Page A-45, Project SM69 The intersection of Twin Oaks Valley Road and Barham Drive in San Marcos is currently hostile to pedestrian and bicycle traffic, with slip-lanes and disappearing bicycle lanes. What plans are in place to increase use of active transportation at this intersection?</p> <p>Page A-45, Project CB212 What classification of bicycle facilities are being planned for College Boulevard Reach A?</p> <p>Page A-45, Page CNTY35 What classification of bicycle facilities are being planned for the Ramona Street Extension? SANDAG should also consider re-striping and adding more signage to Ramona Street's currently-existing lanes.</p> <p>Page A-45, Project SD190 What bicycle facilities will SANDAG include in the Palm Avenue Bridge project?</p>	
L308	<p>Page A-54, Table A.17 Support for increased funding for GO by BIKE, and an e-bike incentive program.</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
L309	<p>Page A-54, Table A.18 What is the cost breakdown of the local bike program?</p>	<p>These costs are either a per-mile by-facility-type estimate or, percentage of a local jurisdiction's CIP budget.</p>
L310	<p>Page A-55, Table A.19 SANDAG should consider incentivizing alternative cargo delivery vehicles for local delivery services under this table. For example, incentivize the usage of cargo e-bikes for parcel delivery in dense, urban neighborhoods.</p>	<p>Flexible Fleets include a variety of mobility services that provide sustainable alternative for moving people and goods. Last mile delivery services like cargo bikes, autonomous shuttles, and drones are part of the Flexible Fleets strategy and are envisioned to be concentrated within mobility hubs throughout the region. SANDAG is developing a Flexible Fleet Implementation Strategic Plan that will identify near-term opportunities for Flexible Fleets including last mile delivery. SANDAG will also be initiating a "San Diego and Imperial Counties Sustainable Freight Implementation Strategy" (Strategy) this winter that will identify regional opportunities for sustainable freight projects and policies, and increasing the use of cargo bikes and their supporting infrastructure will be explored as one of these strategies. The next Regional Plan will incorporate recommendations from this Strategy and future last mile delivery pilots.</p>
L311	<p>Page A-68, Figure A.11 Segments of the Bayshore Bikeway that are already completed seem to be missing from this map.</p>	<p>SANDAG staff will review the final maps specifically to ensure that all portions of the Bayshore Bikeway which have been built to their final proposed condition are included appropriately.</p>
L312	<p>Page B-4, Section 3(b) Support updating the evaluation and monitoring procedures of projects using TransNet local streets and roads funds, including prioritization of safety for vulnerable road users in the development of complete streets. The procedures should include a mechanism for the public to comment.</p> <p>Page B-4, Section 3(c) Support the development of a Regional Active Transportation Plan, including updating the San Diego Regional Bike Plan to reflect need for safe bicycle infrastructure county-wide.</p> <p>Page B-4, Section 3(d) Support the development of a Regional Vision Zero Action Plan, including a Regional Safety Policy. This regional safety policy should establish clear procedures that allow for the collection of accurate crash data, and the usage of that data to make changes to dangerous designs.</p> <p>Page B-7, Section 7(a) Support the implementation of the 2021 Regional Transportation Improvement Program (ETIP) &amp; building bike early action program projects</p> <p>Page B-7, Section 7(d) Support building projects with an emphasis on safety for all road users to implement Vision Zero</p> <p>Page B-7, Section 8(b) Support for updating evaluation criteria and provisions of SANDAG grant programs to improve social equity, advance roadway design with an emphasis on safety for vulnerable road users, implement climate action plans, and others listed.</p>	<p>We appreciate your support and feedback on the implementation actions outlined in Appendix B. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>

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	<p>Page B-8, Section 8(e) Support for incentivizing implementation of complete streets projects that complement regional investments within Mobility Hubs, along Complete Corridors, and supporting Flexible Fleets. We absolutely support a formalized Quick Build implementation program that develops complete streets solutions.</p> <p>Page B-9, Section 9(g) Support for transportation demand management grant and incentive programs, including e-bike, carpool, and vanpool incentives</p> <p>Page B-10, Section 10(a)(b)(c)(d)(e) Support for policies outlined under this heading</p>	
L313	<p>Page D-8, Table D.3 This table lists micromobility costs as \$0 for access/egress to transit. Does this mean SANDAG is planning on subsidizing micromobility rides as a last mile solution?</p>	Yes, SANDAG has modeled micromobility with no cost when it is used to access/egress transit. The implementation of this would be through Flexible Fleet partnerships.
L314	<p>Page D-8, Table D.3 What model is SANDAG using to determine that 36% of privately owned bikes will be e-bikes by 2035?</p>	SANDAG estimated future use of e-bikes based on market trends and impact of future incentives for e-bike purchases.
L315	<p>Page E-2, Section: Housing Support the addition of using Housing as a Performance Indicator.</p> <p>Page E-2, Section: Quality of Life Support the addition of using unemployment, social equity, telework, and homelessness as a Performance Indicator.</p> <p>Page E-3, Section: Transportation Planning Support the addition of using Bike Lane Miles and Annual Transit Ridership as a Performance Indicator.</p>	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
L316	<p>Page G-50, Section 3.0 Support the inclusion of SANDAG's Commitment to Equity Statement</p> <p>Page G-50, Section 3.1 Support for Social Equity and Environmental Justice Considerations</p> <p>Pages G-51 &amp; G-52, Sections: 3.2 - 3.5 Support for working in partnership with Tribes, Mexico, Military, and other stakeholder agencies</p>	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
L317	<p>Page G-53, Section 4.0 - Table 1: Public Workshops Rather than increasing the amount of public workshops by an arbitrary number (10%), SANDAG staff should use data to calculate public engagement by geographic region throughout the county, and use that data to determine low engagement rates where more public workshops are needed.</p>	Community input is critical to creating a plan that represents the varied values, needs, and interests of the San Diego region's residents and businesses. SANDAG is committed to conducting effective public outreach as part of the 2021 Regional Plan as well as all of our planning and constructions activities and agrees that data should continue to inform our planning as well as outreach and communications activities.
L318	<p>Page G-53, Section 4.0 - Table 1: Pre-document consultation Add: "Gather an additional" to "5,000 individual remarks" so context is more clear</p>	We appreciate your feedback and suggestions.
L319	<p>Page G-53, Section 4.0 - Table 1: Opportunities for engagement Rather than "increasing variety of platforms for public engagement by 15%", the goal should be to re-evaluate the effectiveness of current platforms being used during a certain time period and then determine if another platform could be more effective. In addition, special topic/targeted workshops should be made available in as many languages as possible and include dedicated outreach to stakeholder groups who have not participated in or have been historically excluded from the public engagement process prior to the 2021 Draft Regional Plan.</p>	A key objective of SANDAG's outreach effort is to engage with people in historically underserved communities throughout the planning process. SANDAG is currently identifying the potential effectiveness of new communications platforms, including new social media platforms. Additionally, we routinely evaluate the effectiveness of outreach to traditional media platforms, such as print, radio, and TV outlets, to determine if outreach should be expanded to more effectively reach diverse audiences throughout the region. Public facing materials may be translated into multiple languages upon request. Spanish language interpretation is made available at public meetings, and interpretation in additional languages is available upon request.
L320	<p>Page G-57, Appendix A.1 In order to reach a younger audience, "San Diego County Media Outlets" should be expanded to include student publications at the region's school systems and colleges/universities. In addition, many young people engage with social media accounts for local news information, so SANDAG should research where they could make an impact through social media channels besides their own.</p>	SANDAG strives to engage people of all ages in public outreach throughout the planning process. This feedback will be incorporated into Appendix G.
L321	<p>Page H-15, Section: Existing Conditions in Disadvantaged Communities in the Region SANDAG notes that 5.7% of households in the region have "zero vehicles available" but hasn't defined what a vehicle is outside of being "dependent on transit services." How does SANDAG define "transit services?" If a person didn't own a</p>	A vehicle, in this case, is considered to be an automobile.

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	car, but used a personal bike, skateboard, or rented a micro-mobility solution to travel, would that person be considered as “not having access to a vehicle”?	
L322	Page H-33, Section: Defining Performance Measures for Social Equity Analysis Support using percentage of population within 0.25 miles of a Bike Facility as a social equity performance measure.	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
L323	Page H-55, Section: Access to Basic Needs Why were biking and walking metrics only included for parks and retail sections, but not for access to employment or education centers?	The purpose of these access measures is to gauge network performance to concentrated, high-demand employment centers (see Figure T.5) and higher education centers that are regionwide destinations. Transit was used to cover the regionwide travel shed with walking and flexible fleets as the means to access transit.
L324	Page H-58, Table H.11 The bicycle statistics laid out in this table are inaccurate and out-of-touch with reality. While theoretically true that a bicycle could use the existing network to access parks, our current street network is dangerous for cyclists due to the lack of safe infrastructure and most parks are not considered accessible by regional bicycle advocates. How was “Access” by bike defined and used in these calculations? Did safety, comfort, bike parking, and ridership play a part in defining “access” by bicycle?  Page H-60, Table H.12 This table has the same issue with Table H.11. The bicycle statistics laid out in this table are inaccurate and out-of-touch with reality. While theoretically true that a bicycle could use the existing network to access retail spaces, our current street network is dangerous for cyclists due to the lack of safe infrastructure and most retail/commercial areas are not considered bicycle-friendly by regional bicycle advocates.	Access is based strictly on location/proximity of residents to various amenities (parks, retail, employment, etc.).
L325	Page K-29, Section 5: Objectives and Factors Support the promotion of shared-use mobility, including bike sharing	We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a> .
L326	How does SANDAG plan to promote use of active transportation by allowing bicycles on transit?	By working with our partners at NCTD, MTS, and Caltrans/LOSSAN.
L327	How does SANDAG plan on expanding the bicycle locker program?	SANDAG is adding new electronic bike lockers at all the Mid-Coast stations in Fall 2021. Two of those stations (Nobel & University Towne Center) will have group bike parking facilities to accommodate up to 40 bikes each. We will continue to monitor daily usage and reallocate resources accordingly. Additionally, SANDAG will study existing transit stations to determine if bike lockers could be beneficial in the future.
L328	SANDAG should consider adding bicycle cars on trains to accommodate bicycles on trains.	Thank you for the suggestion.
L329	Page L-6, Section: Complete Streets in Mobility Hubs What does “enhanced bike and micromobility parking” mean?	Secure Parking Areas, primarily.
L330	Page L-7, Section: Vision Zero What are the details of SANDAG’s plan to collect and analyze crash data for bicycle traffic?	We will continue to use the statewide resources provided by CHP via SWITRS. Additionally, SANDAG’s ARJIS staff works with public safety data and discussions are ongoing with local jurisdictions regarding the prospect of supplementing that statewide-maintained data with any additional collision reporting at the local jurisdiction level which may not be included in the FARS/SWITRS databases.
L331	Page L-7, Section: Riding into the Future What is the timeline for SANDAG developing a new, comprehensive Regional Active Transportation Plan as a near-term action from the 2021 Regional Plan?	Near-term actions are commitments to be implemented prior to the next Regional Plan (2025).
L332	Page L-10, Section: Significance of Reduced Speed Limits What is SANDAG’s plan to reduce speed limits in San Diego County?	SANDAG submitted a letter of support for Assembly Bill (AB) 43 and will continue to support the recommendations from the AB 2363 Zero Traffic Fatalities Task Force.
L333	Page L-16, Section: Principles by Layer: General Add: Limit bicycle interaction with mixed traffic wherever possible	SANDAG follows national and international best practices in bikeway design to create safe facilities for users of all ages and abilities. Multiple studies show that most people feel safer in protected bikeways, and when well designed, they are safer than any other type of bike facility. The focus of our efforts is on people who may be “interested but concerned” in riding a bike alone or with family. For those who do not feel comfortable riding in protected bikeways, the California Vehicle Code allows people to bike in the roadway with traffic. While protected bikeways are a great solution in many cases, we know they are not always the best solution. Every project goes through a detailed and context sensitive design process which results in decisions regarding the best facility, which may include protected bikeways, buffered bikeways, shared use paths, or shared streets with significant traffic calming elements. The Regional Plan also includes funding for upgrading existing bikeways that may not meet current best practices in maintenance or bikeway design.
L334	Page L-16, Section: Principles by Layer: General All Transit Leap nodes should be served by bicycle routes.	Bikeways are fundamental component of the Mobility Hubs and the active transportation networks will be developed in conjunction with these projects.



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L335	<p>Page L-22, Table L.1 SANDAG should ensure that Bicycle Facility Selection Plan tool is used consistently throughout the region, and that any arterial/TransNet funds follow this tool.</p>	<p>SANDAG intends to make the Bicycle Facility Selection Plan tool available to local jurisdictions and a recommended approach.</p>
L336	<p>Page M-8, Near-term Action #4 Support for the promotion of vehicle miles traveled reduction through Regional Complete Streets Policy</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>
L337	<p>Page M-9, Near-term Action #5 This action item should be amended in two ways: 1) SANDAG should include pursuing data-sharing agreements with mobility companies operating in the San Diego region, and 2) SANDAG should begin procuring more bicycle and pedestrian counters, and identify places where they are needed</p>	<p>1) SANDAG is actively developing data sharing agreements to be executed with shared mobility providers operating in the San Diego region. Beginning first with micromobility providers, this data will assist SANDAG with honing our planning and modeling capabilities as we demonstrate how Flexible Fleets contribute to the reduction of vehicle miles traveled and enhanced personal mobility.</p> <p>2) SANDAG maintains 10 automated bike counters and 2 pedestrian counters on 8 regional bike network corridors. SANDAG will be purchasing more counters in order to re-install at these same locations in conjunction with our bikeway projects in order to have longitudinal data on these upgraded bikeways. SANDAG also convenes a bi-monthly meeting of local agency staff that are currently, or will be, maintaining bike and pedestrian counters to ensure technical assistance and knowledge sharing is facilitated at the regional level.</p>
L338	<p>Page M-16, Near-term Action #11 Support for the development of a regional military base access plan and implementation program. Most of San Diego’s military installations are uniquely positioned within urban contexts and SANDAG should incentivize active transportation and public transportation usage to/from these sites.</p> <p>Page M-17, Near-term Action #12 Support for the development of a Regional Mobility Hub Strategy</p> <p>Page M-25, Continuing Action #11 Support for continuing to seek funding for transportation investments that provide a variety of choices, reduce greenhouse gas emissions, and promote healthy lifestyles through more active transportation.</p> <p>Page M-26, Continuing Action #12 Support for capital and planning grants to local jurisdictions to support smart growth, biking, and walking, and seek additional funds to leverage existing grant programs.</p> <p>Page M-27, Continuing Action #14 Support for implementation of state-of-the-art technologies and Transportation Demand and Systems Management Programs to provide more mobility choices and allow the transportation system to function more efficiently. SANDAG should prioritize bike education services, upgrading and expanding bike lockers and bike parking throughout the region, and increase funding for Shared Streets grants.</p> <p>Page M-30, Continuing Action #18 Support for opportunities to expand shared mobility services near Smart Growth Opportunity Areas. SANDAG should consider how expanded mobility services interact with the surrounding communities and provide safe infrastructure for those services.</p> <p>Page M-31, Continuing Action #20 Support for identifying transportation solutions to improve connectivity to the San Diego International Airport. These solutions should include building safe long-term bike parking and provide connectivity to existing bikeways in the community</p> <p>Page M-33, Continuing Action #22 Support for continuing to apply social equity and environmental justice considerations in the implementation of SANDAG projects and programs.</p> <p>Page M-33, Continuing Action #23 Support for collaboration with key partners and stakeholders, including representatives from low-income and minority communities, and actively involve the public in the planning process. SANDAG should create guidelines for conducting outreach and collaboration, and gather data to improve performance. SANDAG should also continue to provide ongoing</p>	<p>We appreciate your support and feedback. Please continue to follow along in this process by visiting <a href="http://SDForward.com">SDForward.com</a>.</p>



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	<p>outreach across many languages to ensure communities that were traditionally underrepresented have a voice in the process.</p>	
L339	<p>Page P-1, Section: Year-Round Tourism San Diego has a thriving tourism industry that unfortunately relies on tourists renting cars to visit popular tourist destinations. This appendix does not present any strategies to mitigate VMT from car rental services, nor does it lay out any strategies to provide alternative transportation access to any of San Diego’s major tourist attractions that rely on vehicle access. Tourist destinations are not only places to visit, but many of them are major employment centers that could benefit from efficient transportation connections.</p> <p>Page P-1, Section: Year-Round Tourism SANDAG should also consider other services that tourists use in San Diego County and how they interact with the Regional Plan. This includes hotels, the airport, the cruise ship terminal, and alternative tourist mobility solutions such as the Old Town Trolley, GoCar City Tours, hotel and airport shuttles, etc.</p> <p>Page P-1, Section: Year-Round Tourism San Diego is a world-class bike tourism destination. The 2021 Regional Plan should reflect the need for facilities to accommodate bicycle tourism.</p> <p>Page P-3, Section: Special Events SANDAG should consider adding pop-up safe bicycle parking to special events to incentivize San Diegans to ride their bicycles to special events.</p> <p>Page P-4, Section: Next Steps SANDAG should study traffic patterns of major tourist destinations and devise strategies to reduce VMT and incentivize public/active transit usage.</p>	<p>The Regional Plan Appendix P highlights transit routes that provide access to major tourist destinations. The Regional Plan addresses connecting rural destinations with complete corridors to improve multimodal connectivity. In addition, the Central Mobility Hub and the San Ysidro Mobility Hub are noted since they will provide critical transit and flexible fleets connections and amenities for residents and visitors. The ideas mentioned in your comments to promote alternative tourist mobility solutions present an opportunity for collaboration with the tourism authority, visitors bureau, local chambers of commerce, and stakeholders such as your organization to seek future grant funding to develop a regional travel and tourism strategy.</p>
L340	<p>Page S-21, Section: Active Transportation Network Input The five classification types described in this section don’t seem to match anywhere else in the SANDAG RTP, and should be rethought to better fit the language throughout the document. For example, this appendix references bike boulevards as Class IV facility, but Appendix L-25 describes a bicycle boulevard as “most similar to the Class 3 facility.” If SANDAG is going to change classification types for modelling purposes exclusively, this appendix should specify that. In addition, the Active Transportation Network Input should take into account the surrounding infrastructure (speed limits, driveways, and other bikeway intrusions) to determine the comfortability of riders using the facility.</p>	<p>There was a misclassification of “cycle tracks” which are Class IV bikeways as per the CVC. We will make this edit.</p>
L341	<p>Page T-25, Table T.9 The bicycle statistics laid out in this table are inaccurate and out-of-touch with reality. While theoretically true that a bicycle could use the existing network to access parks or retail within 15 minutes, our current street network is dangerous for cyclists due to the lack of safe infrastructure and most parks and retail spaces are not considered accessible by regional bicycle advocates. How was “Access” by bike defined and used in these calculations? Did safety, comfort, bike parking, and ridership play a part in defining “access” by bicycle?</p>	<p>The data presented in this table are modeled results from SANDAG’s Activity Based Model (ABM). This model can take into account several factors such as travel distance, speed, and network availability but it cannot account for perceptions of safety, comfort, or availability of bike parking. Access is the ability to traverse the transportation network to the specified destination within the designated timeframe. The ABM is updated regularly with the latest available data and best practices to represent regional travel; please see Appendix S: Travel Demand Modeling Tools for more information.</p>
L342	<p>Page T-27, Table T.10 The bicycle statistics laid out in this table are inaccurate and out-of-touch with reality. While theoretically true that a bicycle could use the existing network to access parks or retail within 15 minutes, our current street network is dangerous for cyclists due to the lack of safe infrastructure and most parks and retail spaces are not considered accessible by regional bicycle advocates. How was “Access” by bike defined and used in these calculations? Did safety, comfort, bike parking, and ridership play a part in defining “access” by bicycle?</p>	<p>The data presented in this table are modeled results from SANDAG’s Activity Based Model (ABM). This model can take into account several factors such as travel distance, speed, and network availability but it cannot account for perceptions of safety, comfort, or availability of bike parking. Access is the ability to traverse the transportation network to the specified destination within the designated timeframe. The ABM is updated regularly with the latest available data and best practices to represent regional travel; please see Appendix S: Travel Demand Modeling Tools for more information.</p>
<p><b>San Diego County Regional Airport Authority</b></p>		
L343	<p>The Draft 2021 Regional Plan’s Appendix BB (page BB-1) states that “routes included in the 2011 AMAP continue to be identified in the 2021 Regional Plan.” However, the following appear to be programmed into the Draft Plan:</p> <p>San Diego International Airport - Heavy Rail Grade Separation (Whitherby St. to Laurel St.) - I-5 Direct Access Ramps</p> <p>McClellan-Palomar Airport - Palomar Airport Road Widening (I-5 to Hidden Valley Rd.) - Additional Airport Access at Owens Ave.</p>	<p>All of the routes identified in the 2011 AMAP are reflected in the same version or have been updated.</p> <p>H St Trolley to Cross Border Facility Commuter Rail 582 Central Mobility Hub to US Border Commuter Rail 583 National City to US Border LRT 510 Blue Line Rapid 640 San Ysidro to Central Mobility Hub San Diego International Airport / ITC to Cross Border Facility</p> <p>Commuter Rail 582 Central Mobility Hub to US Border Mobility Hub.TL48 Rapid 640 San Ysidro to Central Mob Escondido to Cross Border Facility via I-15</p>

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	<p>- Modification of Future Route 445</p> <p>Gillespie Field</p> <ul style="list-style-type: none"> <li>- Gillespie Field Trolley Station Relocation</li> <li>- New Bus Rapid Transit (BRT) Station</li> <li>- Marshall Avenue Intersection Improvements</li> <li>- BRT Routes (90, 870, &amp; 890) Modifications</li> </ul> <p>Cross Border Xpress</p> <ul style="list-style-type: none"> <li>- SR 905/Britannia Interchange Capacity Increase</li> <li>- Britannia Road Widening</li> <li>- Siempre Viva Road Widening</li> <li>- Local Bus Route (661) Modifications</li> </ul> <p>As such, the Airport Authority requests that the 2021 Regional Plan clarify whether these AMAP-identified priorities will be implemented or have been substituted with alternative implementation options.</p>	<p>Rapid 235 transfer to Commuter Rail 582 Escondido to San Diego International Airport/ITC via I-15 Rapid 235 Escondido to Downtown San Diego Rapid Express 280 Escondido to Downtown San Diego Transfer to Airport Express McClellan Palomar Airport to San Diego International Airport via I-5Commuter Rail 398 (Coaster) Oceanside transfer at Central Mobility Hub APM</p> <p>McClellan Palomar Airport to Poinsettia Coaster Station</p> <p>Rapid 440 Carlsbad to Escondido via Palomar Airport Road Cross Border Facility to Otay Mesa &amp; Iris Ave Trolley Rapid 638 Iris Trolley to Otay Mesa Rapid 950 Otay Mesa POE to Imperial Beach via 905 Commuter Rail 582 Central Mobility Hub to US Border Commuter Rail 583 National City to US Border El Cajon Gillespie Field Trolley to UTC Rapid 870 El Cajon to UTC via Santee El Cajon Gillespie Field Trolley to Sorrento Mesa Rapid 890 El Cajon to Sorrento Mesa via Santee</p>
L344	<p>Another recommendation in the Airport Transit Plan is the transition of MTS Bus Route 992, which is currently the main transit connection to the Airport, to a Rapid Bus service. It also suggested that combining the new Rapid 992 with other Rapid bus routes, such as the 215 along the El Cajon Boulevard corridor and 235 along the Interstate 15 corridor, could improve airport transit ridership by better linking to major regional destinations and by increasing single-seat access to the San Diego International Airport.</p> <p>As such, the Airport Authority requests that the 2021 Regional Plan assess the potential ridership benefits from upgrading MTS Bus Route 992 to a Rapid service and extending other existing and planned Rapid routes to serve the SAN terminal areas.</p>	<p>SANDAG will take this recommendation under consideration.</p>
L345	<p>Figure 2.4 (Page 27) in the Draft Plan identifies regional mobility hub areas that could accommodate this increased demand for jobs, housing, shopping, and recreation, while being served by expanded transit networks. In the Airport Authority's initial review, it appears that many of these hub areas are in close proximity to airports.</p> <p>As such, the Airport Authority requests that the 2021 Regional Plan ensure that new incompatible land uses are not introduced near airports, as outlined in each ALUCP. The Draft Plan's Environmental Impact Report should also formally assess any land use conflicts with the applicable ALUCPs. Important factors include:</p> <ul style="list-style-type: none"> <li>- Limiting new noise-sensitive development within an airport's noise contours and ensuring that any new noise-sensitive development includes sound insulation limiting the number of people in areas subject to the highest risk of aircraft accidents</li> <li>- Assuring aircraft safety and preserving airport operations by limiting the height of new structures and objects</li> </ul>	<p>The land use pattern proposed in the 2021 Regional Plan focuses growth and development in the mobility hub areas. The allocation of housing units to subregional areas represents general areas projected for future growth and not precise locations for future housing development or housing unit type. The exercise of land use authority is reserved to local jurisdictions.</p>
L346	<p>Page 21 in Appendix Y states that "when combined with the rate at which trucks produce emissions per day, neighborhoods in close proximity to the airport are put at a higher [air quality] risk" without citing any environmental impact study to substantiate this conclusion.</p> <p>The Airport Authority has ensured that current and future emissions from the San Diego International Airport's activities are included in the most recent 2020 State Implementation Plan (2020 SIP) for attaining air quality standards in the San Diego region under the federal Clean Air Act. The 2020 SIP determined that SAN's emissions can be accommodated without causing the region to experience additional exceedances of criteria pollutant standards.</p>	<p>We have clarified the narrative in Appendix Y and cited CalEnviroScreen 3.0 for community pollution exposure and vulnerability data.</p>
L347	<p>Figure 2.10 in Appendix Y is an outdated map of SAN, which doesn't properly reflect the airport property boundaries and onsite aeronautical uses.</p>	<p>We have replaced the outdated map with the Regional Location Map included in the San Diego International Airport Airfield Improvements and Terminal 1 Replacement Project Draft Environmental Assessment, released in June 2021.</p>
L348	<p>Page 78 in Appendix Y includes statements that air cargo operations are constrained due to limited airport space for expansion.</p> <p>As identified in its 2013 Northside Improvements Environmental Assessment, the Airport Authority is proposing a new SAN Northside Cargo Development project. The project would include a consolidated as expanded apron to accommodate additional cargo aircraft parking.</p> <p>Additionally, the Airport Authority opened a new 93,000-square-foot Airline Support Building on North Harbor Drive this</p>	<p>We have incorporated this updated information into Appendix Y.</p>

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	year, which will allow for more efficient processing of bulky cargo items shipped in the bellies of passenger jets. Approximately 15% of SAN's freight volumes are transported as "belly cargo."	
L349	<p>Page 78 in Appendix Y relies on the outdated 2009 Destination Lindbergh Study to estimate SAN's air cargo capacity and identify cargo operational deficiencies.</p> <p>The FAA approved the most recent SAN aviation activity forecast in June 2019, which is publicly available at <a href="http://www.san.org/plan">www.san.org/plan</a>. The forecast anticipates that the number of cargo aircraft operations (i.e. takeoffs or landings) will increase by nearly 71% by 2050, even with the Airport's single-runway configuration.</p>	We have incorporated this updated information in Appendix Y.
L350	On page 20 in Appendix C, the Draft Plan states that its model relies on airport passenger survey data from 2008 to estimate airport-related travel patterns and demands on local and regional transportation facilities. The Airport Authority notes that ground access characteristics have changed dramatically over the last decade, especially with the introduction of rideshare companies. The Airport Authority also noticed that the modeling appears to be based on SAN aviation activity forecasts that were developed in 2013 (Figure S.18 in Appendix S). As previously stated, the FAA approved the most recent aviation activity forecast in June 2019, which is publicly available at <a href="http://www.san.org/plan">www.san.org/plan</a> . The new "constrained demand scenario" forecast estimates that SAN will serve approximately 20.3 million enplaned passengers in 2050.	<p>SANDAG appreciates you bringing to our attention new data that we can incorporate for future airport operations. We will incorporate the new aviation activity forecast in a post-Regional Plan version release of the activity-based model.</p> <p>While the current airport model was updated to include new ground access modes such as TNC usage, we will also be incorporating new survey data for the airport during the Central Mobility Hub study including calibration to the latest ground counts.</p>
<b>San Diego County Taxpayers Association</b>		
L351	What assumptions (i.e. debts service and length of projects) are going into estimating costs in YOE dollars?	The Cost Estimation Methodology and Funding Strategies for the RTP were presented to the SANDAG Board of Directors on March 21, 2021, Item No. 8B. This report and presentation described the various funding assumptions developed for the draft 2021 Regional Plan. The entire Board meeting can be found at <a href="http://www.sandag.org">www.sandag.org</a> .
L352	All existing TransNet funding has been claimed by currently running projects. How is the \$15 billion in TransNet funding estimated? Is the \$15 billion based on the assumption that San Diego voters will approve of a new extension to the program in 2024? How much of the \$15 billion relies on the assumption that there will be TransNet revenue between 2048 and 2050?	<p><i>How is the \$15 billion in TransNet funding estimated? - See Appendix V for methodology. The \$15 billion is in YOE dollars.</i></p> <p><i>Is the \$15 billion based on the assumption that San Diego voters will approve of a new extension to the program in 2024? – Yes.</i></p> <p><i>How much of the \$15 billion relies on the assumption that there will be TransNet revenue between 2048 and 2050? - There is an estimate of \$1.5 billion for 2049 and 2050 in YOE dollars.</i></p>
L353	Is the Quarterly TransNet Forecast a reliable source for estimating revenue from the Transportation Development Act (TDA) even though there have been observed "small differences" in TransNet and TDA growth rate? Is TDA growing faster than TransNet, or is it the other way around?	From FY 2002 to FY 2020, on average <i>TransNet</i> growth has been just 0.2 percentage point higher than TDA. Therefore, SANDAG considers <i>TransNet</i> as a reliable source to estimate future TDA revenue in the long-term.
L354	Has the growth of General Fund/Miscellaneous Local Road Funds been linear historically? Are you assuming that they will continue to be linear (why or why not)? If the 5-year average growth in these funds is 2.7, how did you derive a 3% growth during the period of the 2021 RTP implementation. Is this a weighted average or an average of averages across jurisdictions?	The 5-year average is 2.7%, however, the 10-year average is 6.6% in the initial review of these funds. With additional information related to one more year of data, it revealed that the 10-year average was 3.6%. SANDAG believed it would be best to be conservative with these funds and assume an average of 3% growth that is consistent through 2048. This growth rate is linear as it should encompass the extreme highs and lows that accompanies this particular fund source.
L355	How much of the value capture estimate (2.7 billion) relies on the estimated value of Central Mobility Hub Enhanced Infrastructure Financing as opposed to existing agreements and programs?	59%
L356	What is the Managed Lanes Feasibility Tool mentioned in Appendix V? What model or data did SANDAG use to estimate the \$22 billion from FasTrak revenue?	The Managed Lanes Feasibility Tool is an interactive dashboard model developed by SANDAG's consultant, HNTB, that can be used to forecast managed lane performance and revenues. It has been used by agencies around the country to inform implementation of Managed Lane projects, phasing, and the development of associated operational policies. When outputs from the tool are compared to data from Managed Lanes once they are built, it has been found to be very accurate. This tool was used to estimate the FasTrak revenues included in the Regional Plan. The methodology uses revealed preference data from existing operating managed lanes across the country that were specifically selected to be representative based on conditions found to be similar to facilities in the San Diego region. The model analyzes existing traffic and proposed lane configuration for the San Diego facilities that are included in the Managed Lane network to assign traffic volumes. It assumes a baseline volume must be reached before drivers will be willing to pay for the Managed Lanes. Usage of the Managed Lanes is predicted based on the overall level of demand above the baseline volume, available capacity in the Managed Lane, and remaining capacity in the general purpose lanes. It

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		includes assumptions around high occupancy vehicle and clean air vehicle policies and discounts, traffic levels, growth rates, cost assumptions, lane capacity, toll rates and inflation.
L357	How did SANDAG achieve a passenger farebox recovery rate of 35%, and what is the basis of SANDAG's assumption that the recovery rate will be linear? Is the assumption that operating costs would be linear and that farebox recovery would follow the same linear growth? With proposed free fares, how will the estimated revenue be achieved?	Farebox recovery ratio is calculated by dividing the system's total fare revenue by its total operating expenses. Fare revenue is calculated by taking the ridership numbers that are generated through the Activity Based Model and multiplying them by the average fare. Operating costs grow by a Consumer Price Index of three percent annually. Each mode of transit has its own calculator for operating cost. Fare revenue does not grow at a linear rate. Ridership on routes changes based on new routes that come online, changes to land uses, and changes in the overall network. Free fares will be calculated with a subsidy given back to the operators to cover operating costs. Farebox recovery ratio should not change as a result but the amount of revenue subsidy will change.
L358	What will be the source of funding for reduced or free fares? Is it sales tax based?	Fare subsidies may be attached to sales tax measures but could be paid for by other sources as they become available.
L359	What source of revenue is each project listed in Appendix A tied to? If a source of revenue runs low, are there alternative ways to fund the projects associated with that source of revenue?	The project costs shown in Appendix A are related to the revenues explained and tabulated in Appendix V. Other than the revenues associated with the 2025 phased projects and programs, revenues sources are estimates based on future projections, coupled with historical information. If some of those future revenues don't materialize for any reason, it is not unreasonable to anticipate other (currently unknown sources) may take their place. A good recent example is funding received from Senate Bill 1 (SB 1) that was not previously anticipated and contributed to real dollars available to the region for transportation projects. However, if any future dollars do not materialize, and are not backfilled from other sources, future plans would need to be updated. These types of updates can easily be captured incrementally, given that the Regional Plan is updated every four years.
L360	What is the timeline for the development of each of the projects in Appendix A? Are delays in these timelines considered in the cost estimates?	The project development timeline for the projects listed in Appendix A varies but generally follows a 6 to 14 year window, depending on the project. These windows are inclusive of the planning/environmental/design and construction phases estimated for each project. For example, highway projects are estimated to be completed within 6 years once dollars are programmed and Rapid transit projects are assumed to have an 8 year completion window. These estimates are based on recently completed projects in the region.
L361	Have there been or will there be changes in the 2021 RTP to account for the impacts of the Covid-19 pandemic? Is SANDAG assuming that the effects of the pandemic on people's lifestyles and the economy will be short term? How do SANDAG's assumptions about the pandemic impact the RTP?	<p>SANDAG has been considering the impacts of the pandemic on transportation. This includes tracking traffic levels on major corridors in the region and conducting surveys of commuters and employers across the region to understand how the pandemic might change travel behavior in the future. As a result of this research, the 2021 Regional Plan assumes a much higher rate of telework. However only 39% of all occupations in the region are considered home workable. Also, the majority of employers in the region that expect to offer telework, reported that they will offer it on a part time basis to a portion of their employees after the pandemic. Therefor viable commute options will continue to be needed for the many commuters who have to travel to their job site.</p> <p>Also, a common misperception is that teleworkers don't drive much. Data from our own regional household travel survey as well as data from the national household travel survey demonstrates that teleworkers actually make more discretionary trips for shopping, leisure, and social purposes. This is why we are seeing traffic volumes at or above pre-pandemic levels on our major corridors despite the fact that we have more people teleworking. To reduce car traffic in the future, more viable alternatives to driving are needed. The 2021 Regional Plan proposes a variety of convenient travel options, including faster transit service and flexible fleet services, for all types of trips.</p>
L362	Are there technological assumptions as well in the RTP? Is the plan based on all current technology, or are there plans that are based on expected future technology? If some plans are dependent on future technology, how are you making sure that people will feel comfortable with using the new technology?	The 2021 Regional Plan accounts for advancements in technology and potential impacts to the transportation system. For example, the Flexible Fleets of today will evolve to be connected and autonomous. Industry projections vary but widespread deployment of shared, autonomous services is unlikely until 2035 or later. The 2021 Regional Plan lays out a strong backbone transportation network that will evolve and adapt as new technologies and demands change. As new and emerging technologies or Flexible Fleets become available, SANDAG will study, design, and test services to ensure they provide equitable, sustainable and inclusive options so all can benefit from the service.
L363	Have there been changes related to the 2021 RTP already? If so, is there any feedback from users? Please provide a detailed response.	Comments received on the 2021 Regional Plan and responses to each are documented in Appendix G of the proposed final 2021 Regional Plan. This appendix also notes when comments on the draft 2021 Regional Plan resulted in changes to the proposed final 2021 Regional Plan.



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L364	<p>What assumptions are made in the Transit Leap Capital Cost Estimate? Based on observed figures in the SF Bay Area, it seems that, for commuter rail alone, every mile requires \$1billion. How does \$55 billion for all Transit Leap capital costs break down into its modes? Answer to question 9 would probably address this if sufficiently detailed.</p>	<p>Estimating costs for Transit Leap considered development options for new commuter rail, light rail/Trolley, and Rapid improvements to existing transit services. Costs were developed using the Federal Transit Administration Capital Cost Database, which is intended for developing order-of-magnitude cost estimates for conceptual transit projects. The cost models are automatically adjusted to account for differences in regional cost levels between locations. The unit costs generated from the Capital Cost Database were compared with known actual project costs for the San Diego region, and they were adjusted as necessary. Capital transit projects include cost estimates for construction (both station and segment per mile), right-of-way acquisition, and other non-construction “soft” costs such as environmental review, planning, and design. The transit capital costs also include the costs of vehicles through the 30-year timeline of the 2021 Regional Plan.</p>
L365	<p>Since \$27.7 billion of the total estimated revenue will depend on the Regional Road User Charge, It seems that SANDAG is confident that the fee will be implemented in 2026. Why does SANDAG think that this fee would be popular among San Diego voters? Is the \$27.7 billion based on the assumption that every kind of vehicle will be charged? If the fee is not approved by voters, is there a source of revenue that would replace it?</p>	<p>The proposed final 2021 Regional Plan has been updated to reflect 2030 as the start of implementation for the road usage charge to better align with the timing that the State and other regions are expecting to transition to a road usage charge.</p> <p>Next year, SANDAG will study usage-based fees and the effect the fees will have on meeting established goals like greenhouse gas emissions reduction and improving equity for different income levels and different populations. The first phase of the study will calculate the true cost of driving a vehicle – the cost to own and operate a vehicle, the effect on road wear and tear, the cost of increasing capacity of the transportation system to meet demand, local and global pollution caused by both fuel powered and electric vehicles, traffic accidents, traffic congestion, and the cost of delays caused by congestion to the economy and to the quality of life of travelers. The study will determine how existing revenues currently funds different parts of the transportation system and how different populations are impacted. This foundational understanding will help SANDAG design a road usage charge program that encapsulates multiple factors to make it more fair across the community than the current transportation funding sources.</p> <p>The study will assess the potential impacts of user fees on San Diego residents, visitors, and businesses, particularly those relying heavily on transportation. SANDAG staff will consult with its Board of Directors, stakeholders, and community members to develop implementation strategies for a road usage charge. This includes policies such as who will pay what and how much, the fee structure, and the distribution of revenues. SANDAG is committed to developing a carefully constructed program that will ensure that no group, such as those driving fuel-powered vehicles, low-income individuals, rural residents, or those with long commutes, are paying more than their fair share. There are multiple mechanisms, such as caps and rebates, that will be explored to ensure a fair system.</p> <p>The road usage charge, which is being studied by both the federal and state governments, is being considered to replace an old tax system that is no longer relevant. We know this is a challenge and we respect the concerns raised. We are committed to having authentic dialogues to work through the challenges and create a revenue system that is flexible, sustainable, equitable, and fair to all. The intensive outreach and public participation process of the study will help design a system that appeals to San Diego voters. Many of the sources of revenue in the Regional Plan are uncertain, they are estimates that are developed with the best information we have available today. Some of these sources may not come to fruition, however there will also likely be new revenue sources available for transportation projects in the next 30 years that we cannot predict today.</p> <p>The revenue assumptions from the road usage charge in the Regional plan are based on an assumption that the fee would apply to resident trips, airport trips (SAN &amp; CBX), visitor trips, and cross-border trips. Trips that were not included are freight, non-freight commercial, and trips that come into or through the County. Which types of trips are subject to a road usage charge will be refined in future plans as additional work is done towards implementation.</p>
L366	<p>The total estimated revenue is about \$30 billion more than the total estimated expenditure (in YOE dollars) for the 2021 RTP. Where would the extra revenue go?</p>	<p>There are over 30 sources of funding included in the projected revenues for the 2021 Regional Plan. While the assumptions used to develop these revenues are determined to be reasonable based on state and federal standards, the level of projected expenditures provides flexibility to account for any changes in the timing or availability of these funds over the next 30 years.</p>
L367	<p>What is the assumption for increase in construction costs? What is the assumption for inflation? Do the construction cost estimates take into account both an increase in construction costs and inflation in the conversion to \$2020?</p>	<p>Increases in both construction and operating costs are tied to the inflation rate for the Plan which is an escalation rate of 1.93 percent annually applied (starting in 2021) from the 10-year moving average Engineering News Record (ENR) Los Angeles Construction Cost Index (CCI).</p>

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L368	Who participated in the peer review of your models and assumptions?	<p>The SANDAG Activity-Based Model 2+ (ABM2+) Technical Advisory Committee (TAC) included:</p> <p>Brian Gardner (Federal Highway Administration)            Caroline Rodier (University of California, Davis)            Joel Freedman (RSG)            Sherry Ryan (San Diego State University)            Wu Sun (San Diego Association of Governments)            Bayarmaa Aleksandr (Southern California Association of Governments) - 2020            Hsi-Hwa Hu (Southern California Association of Governments) - 2019            Bruce Griesenbeck (Sacramento Area Council of Governments)            Erik Ruehr (VRPA Technologies)            Guy Rousseau (Atlanta Regional Commission)            Joe Castiglione (San Francisco County Transportation Authority)            Lisa Zorn (Metropolitan Transportation Commission)            Maren Outwater (RSG)            Nagendra Dhaker (RSG)            Nesamani Kalandiyur (California Air Resources Board)            Tom Rossi (Cambridge Systematics)            Vladimir Livshits (Maricopa Association of Governments)</p> <p>The TAC panel meet in May 2019 and March 2020 regarding the ABM2+ model used in the 2021 Regional Plan.</p> <p>For the population and jobs forecast we conducted three external Peer Review meetings as follows:            March 2017</p> <p>Attendees</p> <p>Lynn Reaser, PhD, CBE Chief Economist; Point Loma Nazarene University</p> <p>Jeff Tayman, PhD Guest Lecturer, Demography and Economics, UCSD</p> <p>John Weeks, PhD Distinguished Professor Emeritus of Geography</p> <p>Erik Bruvold President, National University System Institute for Policy Research</p> <p>Dowell Myers, PhD Professor, Director, Population Dynamics Research Group</p> <p>Joe Salvo, PhD Director, Population Division, New York City Department of City Planning</p> <p>Ryan Ratcliff, PhD Associate Professor of Economics</p> <p>Stanley K Smith, PhD Professor of Economics; Research Demographer</p> <p>Steve Levy Center for the Continuing Study of the California Economy</p> <p>Ethan Sharygin, PhD Principal Demographer, California Department of Finance</p> <p>John Husing, PhD Primary Analyst, Economics and Politics, Inc.</p> <p>Ira Hirschman, Ph.D. Principal, Economic Services – U.S. Advisory Services</p> <p>February 2018</p> <p>Gary London- London-Moeder Advisors</p> <p>Frank Wen- Southern California Association of Governments</p> <p>Ryan Ratcliff- University of San Diego</p>



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		<p>Nathan Moeder- London-Moeder Advisors</p> <p>Ethan Sharygin- CA DOF</p> <p>April 2021</p> <p>Kirby Brady - City of San Diego</p> <p>Jeff Tayman - UCSD</p> <p>Gary London - London-Moeder Advisors</p>
L369	What is the time period when State Transit Assistance funding is expected to grow at 3% per year versus 5% per year? Is SANDAG's goal to encourage use of public transportation being considered in making assumptions about the growth rate of STA revenue?	STA funds are assumed to grow at a constant rate of 3% per year until 2035. The assumption then changes in 2036 to 5% annually to align with the possible increase in Diesel tax and further legislation similar to SB1. STA is determined from Diesel tax and does not rely heavily on increase in public transit.
L370	Does the State Highway Operations Protection Program only last for 10 years? When did it start, and, if it only lasts a decade, how will it be able support the 2021 RTP projects throughout their lifetimes?	The State Highway Operations and Protection Program (SHOPP) is an ongoing four year program funded by the state, with projects selected from the state's 10-year plan. This program was created by California Code 14526 in 1977 and is adopted every two years along with the State Transportation Improvement Program (STIP). The program is expected to continue unless there is a change to California State Law.
L371	How much of the Cap-and-Trade Revenue is, separately, from the Transit and Intercity Rail Capital Program, Affordable Housing and Sustainable Communities program, and Carbon Transit Operations program? Given that the Transit and Intercity Rail Capital Program and AHSC are competitive programs, how are revenues from these programs estimated through 2050? Is there a source that shows prior success in receiving the competitive funds?	The 2020 base year amounts are as follows: TIRCP \$31.28M, AHSC \$19.4M, and LCTOP \$5.15M. For TIRCP, the region received approximately \$31.278M/year on average from 2015-2020. This estimate assumes a 2% increase every year and a 10% increase every ten years starting in 2030. For AHSC, the region received approximately \$19M/year on average for the first three competitive cycles and assumes a 10% increase every ten years starting in 2030. LCTOP received is approximately \$5M/year since the first 2015 cycle estimated to increase 5% per year and is continuously appropriated from auction proceeds of Green House Gas Reduction (GGRF) funding and distributed based on the STA formula.
L372	What percentage of total revenues are assumed to come from competitive funding sources?	Competitive Fund sources are assumed to make up approximately 13% of the total plan revenue. Recent transportation legislation has seen a shift towards more competitive programs, so that amount could increase in the future, however SANDAG continues to compete well for funding both at a state and federal level due to our international border and major port status.
L373	Why are Motorist Aid Services mentioned twice as a source of revenue (once as state and once as local revenue)? Are they referring to different sources of revenue?	One program is state funded from the Freeway Service Patrol and SB1 funds and the Local program is funded from a \$1 annual fee on vehicle registrations.
L374	SANDAG assumes that the State FASTLANE will receive 20% of the state share of TCEP. In 2020, the revenue reflected 19% of the shares. How much does 1% represent in funding money? Also, what is the basis for the different growth rate estimates?	State FASTLANE assumes a 20% share of the state's 40% share of SB1 TCEP target which is \$300M/year. 40% of the \$300M/year is \$120M and 20% of that is \$24M/year in 2018. In 2019, \$24.5M is assumed and 2020 assumes \$25M/year after applying the 2%/year estimated growth rate. 1% of the \$25M estimate for 2020 represents \$250K. State FASTLANE growth estimates assume a combination of new revenues from SB1, state and federal funds, as well as the state's historic commitment to fund border projects, which is the reason for the different growth rate assumptions.
L375	How much of the \$2.8 billion in revenue estimate from State Managed Federal Programs come from each of the programs? What is the basis for the assumption that there would be additional revenue from Federal Highway Administration discretionary funds, and how much of the \$2.8 billion depends on it? What is the basis for each of the estimated growth rates?	<p>The programs included are the Highway Bridge Program and the Highway Safety Improvement Program. The State is assumed to use its portion of federal funds to supplement the funding for these discretionary programs. The funding is projected to be 74% for Bridge and 26% for Safety programs.</p> <p>As these programs are funded from federal formula funds, the growth rates were assumed to be the same as CMAQ/RSTP and other federal highway formula funds</p>
L376	What is the short-term growth rate of the Solutions for Congested Corridors program that funds the Road Maintenance and Rehabilitation Account?	There is no short-term growth rate for this fund source because it is an off-the-top, set amount per SB1 legislation.
L377	How much of the revenue from the Federal Transit Administration Formula programs go to Sections 5307, 5337, 5339, and 5310 each? What is the basis for the change in the growth rate of this revenue from 2% per year to 10% per six years?	As part of the FTA revenues, the calculation includes 5307, 5337 and 5339 only. The average split is 65% of 5307, 30% of 5337 and 5% of 5339. Based on past history of previous federal legislation the average annual increase of funding is 2% per year. The revenue assumptions include a 10% increase to account for new federal legislation which historically increases revenues substantially.
L378	What is the basis for the assumption that the growth rate of CMAQ and regional STP revenue will change from 5% annually to 10% per six years in 2030?	As new federal acts are approved, we assume a 10 % increase in funding to maintain buying power.
L379	What is the growth rate of the Federal Highway Administration Discretionary revenue before 2030? What is the basis? What is the basis of the growth rate estimation beyond 2030? What years are the estimates based on?	The estimates are based on the averages of actual grants received over the period of the grant programs (2011 - 2020). Due to the elimination of federal earmarks, there is an assumption the funding will double due to

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		growth in the discretionary program funding. The growth rate assumes 5% in 2020 and remains flat until 2030. Starting in 2030, we assume a 10% increase every 6 years with the approval of new federal transportation legislation.
L380	How was the \$294 million in Grant Anticipation calculated?	The Grant Anticipation Notes are calculated from Mid-coast financial model that reflects actual issuance of GANs that occurred in 2018.
L381	The San Diego Taxpayer Association submitted 6 tables with their comment letter requesting various revenue and cost estimate data and analysis. To view these tables, please see the full letter attached to this appendix.	The requested data would require additional transportation model runs and analysis that are beyond the scope of the Regional Plan.
L382	Are Ridehailing Company Service Fees anticipated to be on the 2024 ballot? Do ride hailing companies, separately, have to pay for the Road User Charge? What is the basis of the assumption that Ridehailing Company Service Fees would be popular among voters?	SANDAG will launch a study in the next year to further study the potential of usage-based fees and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. This study will also assess the potential impacts on businesses, particularly those relying heavily on transportation to do business. SANDAG staff will work with Board Members, stakeholders, and community members to develop implementation strategies for a road usage charge, including high level constructs of the program, such as who will pay, the fee structure, and the distribution of revenues. Whether Uber, Lyft, and food delivery drivers would be subject to a road usage charge, and if so, how it may impact the drivers and users of those services will be analyzed as part of this effort.
L383	Have other states been successful so far in transitioning to a Road User Charge?	A variety of states, in addition to California, are in various phases of piloting and deploying a transition to a Road Usage Charge, including Utah, Texas, and a Kansas/Minnesota joint effort. The state of Oregon is the furthest along, with their program called OReGO. Volunteer participants pay 1.8 cents for each mile they drive, and that money goes directly into the State Highway Fund. Starting in 2019, the Legislature authorized ODOT to allow unlimited OReGO participants. Drivers of fuel-powered vehicles can receive a credit for fuel tax and remote emissions testing, and drivers of electric vehicles are eligible for reduced registration fees.
L384	How is the growth rate of Regional Road User Charge revenue 2.7% until 2050 when the assumption is that more people will use transit, as opposed to personal vehicles, with the success of the 2021 RTP?	The road usage charge revenue assumptions were updated between the draft and final plan. The vehicle miles travelled (VMT) assumptions for the region show a decrease annually between 2040 and 2050. The per mile fee in 2020\$ for the Regional Road Usage Charge also decreases between 2030 (first year of implementation) of .033 cents per mile to .028 cents per mile in 2050.
L385	Which projects would be eliminated if Federal and State discretionary grants were not received?	The plan relies on a host of revenues from federal, state, and local sources. Without all three of these sources comingled together, SANDAG would lose the ability to build a multitude of projects and would dampen the ability to maximize local dollars to garner additional funds. Additionally, given that the Plan includes a 30-year planning period, it is possible that some sources could be swapped for others as state and federal priorities change.
L386	What projects would be impacted if the New Sales Tax and MTS Local Revenues measures do not pass?	The absence of new sales tax would impact all types of projects in the Regional Plan. Additionally, the lack of a sales tax measure for MTS would minimize the amount of both transit infrastructure and transit operations in the MTS service area.
L387	How do the Federal Transit Administration and CMAQ estimated growth rates reflect revenue from recent years?	<p>Federal Transit Administration (FTA) revenues increase by 2% on an annual basis which is consistent with historical increases. The Regional Plan assumes a new Federal Transportation Legislation Bill every 6 years which reflect past practices. With new legislation, it is assumed that revenues will have a one-time increase of 10% which has historically been the case.</p> <p>Actual apportionment for federal highway formula funds during the years of the FAST Act would have averaged a 5% increase per year, consistent with the plan estimated growth rates, except for a decrease in CMAQ funds as a result of reaching the end of the maintenance period for carbon monoxide attainment in 2018. That resulted in a decrease to our CMAQ apportionment in FFY 18/19, bringing the average to 4%. SANDAG does not foresee another decrease to CMAQ during the period of this plan so expects to see a continuation of the 5% increase per year.</p>
L388	What is the impact of reduced VMT on revenues from fuel taxes and tolls. Is this accounted for?	<p>SANDAG's 2021 RP assumes the road usage charge will replace the gas tax revenue lost by the move to fuel efficient and zero emission vehicles.</p> <p>For example, if a regional agency estimated receiving \$1 million in 2020 from the gas tax, then in 2030, they could have estimated receiving \$500,000 from the gas tax, and \$500,000 from a road usage charge.</p>
L389	Current Transportation Development Act (TDA) funds are currently used to support existing transportation services and state of good repair capital projects. Are the \$7.6 billion TDA revenues in Appendix V existing TDA revenues or new sources of TDA revenues?	The TDA established two funding sources: 1) Local Transportation Fund (LTF) and 2) State Transit Assistance (STA). The \$7.6B in TDA revenues shown in Appendix V is based on these two existing fund sources.

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L390	Where can we find the “2021 Regional Plan Transit Operations Costing” Excel workbook mentioned in Appendix U?	Costing files are located in our SD Forward Data page at: <a href="https://sdforwarddata-sandag.hub.arcgis.com/">https://sdforwarddata-sandag.hub.arcgis.com/</a> .
<b>San Diego Transportation Equity Working Group (SDTEWG)</b>		
L391	<p>1. A Regional Plan that Prioritizes environmental justice: Demonstrate environmental justice (EJ) communities are a priority by identifying projects that will improve their access to public transportation by 2025. These primarily low-income communities of color face the most pollution in the San Diego region and rely most on transit. The projects should include the development of a Safe Routes To Transit strategy and an early action project Mobility Hub at Euclid Transit Center.</p> <p>Recommendation: Include an equity specific project list as part of Appendix A: Transportation Projects, Programs, and Phasing document that provides all details including the expected project completion year. Response: Pull from 10 transit lifelines</p> <p>2. Youth opportunity Passes (YOP): Provide no-cost transit passes for all youth ages 24 and under to build generations of lifelong transit riders and connect youth to school, work, internships, and early career opportunities.</p> <p>Recommendation: Amend the Plan to explicitly state that transit fare subsidies will be allocated to fund no-cost transit for youth ages 24 and under. The plan currently lacks a commitment to no-cost passes for this age group.</p> <p>3. Bus service every 10 minutes: Make bus service reliable and affordable now– we can’t afford to wait. Buses are one of the most cost-effective ways to get us where we need to go while cutting climate pollution. We need immediate solutions while big infrastructure projects are being built.</p> <p>Recommendation: Projects TL63, TL64, and TL65 on page A-52 of Appendix A, should include cost and bus frequency improvement details to demonstrate they will be prioritized, particularly those planned to be completed 2025. Simultaneously, only one of all the Transit Leap projects within the South Bay to Sorrento Corridor has a 2025 year implementation. The Transit Leap rapids listed on page A-12 through A-14 that will service environmental justice communities should be prioritized for a 2025 completion. Finally, MTS should be included as an agency to collaborate as part of the partnerships listed on page B-3 of Appendix B and near-term actions for the implementation of bus frequency enhancements.</p> <p>4. Blue Line express: Build a 24-hour Express Blue Line. The Blue Line already has the highest ridership and is one of the best-performing transit lines in the region. However, it is overcrowded, has limited frequency, delayed connections, and no 24-hour service.</p> <p>Recommendation: The RP needs to outline clear construction of an additional track that can provide express 24- hour service. Currently, the project details fail to demonstrate that a third track will be implemented. According to project description TL13 on page A-14, a Blue Line (San Ysidro to UTC, Double/Third tracking and Grade Separations at Taylor/Ash) are planned for a 2050 implementation.</p> <p>5. 24-hour service: By 2025, provide 24-hour service on popular transit routes to connect workers to their destinations. Participants in San Diego’s MTS community engagement efforts ranked this as their highest priority.</p> <p>Recommendation: Project ID TL63, TL64 and TL65 should include bus frequency increase to 24 hours. As well as all the Transit Leap projects within the South Bay to Sorrento that will service environmental justice communities.</p> <p>6. The Purple Line:</p>	<p>1. The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. As suggested, this list of projects with phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p> <p>2. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p> <p>3. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>4. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>5. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>6. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study.</p> <p>7. The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>8. Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan.</p>

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	<p>Fund the planning, environmental, engineering, and construction work for the Purple Line as a rail line that connects environmental justice communities in central City Heights and the South Bay to Sorrento.</p> <p>Recommendation: The detailed ridership analysis of the Purple Commuter Rail alignment listed on page A-15 is promising and points to a purple line that will include stations in City Heights. The RP should include project phasing that prioritizes the development of stations in central City Heights and the South Bay region with a 2035 project completion.</p> <p>7. An all-electric bus fleet by 2030: Accelerate the electrification of buses, because our communities cannot afford to wait 20 years to breathe cleaner air and reduce climate pollution.</p> <p>Recommendation: The transition to zero-emission buses, including rapid routes, should be accelerated for a 2030 completion with the support of recently approved state and federal funding sources. Page A-53 outlines program investments for Zero-Emission Buses and Infrastructure. The funding should be redistributed to prioritize the program’s implementation to meet the 2030 completion goal.</p> <p>8. Anti-displacement strategies: Protect low-income communities of color living near transit corridors from gentrification with proactive strategies that include building affordable housing while preserving naturally occurring affordable housing, community ownership, and tenant protections. We need comprehensive solutions!</p> <p>Recommendation: We commend SANDAG for including a Regionwide Displacement Study for near-term implementation. The study is listed on page B-3 of Appendix B and should be completed before the adoption of the RP in order to truly inform and prevent displacement due to the plan’s implementation.</p> <p>9. Restroom access: Create a plan to make restrooms available to the public and provide MTS with funding for a clean and accessible restroom network with access at all major transit stations.</p> <p>Recommendations: Include restroom access as an item in the capital operations budgets. The 2021 Regional Plan states that “mobility needs to be widely accessible, affordable, easy to use, and tailored to a person’s individual needs. In short, mobility must be viewed as a basic human right”. State-of- the-art bathrooms are mobility and key to a successful transit system.</p> <p>10. Emergency-ready transit system: Provide transit for environmental justice communities to evacuate during emergencies. EJ communities are more vulnerable to climate disasters and more likely to live near industries, military operations and other dangerous activities that may have accidents that cause fires, leak toxins, and other crises.</p> <p>Recommendations: Include a study and implementation strategies to establish an emergency-ready transit as part of the near-term action in Appendix B within the Social Equity Planning Framework section.</p>	<p>SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p> <p>9. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p> <p>10. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
L392	<p>Finally, the SDTEWG strongly recommends that SANDAG develop an equity pricing program, a Next OS equity plan, and policies that safeguard the privacy of Black, Indigenous, People of Color (BIPOC). The SDTEWG supports the efforts to implement a regional pricing strategy and the Next OS as long as they are implemented with an equity framework, which is not reflected in the Draft RP. All regional pricing strategies must include mechanisms to protect low-income families who cannot afford to pay to be able to drive. All Next OS infrastructure should give development priority to environmental justice communities. And, policies must be in place to ensure data collected does not target BIPOC or use the information to over-police our communities.</p>	<p>SANDAG will launch a study in the next year to further study the pricing strategies and their capabilities in addressing various goals, including equity and greenhouse gas emissions reduction. SANDAG advances planning on technology initiatives such as Flexible Fleet pilots, Next OS, Mobility Hubs, equity will continue to be a priority for SANDAG.</p>
<p><b>San Diego Transportation Equity Working Group (SDTEWG) - Supporting Organizations</b></p>		
L393	<p>The RP should include EJ specific solutions to be completed by the year 2025. The climate emergency is here and frontline communities cannot continue to wait for relief. The RP is a visionary document by nature, however, it must outline immediate benefits to improve the region’s economy, quality of life and sharply reduce air pollution and GHGs in most climate-impacted communities.</p>	<p>1. The 2021 Regional Plan has been developed with equity at the forefront. An equity specific project list has been included in the Draft 2021 Regional Plan Appendix H. As suggested, this list of projects with</p>



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	<p>10 Transit Lifelines Summarized Descriptions</p> <p>1. A Regional Plan that Centers Environmental Justice: Prioritize environmental justice (EJ) communities by identifying projects that will improve their access to public transportation by 2025, which should include the development of a Safe Routes To Transit strategy and an early action project Mobility Hub at Euclid Transit Center.</p> <p>2. Youth Opportunity Passes (YOP): Provide no-cost transit passes for all youth ages 24 and under to build generations of lifelong transit riders and connect youth to school, work, internships, and early career opportunities.</p> <p>3. Bus Service every Ten Minutes: Make bus service reliable and affordable now - we can't afford to wait. Buses are one of the most cost- effective ways to get us where we need to go while cutting climate pollution.</p> <p>4. Blue Line Express: Build a third track for a 24-hour Express Blue Line. The Blue Line already has the highest ridership and is one of the best-performing transit lines in the region.</p> <p>5. 24 Hour Service: Connect late-night and early-morning workers by 2025. Provide 24-hour service on popular transit routes to connect workers to their destinations.</p> <p>6. The Purple Line: Fund the planning, environmental, engineering, and construction work for the Purple Line as a rail line that connects environmental justice communities in central City Heights and the South Bay to Sorrento Valley.</p> <p>7. An All-electric Bus Fleet: Accelerate the electrification of buses, because our communities cannot afford to wait 20 years to breathe cleaner air and reduce climate pollution.</p> <p>8. Anti-displacement Strategies: Protect low-income communities of color living near transit corridors from gentrification with proactive strategies that include building affordable housing while preserving naturally occurring affordable housing, community ownership, and tenant protections. We need comprehensive solutions!</p> <p>9. Restroom Access: Create a plan to make restrooms available to the public and provide MTS with funding for a clean and accessible restroom network with access at all popular transit stations.</p> <p>10. Emergency-ready Transit System: Provide transit for environmental justice communities to evacuate during emergencies. EJ communities are more vulnerable to climate disasters and more likely to live near industries, military operations and other dangerous activities that may have accidents that cause fires, leak toxins, and other crises.</p> <p>We urge the SANDAG Board to support the 10 Transit Lifelines and ensure their inclusion in the 2021 RP.</p>	<p>phasing will be added to Appendix A in the proposed final 2021 Regional Plan. Thank you for the suggestion and SANDAG agrees that this change will make it easier for the public to understand.</p> <p>2. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p> <p>3. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p> <p>4. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>5. The proposed final 2021 Regional Plan includes increased service spans for the Trolley and bus service up to 20 hours per day. As SANDAG and the transit agencies move into more detailed planning efforts in the near future, some routes will be considered for 24-hour operation.</p> <p>6. The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>7. The proposed final 2021 Regional Plan supports the electrification of the region's transit buses and the state's Innovative Clean Transit regulation. Appendices A and B include SANDAG's proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS' and NCTD's Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p> <p>8. Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG's housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>

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		<p>9. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations.</p> <p>10. MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
<b>SanDiego350 Transportation Committee</b>		
L394	<p>1: Reduce GHG emissions from cars and light trucks to fight the Climate Crisis.</p> <p>We ask you to meet bolder GHG emission reduction targets. Climate change is accelerating and its effects are devastating environmental justice communities. For our families and children to have a livable future we cannot wait any longer to respond.</p> <p>Transportation accounts for half of the GHG emissions in the San Diego region. The targeted 20% reduction per capita of GHG emissions from cars and light trucks below 2005 levels by 2035 will have only a small impact on the GHG emissions from transportation, even if we successfully reach that goal. The emissions reduction goal must be at least 50% by 2030.</p>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions to achieve state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan.</p>
L395	<p>To rapidly reduce GHG emissions, we ask you to accelerate the timeline for development and improvement of transit (trolleys, trains, and buses) and active transportation (biking and walking). Also, the plan must include effective strategies to encourage a rapid shift away from cars to public transit and from fossil fuel burning vehicles to zero-emission vehicles. Managed lanes on freeways should be implemented to enable buses to run faster and on-time and so that they are a more attractive means of transportation than cars.</p>	<p>The 2021 Regional Plan is focused on creating more mobility options to all people in the San Diego region through a fast, reliable and fair public transportation system and micromobility options including e-bikes and scooters, rideshare, and microtransit shuttles. The Regional Plan also proposes a network of managed lanes using existing infrastructure that provide priority access to people using transit, carpooling, or vanpooling.</p>
L396	<p>2. By 2023 or sooner, implement no-cost youth transit passes for those 24 and younger.</p> <p>This would advance social justice by helping youth, who often lack resources, to travel to education, employment, and services. This would immediately improve transit ridership numbers and contribute to transit being seen as a viable alternative to car travel.</p> <p>Youth passes are an investment in the success of transit, as youth who are accustomed to using transit become adults who will choose buses and trains over cars.</p>	<p>One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth under age 19.</p>
L397	<p>3: Improve the transit system now to make it more frequent, reliable, accessible, affordable and fast.</p> <p>The 2021 Regional Plan must prioritize improvements in public transit. We need a real alternative now in order to begin the transition away from cars without delay. The current transit system needs to improve by increasing passenger capacity, frequency and service hours on popular lines to make it more convenient, reliable, accessible, and fast. This means 24 hour service and 10 minute frequency on many popular bus routes currently in service. This should be done immediately to introduce the public to a new transit era by providing MTS and NCTD with the necessary financial support.</p>	<p>SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan.</p>
L398	<p>3: Prioritize the needs of Disadvantaged, Environmental Justice Communities.</p> <p>Disadvantaged, Environmental Justice Communities, which disproportionately suffer from the effects of climate change, cannot afford to wait; they need immediate improvements while long-term infrastructure projects are developed. This means not building new roads, accelerating the Purple Line, and collaborating with MTS and NCTD to make improvements to the Blue Line and Sprinter and add Bus Rapid Transit routes to serve those communities.</p> <p>We ask for the completion of the Purple Line via City Heights all the way to the border by 2035 instead of stopping in National City per the draft Regional Plan. That is because half of the Purple Line ridership will come from Chula Vista, Imperial Beach, and Tijuana. We also ask for enhancement to the Blue Line to reduce travel time from the border and South Bay region to downtown to provide faster access to the jobs in the downtown area.</p>	<p>The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>Additionally, the South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National</p>



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	Road improvements such as grade separations at railroad crossings should be included in the plan to reduce traffic gridlock, congestion, and idling that cause air pollution and health problems.	<p>City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego.</p> <p>The proposed 2021 Regional Plan includes grade separations for the Orange, Green, and Blue Line Trolley in several locations.</p>
L399	<p>4: Transition to a Zero Emission Bus Fleet by 2030</p> <p>Fund the implementation of California’s Innovative Clean Transit rule. Our communities of concern suffer with high levels of toxic pollution and cannot wait 20 years to reduce toxic and greenhouse gas emissions. Investment in zero emission buses now will improve residents’ health and help people thrive in San Diego County. These actions taken now will save money in the long term. The scale of our ambitions must reflect the magnitude of the challenge. SANDAG must invest heavily in infrastructure to continue and accelerate that transition.</p>	<p>The proposed final 2021 Regional Plan supports the electrification of the region’s transit buses and the state’s Innovative Clean Transit regulation. Appendices A and B include SANDAG’s proposed commitment of \$75 million through 2025, \$250 million between 2026 to 2035, and \$332 million between 2036 and 2050 for zero-emission buses and infrastructure to accelerate the implementation of MTS’ and NCTD’s Zero Emission Bus (ZEB) Rollout Plans. Transit agency ZEB Rollout Plans are on the CARB website here: <a href="https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans">https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans</a>.</p>
L400	<p>5: Identify Anti-Displacement strategies:</p> <p>Develop an anti-displacement strategy that includes affordable/low-income housing and preservation of existing affordable housing, community ownership, and tenant protections as part of the comprehensive solutions for any possible impacts of new transit infrastructures. We ask SANDAG to provide an update on the status of the anti-displacement study.</p>	<p>Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues.</p>
L401	<p>6: Develop an Emergency Ready Transit System:</p> <p>There is a need for Environmental Justice Community residents to have an escape route from a community-wide emergency situation such as occurred recently in a ship fire at the Port. We ask for planning and implementation of a transit emergency response strategy that is fully funded. Communities of concern are most vulnerable to climate disasters.</p>	<p>MTS and NCTD work closely with the County Office of Emergency Services to ensure that transit vehicles can be used in the case of any public emergency. Additionally, SANDAG’s specialized transportation grant program requires all grantees to work with the County to get their wheelchair accessible vehicles registered to assist in emergencies. Appendix Q also describes emergency evacuation strategies, including signaling, traffic control guides, roadblocks and barricades, electronic signage, land expansion, contra-flow lanes, traveler information services, use of mass transit, and airport uses.</p>
L402	<p>7: World Class Transit System with Amenities</p> <p>We ask for a truly world class transit system that all members of our society and visitors, regardless of their age and physical condition, can use without hesitation. This requires amenities including clean bathrooms at major transit stations and hubs, electronic information on trolley, train, and bus schedules, routes, and transfer information, seats and sun shelters at all stations and stops, safety provisions for all transit users including persons with disabilities. These amenities would provide comfort and dignity to all transit riders.</p>	<p>The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS is working to provide shelters throughout the region. Bus shelters are provided wherever there is sufficient right of way to locate them. Any new infrastructure build would include shelters. Complete Streets designs are an important component of SANDAG’s planning today and will be included on projects in the future. As part of larger infrastructure projects like Next Generation Rapid, Trolley and Commuter Rail, all stations will have shelters. A goal of the Next Operating System (Next OS) is to provide real time transportation updates about transit schedules and transfer information at travel kiosks and phone applications for travelers to better plan their trips.</p>
<b>Sierra Club San Diego</b>		
L403	<p>All aspects of the RTP are important, although consistent and reliable funding of the plan requirements are essential to achieving the RTP goals. The very backbone of RTP realization is early environmental mitigation, planned, funded and ready to be implemented within San Diego County. The same careful planning should include provisions for maintenance of the Multi Species Conservation Program (MSCP) and conserving Multiple Habitat Planning Areas (MHPA). Not only are these lands invaluable in their own right for the preservation of plant and animal species, they are essential to any Climate Action Plan due to their ability to sequester carbon.</p>	<p>The conservation of native species and their habitat is a key component of SANDAG’s Sustainable Communities Strategy. The land use pattern of the 2021 Regional Plan envisions greater compact development in areas served by high frequency, efficient transit. The result is less urban sprawl and less impacts to native habitat and species. Appendix AA Regional Habitat Conservation Vision of the Regional Plan describes the region’s efforts to develop and implement a system of open space for conservation of San Diego’s unique biodiversity. Additional information has also been added to Chapter 2 of the 2021 Regional Plan.</p>
L404	<p>This initiative for early environmental mitigation is expected to expedite the implementation of transportation projects and reduce the costs associated with mitigation or permit delays.</p> <p>To be absolutely clear, Sierra Club endorses the earliest possible environmental conservation, mitigation, or remediation. Any delays associated with Capital projects should not reflect on the mitigation capabilities of the environmental community or SANDAG.</p> <p>In the introductory section of the RTP numerous potential funding sources are provided. On the subject of funding, we are reminded of the fragility of transportation appropriations at the state and regional level. Gasoline sales tax revenue offers a lesson on the ephemeral nature of voter approved gasoline sales tax revenue increases. In this instance, cars and light trucks have simultaneously improved in miles per gallon along with the advent of increased electric vehicles (EVs)</p>	<p>Regional habitat conservation plans have been established by some of the local jurisdictions within the region. Participating jurisdictions that adopted a habitat conservation plan were provided the authority to impact (“take”) endangered species if they implemented the conservation provisions in their Plan. One of those provisions was to establish a regional funding source for habitat conservation. SANDAG does not have “take” authority, but has assisted the region by leveraging its funding to acquire critical habitat for the mitigation of regional transportation projects, providing stop gap funding for regional management and monitoring, and inclusion of regional funding into the 2016 Proposition A.</p>

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	<p>both of which have contributed to a substantial reduction in gasoline sales tax revenue. This eye-opening shortfall at the state level reflects a local focus when evaluating ballot box funding. The San Diego region failed to fund the proposed 2016 Proposition A Transnet sales tax increase of one quarter cent, although vigorously supported by SANDAG and numerous environmental organizations. At that point SANDAG was left with the barest of funding options.</p> <p>This stark demonstration of the unreliability of voter support for tax increases should not be lost on SANDAG Board members. Reliance on temporary budget sources are unstable and insufficient if they are based on assumption of bond debt refinancing, stock market appreciation, population increases, or property or sales tax increases. Funding must be secured with initial and sustainable investments for a minimum of the first 10-years of the RTP approved environmental mitigation projects. Without such funded safety measures the RTP is confronted with speculative-by-nature “Revenue Assumptions”. The below italicized and bolded statements are taken directly from the RTP supporting documents.</p> <p>Appendix V: Funding and Revenues Assumptions The assumptions made for each major revenue source included in the Plan’s financial analysis are provided below. All revenues have been escalated to the year that dollars are expended, and they are based on the escalation factor appropriate for that specific revenue source. Additional details for each fund source also are included in Technical Appendix 1.</p> <p>By its very definition, the conjecture surrounding proposed long-term financing and funding is apparent in the fundamental terms Assumptions and Escalation, which indicate the uncertainty regarding this 29- year duration RTP. The SANDAG Board members must do everything possible to remove the associated uncertainty and doubts of reliable and assured revenue. This initiative for early environmental mitigation is the keystone to the RTP realization and must be securely funded upon SANDAG Board approval and initiation of the RTP 2050 Transportation Plan.</p> <p>“Without a regional funding source, the implementation—and ultimately, the success—of these plans to protect species and their habitats from extinction falls into question.” Regional funding:AA-6</p>	
L405	<p>The environmental community has repeatedly advised SANDAG staff and Board members that this SANDAG statement is clearly factual, warranted, and long predicted. It would behoove senior staff,</p> <p>under direction of the Board of Directors, to lobby for state and federal environmental grant funding or appropriations. The current, unprecedented state budget surplus is too great an opportunity to ignore in light of the devastating consequences of doing nothing for lack of funding and planning.</p> <p><a href="https://www.sandag.org/uploads/publicationid/publicationid_1236_5646.pdf">https://www.sandag.org/uploads/publicationid/publicationid_1236_5646.pdf</a> \$2.59 billion is the sum of potential grants from the year 2018 titled Transportation Funding in the San Diego Region. While this budget would be stunning news in the environmental community, this grant funding is only available for SANDAG’s CAPITAL projects. This would include new construction, expansion, renovation, or replacement projects for an existing facility, however there would be no mitigation funding for the environmental impacts of the new infrastructure or associated construction. It appears staff went to a great effort in meticulous searches to locate these CAPITAL grants. We request that staff accomplish the same depth of research for environmental mitigation and remediation grants. The rhetoric of “early environmental mitigation” will be far more convincing when SANDAG becomes a proactive source of grant funding information for San Diego’s NGOs. The equity chasm between Capital projects and the mitigation funding to initiate projects is breathtaking and unacceptable.</p> <p>“The estimated unfunded regional cost to implement the regional habitat conservation plans was \$3.0 billion.”</p>	<p>On January 28, 2011 the SANDAG’s Quality of Life Subcommittee discussed regional funding need for various infrastructure; habitat conservation was one of those discussed. The estimated funding need was \$3,083 million in 2010\$. <a href="https://www.sandag.org/uploads/meetingid/meetingid_2872_12391.pdf">https://www.sandag.org/uploads/meetingid/meetingid_2872_12391.pdf</a>.</p> <p>To assist the region to meet its habitat conservation goals, the proposed final 2021 Regional Plan has identified \$2,087 million for an enhanced habitat conservation, management, and monitoring program. These funds are complemented with a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (See Climate Adaptation and Resilience programs). In addition, future mitigation of the transportation projects included in the 2021 Regional Plan will result in an additional \$300-\$500 million of land acquisition and restoration for habitat mitigation (incorporated in project costs presented in Appendix A).</p>
L406	<p>SANDAG Board members please compare this TransNet EMP land grant program to the CAPITAL projects multibillion dollar budget. To say the environmental community is “challenged” speaks to this massive funding and equity disparity. Please consider that in 2011 the deficit was \$3 billion. In 2021 the equivalent dollar shortfall is \$3.62 billion.</p> <p>“Allocation of \$4 million is done annually by the SANDAG Board of Directors pursuant to a two-year work plan. A portion of this funding is allocated and distributed through a competitive TransNet EMP Land Management Grant Program to maintain the integrity of existing regional habitat preserves through enhanced land management.”</p> <p>While the environmental community is grateful, \$4 million a year will require 75-years to catch up to 2011 environmental standards and funding deficit, to say nothing of funding the present Regional Habitat Conservation Vision:</p>	<p>Through SANDAG’s Environmental Mitigation Program (EMP), \$4 million dollars has been allocated annually to assist the region with land management and biological monitoring. The funding has established nine cycles of land management grants, the development of the management strategic plan, regional monitoring and the establishment of the San Diego Management and Monitoring Program (SDMMP).</p>

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	A steady, secure regional funding source is needed to complete the land acquisitions as proposed and to provide for ongoing land management. San Diego Forward: The 2021 Regional Plan AA-10	
L407	<p>Simply stated, SANDAG’s PROTECT, RESPECT and CONNECT current environmental theme will largely remain a slogan until funding becomes a serious SANDAG Board of Directors priority. As San Diego’s premier and leading planning organization, the environmental community is mystified by the seeming lack of Board direction for the required environmental reviews and mitigation for CAPITAL projects.</p> <p>When developing the Regional Habitat Conservation Vision, several barriers were identified that have slowed efforts to fully address regional habitat conservation within the region, including a lack of ongoing secure regional funding, a lack of institutional knowledge and public awareness, and waning political focus on habitat conservation.</p> <p>Similarly, the focus on habitat conservation as a major public policy issued (SIC) has waned since the 1990s. Public policy focuses on imminent issues. Over the years, environmental public policy has shifted towards stormwater issues and climate adaption as the top-of mind issues. Ironically, habitat conservation contributes towards resolving each of these issues. In some respects, regional habitat conservation is a victim of its own success; being perceived as an issue that has been resolved by the region without an understanding of the current gaps.</p> <p>As we evaluate potential funding for existing conserved lands, MSCP Preapproved Mitigation Areas (PAMA), defined reserves, preserve and managed properties, it becomes abundantly clear that there are no planned funding objectives of substance for the San Diego Region’s natural lands. Natural lands protection is currently limited to \$4 million. This defect is delineated in the void of conservation funding in Appendix U: Cost Estimation Methodology of 18 different forecast costs budget totaling \$163,536,000,000. In this unprecedented budget no funds are planned for maintaining MSCP conservation lands and the required mitigation for Capital projects. <a href="https://sdforward.com/docs/default-source/2021-regional-plan/appendix-aa---regional-habitat-conservation-vision.pdf?sfvrsn=bb44fd65_2_AA-4">https://sdforward.com/docs/default-source/2021-regional-plan/appendix-aa---regional-habitat-conservation-vision.pdf?sfvrsn=bb44fd65_2_AA-4</a></p>	<p>To assist the region to meet its habitat conservation goals, the proposed final 2021 Regional Plan has identified \$2,087 million for an enhanced habitat conservation, management, and monitoring program. These funds are complemented with a \$565 million Nature-Based Climate Solutions Program that will promote both habitat conservation and restoration and carbon sequestration (See Climate Adaptation and Resilience programs). In addition, future mitigation of the transportation projects included in the 2021 Regional Plan will result in an additional \$300-\$500 million of land acquisition and restoration for habitat mitigation (incorporated in project costs presented in Appendix A). In total, the proposed final 2021 Regional Plan identified \$3 billion for habitat conservation efforts.</p> <p>SANDAG is committed to working with its regional partners to identify funding to fulfill this commitment.</p>
L408	The TransNet Environmental Mitigation Program (EMP) also established the San Diego Management and Monitoring Program (SDMMP) to provide a coordinated, scientific approach to management and biological monitoring of conserved lands in San Diego County. Appendix AA, addressing The Regional Habitat Conservation Vision contradicts the illusion of effective planning by the \$3.0 billion funding deficiency from 2011 to date. Essentially, the natural lands preservation budget is bereft of new funding sources, relying exclusively on the existing \$4,000,000 per year of the original TransNET sales tax funding.	As described above, the proposed final 2021 Regional Plan identifies \$3 billion for habitat conservation efforts. SANDAG is committed to working with its regional partners to identify funding to fulfill this commitment.
L409	<p>Without a regional funding source, the implementation—and ultimately, the success—of these plans to protect species and their habitats from extinction falls into question. In 2011, the estimated unfunded regional cost to implement the regional habitat conservation plans was \$3.0 billion. This SANDAG RTP statement could not be more timely or appropriate for discussions and decisions to cure the unfunded regional cost. Hesitation to address funding requirements accomplishes nothing. Sierra Club can only speculate on the huge shortfall confronting SANDAG and the San Diego region environment the RTP claims to safeguard. The 2011 deficit in today’s dollar value would be \$3.62 billion and climbing.</p> <p>The bottom line of this Sierra Club communication, is that the RTP plan does not address the on-the-ground reality of SANDAG acting as though the agency did not bear planning responsibility for the huge, and growing, natural land MSCP conservation and preservation costs. Instead, regardless of environmental mitigation first claims, SANDAG has devoted their economic resources solely to CAPITAL projects, disregarding the costs of maintaining already preserved and reserved MSCP lands and mitigating the carbon associated with these capital projects.</p>	As of September 2021, SANDAG has provided \$161 million towards acquisition of lands for capital project mitigation, \$55 million for regional land management and monitoring, and \$16.6 million of Land Management grant funds.
L410	With a \$196 billion California budget passed, it is inappropriate that the entirety of San Diego’s MSCP conserved and MHPA protected lands are hobbled with a \$4 million spending limit. SANDAG must exert the same efforts researching state and federal environmental protection grants or state appropriations as it demonstrates with the vastly more expensive CAPITAL project grants.	Thank you very much for your comment.
<b>Teresa Montero</b>		
L411	I have been a Logan Heights resident (OR BUSINESS OR NON PROFIT) for 10 years. I live 1 blocks from Interstate 5 writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego’s Barrio Logan and Logan Heights communities. Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional Plan (Draft Plan)	Caltrans District 11 has also expressed interest in exploring opportunities for freeway caps. In alignment with the 2021 Regional Plan, SANDAG and Caltrans District 11 are currently developing Comprehensive Multimodal Corridor Plans in coordination with agency partners and local city governments. Comprehensive Multimodal Corridor Plans (CMCPs) are data-driven plans to reduce congestion and generate transportation choices while preserving community character and creating opportunities for enhancement projects. Opportunities for freeway caps will be considered in the CMCPs.

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	<p>Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950’s and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know ReConnect Logan Freeway Lid will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the 1-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.</p> <p>As mentioned, the construction of the 1-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950’s our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that 1-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children’s access to neighborhood schools. It is time for our community to heal - a freeway lid is the answer.</p> <p>Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out ReConnect Logan Freeway Lid as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are: The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)</p> <p>Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)</p> <p>Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)</p> <p>Besides being in line with the 2021 Draft Regional Plan, ReConnect Logan Freeway Lid is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to the addition of a Freeway Lid as a priority project as identified in SANDAG’s 2021 Draft Regional Plan.</p>	
<p><b>University Professional and Technical Employees - CWA 9119, Local 9 UCSD</b></p>		
<p>L412</p>	<p>While the Regional Plan is the boldest that SANDAG has proposed in decades, it is still highway first, which perpetuates a state of structural immobility, and will take too long to create necessary changes for public transit to be an alternative to cars and address our climate crisis. As transportation accounts for 41% of greenhouse gas emissions in San Diego, we have the opportunity to greatly reduce GHG emissions and create a more socially equitable region, by improving our transit system.</p> <p>Therefore, I urge you on behalf of the SDTEWG to support these proposed changes:</p> <ol style="list-style-type: none"> <li>1. Meet the required greenhouse gas emission targets, and ensure measures actually get us to those goals, by using the federal and state funds available to create high quality union jobs. Climate change is accelerating and we are currently seeing the results, which is especially devastating to frontline communities, so the emissions reduction goal of 40% by 2030 is inadequate to meet the climate crisis.</li> <li>2. Accelerate the timeline for all transit (trollies, buses, rail) and biking infrastructure improvements and prioritize the Environmental Justice communities that need transit solutions the most. Environmental Justice communities cannot afford to wait; they need immediate improvements while the long-term infrastructure projects are being planned. This means no new roads but rather accelerating the purple line and collaborating with MTS to make improvements to the blue line, both of which serve these communities.</li> <li>3. Develop a transit system that is fast, frequent, reliable, and accessible by increasing passenger capacity and frequency on popular lines. This should be done immediately to introduce the public to a new transit era by providing MTS and NCTD with the necessary financial support for implementation.</li> <li>4. Create and fund an anti-displacement strategy to protect vulnerable communities living near transit corridors by developing new affordable housing, preserving existing affordable housing, encouraging community ownership.</li> <li>5. Make immediate improvements to current amenities surrounding transit stops with dedicated funding. Amenities</li> </ol>	<p>The 2021 Regional Plan is required to reduce greenhouse gas (GHG) emissions from passenger vehicles and light-duty trucks by 19% per capita by 2035 compared to 2005 levels, as mandated by Senate Bill (SB) 375. Reducing GHG emissions and achieving state goals related to carbon neutrality requires actions at all levels of government. SANDAG looks to support and encourage local jurisdictions, state agencies, and other partners to reduce emissions beyond what is included in the 2021 Regional Plan. The Blue Line Trolley is one of the most successful light rail lines in the nation. It recently had frequencies increased to 7.5 minutes from 5 a.m. to 7 p.m. Grade separations and track work will help to improve the reliability on the Blue Line. Appendix A includes specifics on these projects, but in the short term SANDAG will conduct a Blue Line Express Feasibility and Conceptual Engineering Study as a Near-Term Implementation Action (included in proposed final Appendix B: Implementation Actions). The study will focus the project specifications and clarify next steps for express connectivity along the Blue Line.</p> <p>The South Bay to Sorrento Comprehensive Multimodal Corridor Plan is currently studying alternatives that include a station in City Heights along the Commuter Rail Route 582. The east-west Commuter Rail route 581 between El Cajon and Downtown San Diego/Central Mobility Hub via SDSU includes that station in the current proposed alignment. The first part of Route 582, from National City to Sorrento Mesa, is expected to be built by 2035 and is planned to be extended south from National City, to Chula Vista, and to the border by 2050. An additional route, Commuter Rail 583, traveling from the border to National City on the same alignment as the 582, is expected to be built by 2050 along with a branch to the Central Mobility Hub via downtown San Diego. SANDAG agrees that action is needed now to provide fast, frequent, reliable, and accessible transit, especially on highly utilized routes. Staff are bringing forward an item to the SANDAG</p>



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	<p>include benches, shade from the elements, and bathrooms which should all be accessible according to ADA regulations. 6. Begin no-cost transit passes for youth 24 years old and younger in 2023, not 2027. No-cost transit passes encourage significant participation in public transportation and help shift expectations for how San Diegans use transit.</p>	<p>Transportation Committee and to the Board of Directors in advance of approval of the 2021 Regional Plan to amend the agency budget and act now to invest in transit that benefits environmental justice communities. This action seeks to increase services on transit lines that have infrequent service in the evenings and late nights, and/or provide fare subsidies for youth riders. Additionally, further clarification on planned improvements to the bus network, including frequency and span-of-service improvements, will be added to Appendix A in the proposed final 2021 Regional Plan. Land use authority is reserved to local jurisdictions – the cities and the county. The cities and the county are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan as those jurisdictions understand the unique needs of their communities and geographies. SANDAG is developing a Regional Housing Incentive Program and it will meet the goals of the proposed final 2021 Regional Plan. SANDAG’s housing incentive program will include development of a regional anti-displacement strategy, consider climate change and resilience, consistency with the transportation improvements included in the Regional Plan, and alignment with SANDAG grant programs. Additionally, SANDAG will coordinate with its Social Equity Working Group, tribal nations, and other interested stakeholders to ensure the housing incentive program promotes equity and addresses gentrification, displacement, and other issues. The proposed final 2021 Regional Plan includes a commitment to building bathrooms at all new rail stations and developing a bathroom access plan to study the incorporation of bathrooms into existing stations. MTS is working to provide shelters throughout the region. Bus shelters are provided wherever there is sufficient right of way to locate them. Any new infrastructure build would include shelters. Complete Streets designs are an important component of SANDAG’s planning today and will be included on projects in the future. As part of larger infrastructure projects like Next Generation Rapid, Trolley and Commuter Rail, all stations will have shelters. One of the Implementation Actions listed in Appendix B is a Regional Fare Impact Study. This study will ensure public stakeholders get the chance to weigh in on the options. The study, expected to be completed by FY2024, will include an evaluation of fare subsidies for people with low incomes, seniors, students, and youth. While that work is underway, staff from SANDAG, MTS, and NCTD are working with stakeholders on a one-year pilot that may provide free fares for youth age 18 and under.</p>
<p><b>Urban League of San Diego County; LISC San Diego; People's Association of Justice Advocates; National Black Contractors Association</b></p>		
L413	<p>We are very concerned that the plan does not address both AB 686 Affirmatively Furthering Fair Housing and Sustainable Communities Strategy as interpreted by the California Air Resource Board (CARB) “to reduce greenhouse gas emissions from driving, which can also foster healthier and more equitable and sustainable communities.”</p>	<p>The 2021 Regional Plan, including its Sustainable Communities Strategy and the Regional Housing Needs Assessment (RHNA) Plan, meets state-required greenhouse gas emission reductions while also improving social equity.</p>
L414	<p>SANDAG through the 2021 Regional Plan has an opportunity under AB 686 and the CARB 2018 Progress Report to begin the process of ending the current legal apartheid that exists in our communities and ensure that California meets its greenhouse gas emissions reductions targets for 2030 and beyond with how communities are “planned, funded, and built.” We strongly urge SANDAG to use their role as the Metropolitan Planning Organization and with the 2021 Regional Plan to comply with AB 686 and Sustainable Communities Strategy to encourage and assist cities like the City San Diego to begin desegregating their neighborhoods and provide meaningful opportunities for all residents and families while lowering car emissions and climate change.</p>	<p>As described in Appendix K – Regional Housing Needs Assessment, State law (Government Code Section 65584(d) and 65584.04(e)) requires the Regional Housing Needs Assessment (RHNA) Plan to further five objectives related to (1) housing supply, (2) infill development, (3) jobs/housing relationship, (4) equity, and (5) affirmatively furthering fair housing, and requires that 12 factors be considered in the development of the methodology to allocate housing units. To promote equity and fair housing, as well as to meaningfully address patterns of segregation, the RHNA methodology allocates more housing units within each income category to jurisdictions with a percentage of households in that same category that is lower than the regional percentage. The Equity Adjustment in the methodology assists in overcoming patterns of discrimination and transforming racially and ethnically concentrated areas of poverty into areas of opportunity by allocating a higher proportion of low-income housing units to jurisdictions with a lower share of low-income households, which tend to be jurisdictions with a high concentration of resource-rich areas.</p>
L415	<p>Finally, we strongly urge SANDAG to create an Office of Equity that will ensure that proposals like the Regional Plan and are advancing equity and reducing barriers to inequality, structural racism while enhancing opportunity.</p>	<p>SANDAG has an Office of Diversity and Equity and the social equity analysis for the 2021 Regional Plan is included in Appendix H.</p>
<p><b>Webster Community Council</b></p>		
L416	<p>We see development of our region occurring as planned, as an impediment to our traditional lifestyle and as such, desire a more gentle approach to the conversion a sprawled California city to a high-density commuter city. The use of transportation agency owned parking lot lots next to noisy, government-owned, transit center facilities such as trolley lines is objectionable as is the obvious feeling that our automobiles are being taken away from us. Yes we believe in growth, but it must be phased to include our life styles. We request a plan that will be prepare our community to receive proposed changes occurring in the near future.</p>	<p>SANDAG will collaborate with community members, including the Webster Community, as the 2021 Regional Plan is implemented to ensure transportation solutions meet the needs of each unique community.</p>
L417	<p>Our voice is changing! We have a sophisticated community council who now has experienced the flawed logic of, “oh you are not ready,” for changes that are inclusive in the new modal plans. We ask for a mobility center/hub located</p>	<p>The Southeastern San Diego Mobility Hub area includes all three Transit Leap service types - commuter rail, light rail, and Next Gen Rapid – anchored by a station near the community’s existing transit center and</p>

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	<p>within our existing fledgling transportation center near the intersection of Euclid Avenue and Market Street. This together with communication and information system infrastructure requires fiber optic cable readiness equal to that of other San Diego communities. We ask for assurance that the community will be ready for the state of the art transportation system that is in the design stage at this time. At the very least we ask for an inventory of our existing transportation facilities to demonstrate how far we have been left behind. We want all of our streets to be designed with "Complete Streets" designs enabling all modes of transportation, including unshared bicycle paths where appropriate. We ask for coverings for all of our MTS bus stops.</p>	<p>commercial core. Also included in the regional mobility hub concept is the upgrade of streets to be safer for the use of micromobility, transit, and other alternative modes. Investments in supporting technologies related to transit and an array of mobility hub amenities is also included for this hub such as electric vehicle charging for Flexible Fleets, safe passenger loading areas, and upgraded transit waiting experience inclusive of real-time travel information, comfortable waiting areas, WIFI, and device charging options. All of these improvements will ensure the community is both physically and digitally connected to available travel options.</p>
<b>County of San Diego (Attachments)</b>		
<a href="#">L418</a>	<a href="#">County staff would be interested to better understand and discuss further with SANDAG the potential for Regional Plan strategies to be used as part of a potential regional mitigation strategy related to Vehicle Miles Traveled (VMT).</a>	<a href="#">SANDAG looks forward to coordinating with the County on opportunities for Regional Plan strategies to be used as part of a potential regional mitigation strategy related to VMT.</a>
<a href="#">L419</a>	<a href="#">When would funding be expected to be implemented related to Transit Leap/Flexible Fleet Connections to Mobility Hub areas, as this is a potential opportunity to reduce VMT for residents living in the unincorporated area?</a>	<a href="#">SANDAG has already begun on efforts to implement many elements of the 2021 Regional Plan with funding that is currently available. Appendix B describes the near-term and continuing actions to implement the Regional Plan.</a>
<a href="#">L420</a>	<a href="#">The County has developed an Electric Vehicle (EV) Roadmap and is committed to assisting with the deployment of regionwide EV infrastructure to reduce GHG emissions in the transportation sector. Could SANDAG provide additional details on the future development, application, and implementation of the proposed Road User Fees and other proposed road usage revenues? Will consideration be given to exemptions for use of clean mobility strategies?</a>	<a href="#">The funding strategy for the 2021 Regional Plan assumes that the road usage charge would be applied to both gas-powered and zero-emission vehicles, however, the details of implementation of the road usage charge will be further explored in a pricing implementation strategy that SANDAG will begin developing in 2022.</a>
<a href="#">L421</a>	<a href="#">County staff would like to discuss with SANDAG staff the Regional Plan strategies, including funding for Major Transit (for purposes of CEQA, defined as a rail transit station, ferry terminal served by bus or rail, and a bus stop with two or more lines that provide transit service at 15 minute intervals or better during peak commute periods) in areas of the unincorporated area that are identified as "VMT efficient" in the SANDAG VMT Map.</a>	<a href="#">SANDAG looks forward to discussing major transit stops and associated CEQA implications with County staff.</a>
<a href="#">L422</a>	<a href="#">There is significant investment in development and infrastructure in the Otay Mesa area, and Otay Mesa is identified as a "Mobility Hub" area in the RTP. County staff would like to better understand what funding has been identified for this "Mobility Hub" area.</a>	<a href="#">Appendix A identifies funding for Mobility Hub amenities at a regional level and does not define specific investment on a per hub basis. Appendix A includes specific investments for the Central Mobility Hub and San Ysidro Mobility Hub as those are specific transit station projects with Mobility Hub infrastructure.</a>
<a href="#">L423</a>	<a href="#">County staff would like to discuss with SANDAG the potential for "Major Transit" services along the I-15 corridor, such as the potential for buses on shoulders.</a>	<a href="#">Appendix D (Figures D.10 and D.11) show the 2035 and 2050 Transit Priority Areas, which cover a ½ mile buffer from major transit stops. There are major transit stops included in the I-15 corridor associated with the Rapid bus service in that corridor.</a>
<a href="#">L424</a>	<a href="#">Complete Corridors, such as the SR-67 and I-15 Corridors, are envisioned to act as the backbone of the regional transportation system. In addition to providing for safe and comfortable spaces to get around for all modes of transportation, road improvements such as intersection widening are important for the safe and reliable movement of all road users. County staff would like to discuss further identification and investment within complete corridors that provide linkages to the unincorporated area. These improvements could assist in providing routes for the County's eastern and northern rural regions that could be essential in the event of accidents or fire evacuation. For example, County staff would like to discuss with SANDAG the option of including safety improvements along the SR-67 Corridor on Wildcat Canyon Road, as this road is a relief route to SR-67. Additionally, road improvements on Old Hwy 395 and Pala Temecula Road in the north county may merit further conversation, as both of these roads serve as alternate routes to I-15 during peak traffic hours.</a>	<a href="#">The 2021 Regional Plan identifies technology and operational improvements to SR-67 to improve safety. During corridor-level and project-level planning, SANDAG will coordinate with the County on the specifics of these improvements.</a>
<a href="#">L425</a>	<a href="#">County staff would like to further discuss improvements of low flow crossings that are necessary to limit area flooding as well as the safe passage of motorists.</a>	<a href="#">The 2021 Regional Plan acknowledges the need to address environmental effects, such as flooding, that currently occur and could be exacerbated by climate change. The details of these improvements will be defined during corridor-level and project-level planning.</a>
<a href="#">L426</a>	<a href="#">County staff would like to work with SANDAG to identify evacuation routes at a regional level, and the possibility of creating a separate section within the Regional Plan that would identify improvements of these routes and potential funding that could be part of the 2021 Regional Plan.</a>	<a href="#">Appendix A details the funding for rural corridors and how these improvements would support regional evacuation routes.</a>
<a href="#">L427</a>	<a href="#">County staff would like to discuss with SANDAG how Smart Infrastructure and Connected Vehicles will address the legal and financial challenges with sharing traffic signal data with private entities and the liability of the potential misuse of signal timing data.</a>	<a href="#">Appendix B details implementation actions for the Regional Plan, including Priority Implementation Action 6 to advance the Next OS by preparing technical and planning studies and initiating pilot opportunities. Near-term actions would establish policies for data sharing and cross-agency procedural guidelines. SANDAG will be working closely with the County on these actions.</a>
<a href="#">L428</a>	<a href="#">County staff would like to better understand the impact of Electric Vehicle Infrastructure on County of San Diego public right of way.</a>	<a href="#">SANDAG will continue to collaborate with the County of San Diego on electric vehicle infrastructure. The 2021 Regional Plan does not address details on electric vehicle infrastructure in County of San Diego public right of way.</a>



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L429	<p>Stormwater Management &amp; Regional Needs Assessment; suggested edits in Appendix R, page R-2:</p> <p><u>"The County of San Diego has initiated an update of the 2010 Needs Assessment's 40- year water quality cost estimate using more recent water quality planning documents and strategies for achieving regulatory compliance and water quality objectives throughout the region. Since 2010, the Copermittees have worked to formulate Water Quality Improvement Plans (WOIPs) for the region's watersheds, including strategies, planned projects, and schedules to address their respective water quality objectives and compliance needs. The update to the Needs Assessment is intended to assist the County in planning and decision making and will draw upon the most recent WOIPs, with a focus on unincorporated areas to develop updated cost information."</u></p>	<p><u>Thank you for these suggested edits. These are incorporated in the proposed final 2021 Regional Plan Appendix R.</u></p>
L430	<p><u>Figure AA.1 shows the conserved habitat lands in the San Diego region (light green) and displays the areas included in the four subregional habitat conservation plans (subfigure).</u></p> <p><u>The Pre-Approved Mitigation Area (PAMA) of the South County Multiple Species Conservation Program (MSCP) and draft PAMA of the draft North County MSCP are labeled as "Proposed Conserved Habitat Lands" (dark green). This label may be misinterpreted by readers. While the MSCP Preserves will be assembled within the PAMA, not all PAMA designated lands will be conserved or are being actively pursued for conservation at this time.</u></p> <p><u>The draft Focused Conservation Area (FCA) of the draft East County MSCP was not included in the "Proposed Conserved Habitat Lands" (dark green). This area is equivalent to the draft North County MSCP's draft PAMA and should be included in this figure.</u></p> <p><u>The Rancho Guejito property located north of San Pasqual Valley Road will not be included in future iterations of the draft North County MSCP Permit Area. The portions of this property identified within the draft North County MSCP should be changed from dark green to white to reflect this change.</u></p> <p><u>In the subfigure, both the draft North County MSCP and Multiple Habitat Conservation Plan (MHCP) are identified by the number "4." The MHCP area should be identified by the number "1" to correspond with the provided key.</u></p>	<p><u>Thank you for these suggested edits to Figure AA-1. The figure has been updated accordingly.</u></p>
L431	<p><u>Although the draft 2021 Regional Plan mentions the importance of protecting habitat corridors and wildlife linkages through land acquisition, it does not appear to include the construction of safe passageways to connect wildlife to preserved lands bisected by existing and future regional transit corridors. It is recommended that SANDAG work with the San Diego Monitoring and Management Program (SDMMP) and community partners to identify the areas along regional transit corridors that would benefit from wildlife crossings and that these improvements be included in future regional projects.</u></p>	<p><u>Thank you for this recommendation. Appendix AA has been updated to reflect this suggestion.</u></p>
L432	<p><u>For proposed projects that occur adjacent to Department of Parks and Recreation (DPR) County-managed lands, DPR staff would like to coordinate with SANDAG staff to ensure wildlife connectivity is maintained from adjacent lands to preserved County lands, including wildlife-only crossings.</u></p>	<p><u>SANDAG looks forward to coordinating with DPR staff to ensure wildlife connectivity is maintained for those proposed projects adjacent DPR County-managed lands.</u></p>
L433	<p><u>For proposed projects that occur adjacent to or near existing or potential future trail connections, DPR staff would like to coordinate with SANDAG staff on trail connectivity throughout the County and incorporate safe multi-use crossings such as bridges or overpasses for recreational use.</u></p>	<p><u>SANDAG looks forward to coordinating with DPR staff on trail connectivity for those proposed projects that occur adjacent to or near existing or potential future trail connections.</u></p>
L434	<p><u>DPR staff request SANDAG staff coordinate in developing SANDAG's 5 Comprehensive Multimodal Corridor Plans as mentioned in Appendix B: Implementation near DPR facilities:</u></p> <p><u>Central Mobility Hub and Connections, Coast, Canyons, and Trails - State Route 52, North County - SPRINTER/Palomar Airport Road/State Route 78/State Route 76, San Vicente - State Route 67, South Bay to Sorrento - Purple Line/Interstate 805/Blue Line/Interstate 5 South.</u>  <u>Study additional seven corridors to inform the next Regional Continuing Actions.</u></p> <p><u>Pursue funding opportunities for projects, programs, and services identified in completed CMCPs.</u></p>	<p><u>SANDAG looks forward to the County's participation in developing the Comprehensive Multimodal Corridor Plans.</u></p>
L435	<p><u>County Staff would like to discuss with SANDAG the possibility of including trails and trail systems within the unincorporated area as part of the 2021 Regional Plan and to consider California Coastal Trail connections to DPR facilities.</u></p>	<p><u>As an implementation action of the 2021 Regional Plan, SANDAG will prepare a Regional Active Transportation Plan and will coordinate with the County of San Diego on the inclusion of trail systems.</u></p>
L436	<p><u>As the owner and operator for eight airports in the region, County Airports continues efforts to safely operate its facilities, ensure future land uses are compatible with aircraft operations, and protect the health and safety of people and property within the vicinity of an airport. The County's airports serve as transportation hubs, emergency service facilities and economic engines in their communities. McClellan-Palomar Airport is the only commercial airport in North</u></p>	<p><u>SANDAG looks forward to continuing coordination on the region's airport facilities with the County. "Appendix BB: Regional Aviation Strategic Plan (RASP) and San Diego Airport Multimodal Accessibility" in the 2021 Regional Plan discusses our regional airport facilities and includes the RASP Implementation Plan.</u></p>

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	<p><u>County and has over 145,000 annual aircraft operations. It is also a Customs and Border Protection Port of Entry. In East County, Gillespie Field is the 44th busiest airport in the nation with 240,000 annual operations. Both of these airports support thousands of jobs and generate hundreds of millions of dollars in economic activity. The County looks forward to the integration of these airports into the regional transportation system.</u></p>	
<p><u>L437</u></p>	<p><u>The San Diego County Regional Airport Authority adopted Airport Land Use Compatibility Plans for the eight airports, which included land use compatibility policies related to airspace, noise, safety and overflight. Those policies have been adopted by the County of San Diego through its General Plan and Zoning Code. After evaluating the forecasted increases in housing and jobs around the Mobility Hubs, there are several land use assumptions related to safety and noise around Fallbrook Airpark, Jacumba Airport, Gillespie Field and McClellan Palomar Airport that County staff would like to better understand. For example, there are forecasted incompatible housing increases within the Runway Protection Zones at Gillespie Field. These inconsistencies could result in the assumed intensities and densities increases being unachievable.</u></p>	<p><u>The land use pattern proposed in the Draft 2021 Regional Plan focuses growth and development in the mobility hub areas. The allocation of housing units to subregional areas represents general areas projected for future growth and not precise locations for future housing development or housing unit type. The exercise of land use authority is reserved to local jurisdictions.</u></p>
<p><u>L438</u></p>	<p><u>The Regional Plan will focus future investment, development, and growth in centralized areas referred to as "mobility hubs." There are locations in the unincorporated area that the County has forecasted for future growth, which included already designated Regional Housing Needs Assessment (RHNA) sites, and are located within close proximity to a proposed mobility hub. The County would like to work with SANDAG to consider the expansion of proposed mobility hubs to include additional unincorporated north and east county communities. As indicated in Figure 1, these proposed expansions include areas in North County Metro, Lakeside, and Spring Valley. Additional details for these three mobility hub expansions are provided below.</u></p> <p><u>The North County Metro community is located between the proposed Vista and San Marcos mobility hubs. Expansion of the San Marcos mobility hub could include the Buena Creek Sprinter Station and additional housing units, including multiple RHNA sites.</u></p> <p><u>Lakeside has multiple areas that are identified as efficient areas compared to the regional vehicle miles traveled (VMT) average. These areas are located immediately adjacent to the proposed El Cajon mobility hub. Expansion of the El Cajon mobility hub could include these VMT efficient areas as well as potentially including additional growth areas in Lakeside along the I-8 corridor.</u></p> <p><u>Spring Valley is located east of the proposed Lemon Grove mobility hub and south of the proposed La Mesa mobility hub. This community has existing transit access along Jamacha Boulevard and is in close proximity to the MTS Trolley stations in Lemon Grove. Expansion of this mobility hub could include the Spring Valley areas near SR-125 and along Jamacha Boulevard.</u></p>	<p><u>SANDAG appreciates these suggestions from the County of San Diego and agrees that these are areas adjacent to the mobility hubs identified in the draft 2021 Regional Plan that should be considered as part of the identified mobility hub areas.</u></p>





Chair Catherine Blakespear and Board of Directors  
 San Diego Association of Governments  
 401 B Street, Suite 800  
 San Diego, CA 92101

**RE: Include Youth Opportunity Passes in the 2021 Regional Plan and Early Actions**

Dear Chair Blakespear and SANDAG Board of Directors:

We are excited for the future of transportation in our region. The 2021 Regional Plan includes visionary elements to building an efficient, accessible, and sustainable transportation system. Thank you for everyone’s effort on it. However, we bring to your attention that a key program is missing. We request that you amend the draft 2021 Regional Plan to include Youth Opportunity Passes (YOP), no-cost transit passes for youth ages 24 and under.

For 10 years, the Improving Transportation in City Heights Team (ITCH) has advocated to have no-cost transit passes for youth in San Diego. Mid-City CAN, the ITCH team, and the undersigned supporters request that you include YOP (ages 24 & under) in the 2021 Regional Plan. YOP requires a spot among to priorities in our 30-year vision for transportation in the region.

We ask the Board of Directors to take the following actions:

1. Amend the 2021 Regional Plan to state that Youth Opportunity Passes, no-cost-transit passes for youth ages 24 and under, will be funded when transit subsidies are allocated.
2. Amend the 2021 Regional Plan to state that transit subsidies will be allocated at the earliest implementation possible.
3. Fund Youth Opportunity Passes (24 & under) as an early-action Transit Pilot Program this year.

YOP (24 & under) is a necessary program, as illustrated by the following facts:

1. **Transit-dependent youth have been disproportionately impacted by the COVID-19 pandemic.** In San Diego County, there are approximately 86,000 young workers (ages 16-24) who work in the industries that were hard hit by the COVID-19 epidemic.<sup>1</sup> The industries include hospitality, food services, retail, oil and gas mining, transportation, employment services, travel, and leisure.<sup>2</sup>
2. **YOP (24 & under) is a way to increase ridership and develop a transit-culture.** Only 10,463 youth (ages 16-24) use public transit in San Diego, but these young commuters use public transit at a rate double that of their older counterparts (adults ages 25-59).<sup>3</sup> YOP will further promote transit use among young San Diegans.
3. **YOP (24 & under) helps divert youth away from the school to prison pipeline.** MTS officers decide who to check for fare evasion, YOP prevents the criminalization of youth of color due to their inability to afford a pass. Literature suggests that Black youth are arrested for fare evasion at a rate 5 times higher than their white peers and Latino/a/x youth are arrested at a rate 4 times higher than their white peers.<sup>4</sup>
4. **YOP (24 & under) promotes the reductions of GHGs.** A person who switches from a 20-mile round-trip commute by car to using existing public transit, can reduce his or her annual CO2 emissions by 4,800 pounds per year.<sup>5</sup> Decreasing greenhouse gas emissions is a matter of equity. Residents in low-income, BIPoC communities are exposed to more pollution than their more affluent counterparts. For example, City Heights residents are exposed to twice the amount of diesel particulate matter from trucks & cars than La Jolla residents.<sup>6</sup>
5. **YOP (24 & under) addresses climate justice.** Mid-City CAN has conducted 250+ conversations with residents in Communities of Concern (CoC). Over 86% of residents noted that climate change directly impacted them. Extreme weather has become a barrier to work and school for CoC residents who already face significant barriers to education and employment. Residents who normally walk or bike to work must increasingly rely on

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<sup>1</sup> The places a COVID-19 recession will likely hit hardest”: Mark Muro, Robert Maxim, Jacob Whiton. March 17, 2020. <https://www.brookings.edu/blog/the-avenue/2020/03/17/the-places-a-covid-19-recession-will-likely-hit-hardest/>; “ECONOMY IN CRISIS: APRIL JOBS REPORTS LIKELY TO REVEAL RECORD SD JOB LOSSES”: Nate Kelly. May 12, 2020. <https://www.sandiegobusiness.org/blog/tag/covid-19-unemployment/>; “Who are the workers already impacted by the COVID-19 recession?”: Alan Berube and Nicole Bateman. April 3, 2020. <https://www.brookings.edu/research/who-are-the-workers-already-impacted-by-the-covid-19-recession/>

<sup>2</sup> MCC analysis of 2019 IPUMS CPS USA data. IPUMS CPS USA: Sarah Flood, Miriam King, Renae Rodgers, Steven Ruggles and J. Robert Warren. Integrated Public Use Microdata Series, Current Population Survey: Version 7.0 [dataset]. Minneapolis, MN: IPUMS, 2020. <https://doi.org/10.18128/D030.V7.0>

<sup>3</sup> MCC Analysis of 2019 IPUMS CPS USA Data [IPUMS CPS USA: Sarah Flood, Miriam King, Renae Rodgers, Steven Ruggles and J. Robert Warren. Integrated Public Use Microdata Series, Current Population Survey: Version 7.0 [dataset]. Minneapolis, MN: IPUMS, 2020. <https://doi.org/10.18128/D030.V7.0>]

<sup>4</sup> Economic inequality is directly correlated with public safety concerns like robbery and homicides (“Inequality and Violent Crime,” Fajnzylber et. Al, April 2002, Journal of Law and Economics). Connecting low-income youth to economic opportunity is an investment in public safety.

<sup>5</sup> American Public Transportation Association, “Public Transportation Reduces Greenhouse Gases and Conserves Energy,” “Public Transportation Saves Energy and Helps Our Environment.

<sup>6</sup> Major sources of diesel particulate matter include trucks, cars and buses; Source: <https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30>)

cars or public transportation that is inaccessible due to cost or distance. YOP eliminates the cost barrier to transportation for youth ages 24 and under.

6. **YOP (24 & under) is a proven program.** Similar programs exist in Alameda County, Los Angeles, Sacramento, San Francisco, and Santa Ana. Youth Opportunity Passes helps ensure youth from all background are connected to their schools, internships, medical care, and early-career opportunities.

Amend the 2021 Regional Plan to include Youth Opportunity Passes (24 & under). Upon your commitment to include no-cost transit for youth ages 24 and under in the Plan, a study may be conducted to begin its implementation. But the community needs a commitment from you TODAY. It's been 10 years of advocacy. Thank you.

Sincerely,

ACCE  
ACLU of San Diego and Imperial Counties  
Center on Policy Initiatives  
City Heights Community Development Corporation  
Climate Action Campaign  
Environmental Health Coalition  
Logan Heights CDC  
Mid-City CAN  
Muslim American Society-Public Affairs and Civic Engagement (MAS-PACE)  
Outdoor Outreach  
Parent Voices San Diego  
Partnership for the Advancement of New Americans (PANA)  
Planned Parenthood Action Fund of the Pacific Southwest  
Youth Will  
Viet Vote

CC:  
MTS Board of Directors  
NCTD Board of Directors  
Hasan Ikhrata, Executive Director – SANDAG  
Sharon Cooney, Chief Executive Officer – MTS  
Matthew O. Tucker, Executive Director – NCTD



August 5, 2021

Mr. Hasan Ikhata  
SANDAG, Executive Director  
401 B St, Suite 800  
San Diego, CA 92101

**Re: Support Incorporating *Reconnect Logan, 5 Freeway Lid Project* in the San Diego Association of Governments' (SANDAG) 2021 Regional Plan**

Dear Mr. Ikhata,

My name is Andrew Puls and my wife and I have been Logan Heights residents for approximately five years. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities. **Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan (Draft Plan)**

Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know *ReConnect Logan Freeway Lid* will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.

As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.

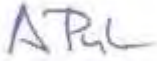
Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out *ReConnect Logan Freeway Lid* as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:

- The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)
- Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)
- Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)

Besides being in line with the 2021 Draft Regional Plan, *ReConnect Logan Freeway Lid* is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to **the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.**

If you have any questions, you may contact me at [andypuls@gmail.com](mailto:andypuls@gmail.com).

Sincerely,



Andrew Puls

2054 Julian Ave.

San Diego, CA 92113

# **AVAD INVESTMENTS, INC.**

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A California Corporation dba ARCO-Home

August 5, 2021

Mr. Hasan Ikhata, Executive Director

SANDAG [SDForward@sandag.org](mailto:SDForward@sandag.org); [MonicaMontgomery@sandiego.gov](mailto:MonicaMontgomery@sandiego.gov); [SeanEloRivera@sandiego.gov](mailto:SeanEloRivera@sandiego.gov)

401 B St Ste 800, San Diego, CA 92101

Subject: 2021 Regional Plan Comment SeanEloRivera@sandiego.gov

Dear Mr. Hasan Ikhata, Executive Director

Thank you for providing the public and businesses with the opportunity to comment on the draft Regional Plan. Our business, ARCO AMPM, is located in the City Heights community adjacent to the I-805 Freeway Home Avenue Ramps.

My team members and I daily observe the traffic patterns along Home Avenue and particularly the stacking on the I-805 ramps. We know the travel patterns of our customers at our fuel station and its convenience store. These experiences make clear that local neighborhood traffic is using longer less direct freeway trips to and from the Mt. Hope community and the Gateway employment and shopping centers. Buses, Bicycles, vehicles, and pedestrians cannot go directly Market Street. The Fairmount Park, Azalea Park and Hollywood Parks residents are cut off from the Gateway Centers jobs, visiting deceased loved ones at the Mt. Hope cemeteries, and the significant shopping areas between the I-805 and the SR-15 freeways. Our list of priority projects for our D9 /D4 are as follows:

1. Extension of the Home Avenue Route to Market Street for Pedestrians, Bicycles, and Vehicles. The Home / Market connection would provide significant economic development stimulus to the Mt. Hope and City Heights areas. It would assist in congestion relief by providing an alternate to freeway traffic on the SR 94 - Martin Luther King Freeway.
2. Completion of the Transportation markings along Home Avenue. Curbs are not marked for safety, to promote proper parking, traffic movement, and access for Buses and the Disabled. The Bicycle route is not fully painted and warning ramps for the visually impaired are not in place. Bulbing out at key intersections should be funded to increase pedestrian crossing safety.

I believe that the business community, along Fairmount and Home Avenues, would be open to establishment of a Business Improvement and Maintenance Area to assist in cooperative funding of some of these improvements. We would appreciate assistance in establishing such special districts. If you need further information feel free to contact me directly on my mobile 619-977-8485.

Respectfully,



Arkan Somo

President

Copy: Councilwoman Monica Montgomery [MonicaMontgomery@sandiego.gov](mailto:MonicaMontgomery@sandiego.gov)  
Councilman Sean Elo Rivera [SeanEloRivera@sandiego.gov](mailto:SeanEloRivera@sandiego.gov)

August 6, 2021

Mr. Hasan Ikhata  
Executive Director  
San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, California 92101  
[hasan.ikhata@sandag.org](mailto:hasan.ikhata@sandag.org)

Dear Mr. Ikhata:

California Air Resources Board (CARB) staff appreciate the opportunity to review and engage with the San Diego Association of Governments (SANDAG) staff on the draft Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) known as "2021 Regional Plan." This work is more important than ever as CARB's first Senate Bill (SB) 150 report<sup>1</sup> evaluating progress meeting SB 375 goals showed that California is not on track to meet the greenhouse gas (GHG) reductions expected under SB 375 for 2020 and that vehicle miles traveled (VMT) are increasing. To achieve the State's climate mandates, California needs significant and immediate changes to how we plan, fund, and build our communities and transportation systems. SANDAG has demonstrated important leadership, creativity, and innovation in developing its draft RTP/SCS, and we appreciate your ongoing efforts to work with CARB and other State agencies.

The SCS plays a critical role in supporting the State's climate efforts, and local objectives to create an economically vibrant region that responds to the needs of its diverse communities and provides better access to jobs and cleaner air for its residents. We appreciate SANDAG's work to innovate beyond its previous RTP/SCS plan in considering how to better connect the region with a reimagined transportation system and incentivize growth in strategic areas, as well as its approach to increase public engagement in the plan development process.

In reviewing the draft RTP/SCS, CARB staff looked to identify whether additional information would be needed to conduct our final SCS GHG evaluation under SB 375. As discussed with SANDAG staff in meetings this spring and summer, for all third-round RTP/SCSs, like SANDAG's 2021 Regional Plan, CARB will focus on assessing whether GHG reductions are reasonably supported by the plan. CARB staff will conduct its final evaluation, as outlined in the Final Sustainable Communities Strategy Program and Evaluation Guidelines (SCS Evaluation Guidelines).<sup>2</sup>

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<sup>1</sup> CARB's *2018 Progress Report: California's Sustainable Communities and Climate Protection Act*.

<sup>2</sup> CARB's *2019 Final Sustainable Communities Strategy Program and Evaluation Guidelines*.

CARB staff have identified areas where we would need additional information to complete our evaluation. We request that you include the information below as part of your SCS Submittal to CARB.

### **SCS Strategies to Reduce GHG Emissions**

CARB staff request that SANDAG provide further clarification regarding the following highlighted draft strategies to support CARB's assessment of whether the strategies are likely to be implemented as assumed, and therefore, reasonable for inclusion and credit:

- Land Use Pattern That Considers Jobs-Housing Balance, Mixing of Uses, Transit-Oriented Development and Housing Needs as Part of The Mobility Hub Framework: SANDAG's efforts to plan for and identify ways to incentivize future housing development in transit-rich areas with services and jobs, are vital to helping further State goals for climate, housing, and VMT reduction. CARB staff were able to identify actions in the draft RTP/SCS intended to support local jurisdictions in implementing the SCS land use pattern. As part of CARB's SCS Policy Commitments evaluation, CARB staff will also need to consider whether and to what extent these actions advance the region's land use vision. To support this analysis, CARB staff request that SANDAG provide information that summarizes differences between existing residential and commercial density and type assumptions in its Mobility Hub areas, compared to what is currently allowable in local land use plans for the corresponding geographies as part of its final SCS Submittal.
- Road User Charge Pricing Strategy: CARB staff notes that the draft RTP/SCS plans for a regionwide road user charge to be operational and generating revenue in the region starting as soon as 2026. CARB staff recognizes both the importance of, and difficulty in, implementing this pricing strategy. While the draft RTP/SCS includes actions committed to support implementation of this strategy (e.g., partnering on pilots, pursuing legislation, and investing in studies), which we support, they appear to be similar to those being pursued by other regions around the state that are assuming operations starting no sooner than 2030. CARB staff requests further clarification from SANDAG on how it may be able to implement sooner than others around the state as part of its final SCS Submittal.

### **Strategy Funding and Revenues**

The draft RTP/SCS identifies that \$29 billion needs to come from new funding sources in order to implement the plan through 2035.<sup>3</sup> Of those new funding sources, about \$18 billion, or 25 percent of the plan's total funding need through 2035, is attributed to new pricing strategies including *Ridehailing Company Service Fees*, *Future State Revenues for Transportation*, *Regional Road User Charge*, and *Future Federal Revenues for Transportation*. CARB staff is concerned that other strategies that contribute to the SCS meeting its targets

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<sup>3</sup> See, SANDAG Draft 2021 Regional Plan (May 2021) Appendix V: Funding and Revenues, at page V-25.

may be at risk if the region is not able to fully secure these new funding sources within the timeline assumed in the draft RTP/SCS. CARB's evaluation will look at the extent to which the RTP/SCS strategies will be supported by existing revenue sources, as one measure of likely implementation. CARB requests that SANDAG identify whether and to what extent the high-impact strategies for achieving the GHG reduction targets in the plan are reliant on new revenue sources versus existing revenue sources as part of its final SCS Submittal.

### **Managed Lanes and Complementary Strategies**

CARB staff reviewed Appendix A of the draft RTP/SCS and appreciate the detail provided on the region's transportation project investments by corridor. CARB staff is encouraged to see that the draft RTP/SCS includes planned investments across modes within the region's key corridors and that when investing in roadway projects, the region is prioritizing conversion of existing free-flow lanes into managed lanes with priority access for transit, carpool, and vanpool users, and fee access for single-occupant drivers. CARB staff observe that the plan also includes some managed lane projects whose scope includes adding new lanes. Specific to those projects, CARB staff requests that SANDAG provide further information that contextualizes the risk, if any, to the region's ability to achieve, and maintain its 2020 and 2035 GHG targets when adding new lanes in those locations (e.g., clarifying whether and how those projects align with and facilitate the region's preferred land use pattern, identifying whether other policies or mechanisms that will limit adverse passenger vehicle GHG/VMT emissions impacts are present in those locations) as part of its final Submittal.

CARB staff looks forward to continuing our collaboration with SANDAG staff and are committed to working together on potential approaches to address these requests. If you have any questions, please contact me at [Lezlie.Kimura@arb.ca.gov](mailto:Lezlie.Kimura@arb.ca.gov).

Sincerely,

Lezlie Kimura Szeto, Manager

Sustainable Communities Planning and Policy Section

Sustainable Transportation and Communities Division

cc: Elisa Arias, Director of Integrated Transportation Planning  
[Elisa.Arias@sandag.org](mailto:Elisa.Arias@sandag.org)

Phil Trom, AICP, Principal Regional Planner  
[Phil.Trom@sandag.org](mailto:Phil.Trom@sandag.org)

Bill Higgins, Executive Director, CALCOG  
[bhiggins@calclog.org](mailto:bhiggins@calclog.org)

Jennifer Hargrove, CalCOG  
[jennifer@calcog.org](mailto:jennifer@calcog.org)



**CALIFORNIA COASTAL COMMISSION**

San Diego District Office  
7575 Metropolitan Drive, Suite 103  
San Diego, CA 92108-4421  
(619) 767-2370



August 6, 2021

San Diego Association of Governments Board of Directors  
401 B Street, Suite 800  
San Diego, California 92101

**RE: San Diego Forward – Draft 2021 Regional Plan Coastal Commission Staff Comments**

To the Honorable Board:

Thank you for the opportunity to review and provide comments on the Draft 2021 Regional Plan (Regional Plan). The Coastal Commission is an independent state agency that regulates development along California's coastline to protect natural coastal resources and to maximize coastal access and recreation for all. We have a long history of partnership with Caltrans, SANDAG, and other state, regional, and local agencies on transportation issues along California's coastline, often also in partnership with local county or city governments. Through these partnerships we are striving to provide a safe and resilient transportation network along California's coastline that also protects and enhances coastal natural resources and public access.

As an initial and overall comment, we want to applaud this document and the important direction it sets on multiple policy issues. Coastal Commission staff specifically appreciate the acknowledgement that bold changes to San Diego's regional transportation network and compelling alternatives to driving alone are needed to meet greenhouse gas (GHG) emission targets. The Regional Plan will provide a key blueprint for reducing transportation air pollution and greenhouse gas emissions (GHGs), minimizing vehicle miles traveled (VMT), improving multi-modal transportation, addressing the need for greater equity in transportation systems, and enhancing the resiliency of our transportation network in the face of climate change, particularly with respect to sea level rise and our coastal highways. We primarily want to offer ourselves as a partner in this important work to carry forward the Regional Plan. In this letter, Commission staff would like to offer a few broad comments on how the Regional Plan could be modified to strengthen its consistency with the California Coastal Act.

***Consistency of the Regional Plan with the California Coastal Act***

Overall, the policies of the California Coastal Act that guide our work at the Coastal Commission significantly overlap with the goals of SANDAG's Regional Plan, including policies to protect marine and coastal land habitats, concentrate urban development, maximize public access and expand multi-modal transportation, reduce VMT, and improve coastal resiliency to sea level rise and other climate-change hazards. For example, Appendix B: Implementation Actions identifies eight 2035 goals drawn from the Regional Climate Action Planning Framework which generally align with the referenced Coastal Act policies:

- "High density, transit-oriented housing" aligns with the Coastal Act policy of focusing development in or near existing developed areas (Coastal Act Section 30250).
- "Conserve open space and agricultural lands" aligns with Coastal Act policies related to conservation of sensitive habitat, open space, and coastal agricultural lands (Coastal Act Sections 30230, 30231, 30233, 30241).

- "100% of new buses are zero-emission," "400,000+ electric cars on the road," "Sustainable freight (transitioning to zero emissions where feasible)," and "Up to 100% renewable electricity" aligns with the Coastal Act requirement that new development minimize energy consumption and VMT and be consistent with requirements imposed by an air pollution control district or the State Air Resources Board on each particular development (Coastal Act Section 30253).
- "Walkable and bikeable communities" aligns with Coastal Act policies promoting the protection, addition, and enhancement of public access (Coastal Act Sections 30210, 30212.5, 30252).

Appendix B additionally identifies strategies for the implementation of affordable housing, such as minimum zoning near transit, fee-waiver programs, and accessory dwelling units, which align with Coastal Act Sections 30213 (Lower Cost Overnight Accommodations) and 30013 (Environmental Justice). However, there are aspects of the Regional Plan that could be strengthened to be more consistent with the Coastal Act as described below.

### ***Implementation and Prioritization***

Consistent with Senate Bill (SB) 375, the California Air Resources Board (ARB) sets targets for reduction of GHG emissions from passenger vehicles for the target years 2020 and 2035, which Chapter 2, "Sustainable Communities Strategy," notes the Regional Plan will accomplish. However, as noted in the Regional Plan, Executive Order B-30-15, and California Senate Bill 32 (Pavley, 2016), set a further statewide goal of reducing California's GHG emissions to 40 percent below 1990 levels by 2030 and the Executive Order B-55-18 set a statewide goal of carbon neutrality by 2045. Recognizing the needs of all residents and visitors to the San Diego region, the Regional Plan rightfully includes improvements to all transportation modes, including roads and parking, but in order to meet or exceed the referenced GHG and climate goals, projects that improve public transit and active transportation to minimize VMT should be completed as quickly as possible, consistent with the Coastal Act (Section 30253). Additionally, active transportation projects that provide emission free transportation options and can be implemented relatively quickly should be prioritized, including completing segments of the California Coastal Trail and Coastal Rail Trail in the near-term (2025) rather than in future phases (2035 or 2050). Specifically, trail segments providing access to major employment centers that would relieve strain on coastal access corridors and that would help relieve congestion on Interstate 5, such as the segments connecting Carmel Valley to Roselle Canyon; Del Mar to Sorrento; and Roselle Canyon/UTC to Rose Canyon, should be prioritized for near-term construction. In general, Coastal Commission staff support greater proportions of investment in transit, active transportation, and environmental enhancement projects as compared to roadway improvements targeting single-occupant vehicles.

Finally, the Coastal Act (Section 30250) encourages new residential, commercial, or industrial development, to be located within, contiguous with, or in close proximity to, existing developed areas. Accordingly, the Regional Plan should prioritize transportation investments which encourage jobs and housing to be concentrated in developed areas and avoid further encroachment into habitat, farmland, and open space recreational areas by moving them forward to earlier construction phases.

### ***Public Access and Recreation – Emphasize and Fund the California Coastal Trail***

A pillar of the Coastal Act is the protection and provision of public access to and along the coast. Coastal Act Sections 30210 and 30212 require that maximum opportunities for public access and

recreation be provided in new development, consistent with public safety, private property rights, and natural resource protection. Additionally, Section 30252 dictates that new development should maintain and enhance public access through such actions as facilitating transit service, providing non-automobile options, and providing adequate parking.

Given that beaches and coastal resources are major destinations in the San Diego region, the Regional Plan should maximize access to the coast, including expanded investments in bicycle and pedestrian routes. The proposal to dedicate 55% of the anticipated \$163 billion in funding over the next 30 years to capital improvements to the transit system will improve public access to and along the coast, and is supported by Commission staff, but projects that specifically facilitate access to beaches and coastal areas from the inland portions of the region should be expedited, as well as options for enhancing connections to public transit, the California Coastal Trail (CCT), the Coastal Rail Trail, and other visitor-serving recreational opportunities. Implementation of the Regional Plan would make significant improvements to the regional bike network, most notably in terms of Class I corridors and in coastal communities that will enjoy enhanced coastal access as a result of these improvements. Coastal Commission staff support these improvements as well as further network and infrastructure enhancements for active transportation, such as widened sidewalks in areas without designated bike lanes, increased funding for bicycle parking and locker facilities, and bicycle-specific signaling integration on local arterials and feeder streets.

Coastal Commission staff acknowledge and appreciate the inclusion of updated information regarding the completeness and deficiencies in the San Diego region's portion of the California Coastal Trail in the 2021 Technical Addendum to Appendix W: California Coastal Trail. The addendum should also reference the recent work of the California Coastal Commission, California Department of Transportation, and Coastal Conservancy in developing an ArcGIS-based mapping tool that identifies all complete and incomplete segments of the Coastal Trail and classifies them according to trail type, identifies land ownership, and identifies features, such as individual stairways and pathways. The most recent update to the CCT mapping effort is outlined in the [California Coastal Commission Memorandum Re: California Coastal Trail Mapping Project, April 2021](#). In light of these improvements to the available data and SANDAG's identification of large portions of the CCT that are still in need of completion, a stronger emphasis on pedestrian and bicycle improvements necessary to complete the trail should be provided in Chapter 3 and a stronger and more specific funding commitment for the CCT should be provided in Appendix A: "Transportation Projects, Programs, and Phasing." Specifically, a portion of the funding identified for "Local Streets and Roads" (9% of the Regional Plan expenditures) should be allocated to funding the completion of the CCT.

Further, Commission staff encourage the integration of data related to weekend peak traffic in the planning phase of projects with potential impacts to congestion on major coastal access corridors used to access weekend recreation, such as Interstate 8, Interstate 5, and Pacific Coast Highway. Commission staff encourage SANDAG to implement enhanced transit alternatives where weekend coastal access will be significantly affected.

### ***Environmentally Sensitive Habitat Areas and Marine Resources***

Coastal Commission staff suggest that the Regional Plan include specific reference to Coastal Act Chapter 3 policies requiring the preservation of coastal resources, as well as specific language concerning the importance of protecting and restoring the region's urban canyons, coastlines, beaches, and water resources. Transportation corridors within the San Diego region bisect or are located directly

adjacent to sensitive marine resources including coastal bluffs, streams, lagoons, and the Pacific Ocean. Many of these coastal systems have already been impacted by historical transportation infrastructure development and additional impacts to these resources are restricted by Coastal Act policies. Except for certain specific instances, fill of a wetland or other coastal waters is prohibited (Section 30233), and the marine resources (Section 30230), water quality (Section 30231), and environmentally sensitive habitat areas (Section 30240) often associated with the coastal environment are also protected.

### ***Planning for Climate Change and Sea Level Rise***

In addition to requiring new development to minimize VMT, Coastal Act Section 30253 requires that new development minimize risks to life and property from hazards and assure stability and structural integrity without the use of a shoreline protective device. Understanding the potential impacts of climate change and sea level rise (SLR) is of critical importance when beginning long-range planning efforts and evaluating projects that may be at risk from coastal hazards. Given the proximity of key regional infrastructure to the coast, it is imperative that transportation and land use plans carefully anticipate the effects of SLR and associated hazards. Ensuring that new coastal infrastructure is designed to adapt to the effects of SLR throughout the expected life of the infrastructure is a principal concern of the Coastal Commission, as clarified through the [Commission's Sea Level Rise Policy Guidance](#), which was most recently updated in November 2018, and through recent local government vulnerability assessments and planning efforts related to climate change. In recognition of the importance of this subject, many state directives, guidance documents, and regional planning documents have called for SLR to be included in planning processes.

- [Safeguarding California](#) (2018), the state's climate adaptation strategy, recognizes that "Climate change impacts from SLR to storm surge and coastal erosion are imminent threats to highways, roads, bridge supports, airports at or near sea level, seaports, and some transit system and rail lines" (page 118) and calls for vulnerability assessments and adaptation planning at various scales.
- The State Ocean Protection Council (OPC) stated in its [2018 Sea Level Rise Guidance](#) document that "California has an immediate opportunity to make smart, informed, and risk-based decisions that prepare our coastal and inland communities for change while ingraining sustainability, longevity, and resiliency into our planning, permitting, investment, development, transportation, and recreational decisions." The document provides guidance and guiding principles for SLR planning work. Although the Regional Plan references the potential for 2.5 ft of SLR by 2050 and 6.6 ft of SLR by 2100, OPC's guidance recommends, and Commission staff agrees, that the H++ scenario should be considered for projects with a lifespan beyond 2050 that have a low tolerance for risk, such as major infrastructure investments, and that could result in threats to public health and safety, natural resources and critical infrastructure, should extreme sea-level rise occur. By 2100, the H++ scenario is 10.2 ft of SLR.
- The [California Transportation Plan 2050](#) calls for sea level rise adaptation planning, notably stating that: "As our population grows to nearly 45 million by 2050, providing high-quality infrastructure also means adapting assets to accommodate changing demand, and leveling the playing field for active transportation, rail, transit, and shared modes. Our infrastructure must also be resilient to the impacts of earthquakes, extreme temperatures, fires, sea level rise, and pandemics" (page 79). It includes a recommendation: "The CTP 2050 calls for expanded

funding for implementing state, local, and regional climate mitigation and adaptation plans, such as the Caltrans District Vulnerability Assessments; increasing multi-jurisdictional collaboration on resiliency and adaptation efforts; creating a statewide transportation risk management plan; and increasing access to data, technical tools, and information sharing to make communities stronger and more resilient to future disruptions” (page 112).

- The [2018 California State Rail Plan](#) calls for similar implementation efforts, noting that “Coastal rail corridors are commonly the first, or second, line of development adjacent to the sea, particularly in central and southern California. If reactive, emergency-based hard-armoring measures are constructed to protect corridors in place, beach loss may result. Thoughtful, long-term adaptation planning for sea-level rise is necessary to identify alternatives, including relocation of corridors where opportunities to do so exist, that would protect transportation corridors as well as California’s popular beaches and other coastal resources” (page 224). The Plan highlights segments of rail in San Diego, including along the Del Mar bluffs, which are at risk from sea level rise.
- Finally, Caltrans highlighted the importance of planning for sea level rise in its [2017 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations](#).

The Regional Plan should include increased funding to adapt and/or relocate existing transportation infrastructure known to be vulnerable to climate change and sea level rise (e.g., Pacific Coast Highway and the rail corridor along Del Mar bluffs). New infrastructure proposed to be funded should be analyzed not only for vulnerability to H++ projections of SLR over the expected life of the proposed project, but also tidal and fluvial hydraulics as applied to the local area and in the context of storm surge, wave run-up, erosion, and other variables. Projects which reduce vulnerability to climate change and sea level rise (e.g., active transportation projects and relocation of the rail corridor from coastal bluffs) should be prioritized and expedited.

### ***Environmental Justice and Social Equity***

The Coastal Act was also recently amended to add Environmental Justice as a policy to be analyzed in our regulatory work, and to add a designated Environmental Justice commissioner on the Coastal Commission. Accordingly, although we applaud the Regional Plan’s focus on equity and recognize the need to generate revenue for implementation, Commission staff urge SANDAG to carefully analyze the equity implications of the Regional Pricing Strategy, including ensuring that dynamic tolling on managed lanes, parking and curb pricing, and road user charges do not regressively impact low-income community members who may not be able to afford to live in transit-oriented neighborhoods.

Further, the Regional Plan should utilize access to coastal recreation as a metric with which to measure the efficacy of its Environmental Justice programs. This should be accomplished by comparing travel times to coastal resources (e.g., the nearest usable beach) in communities of concern to travel times in other nearby communities. Transit programs should be designed to reduce these travel times and close gaps between communities to achieve equitable coastal access across the San Diego region, consistent with Coastal Act Section 30252.

### ***Railroad Corridor at Del Mar Bluffs***

Previous Regional Transportation Plans and the North Coast Corridor Public Works Plan / Transportation and Resource Enhancement Program (NCC PWP/TREP) have referenced the need for

relocation of the rail corridor that passes along the Del Mar bluffs to an inland alignment. Erosion due to wave action currently threatens the toe of the Del Mar bluffs and the stability of the railroad tracks at the top of the bluffs. Given that this segment of the LOSSAN rail corridor is already experiencing periodic bluff failures, which will only be exacerbated as sea level rise continues, Coastal Commission staff support relocation of the rail corridor and completion of double tracking as quickly as possible. The Coastal Commission has authorized a series of improvements to existing shoreline protection devices in Del Mar to maintain continued rail operations, including the most recent Consistency Certification No. CC-0004-18 in February 2019 and CC-0001-20 in August 2020; however, these projects are intended to serve as interim measures only. Although these types of repair and maintenance projects may be necessary in the short-term, they should not delay the planning efforts associated with a long-term solution, including identifying a preferred tunnel alignment and allocating funding to initiate environmental review of the rail corridor relocation project. If we continue to rely on reactive, hard-armoring measures to protect the rail corridor in place, we will lose our coastal beaches in the face of anticipated sea level rise at Del Mar and elsewhere. Therefore, Coastal Commission staff request that the Del Mar tunnel project be prioritized further by being moved to the five-year capital project list. This would allow double tracking to occur sooner, improving coastal access by sustainable modes of transportation while protecting the Del Mar bluffs, a vital visual and habitat resource for the San Diego region.

#### ***Enhanced Rail Service and the California State Rail Plan***

The Coastal Commission has previously approved transportation projects and programs that balance roadway expansion with the provision of transportation alternatives including railway enhancements, bicycle corridors, and pedestrian accessways (e.g., the North Coast Corridor Public Works Plan/Transportation and Resource Enhancement Program). In actions throughout California, the Coastal Commission has found that projects supporting alternative modes of transportation, particularly enhanced rail service, are consistent with Coastal Act policies requiring maximum public access and a reduction in VMT (Coastal Act Sections 30210 and 30253). The Regional Plan proposes funding for high-frequency transit services that incorporate new transit modes and improve existing services. Commission staff supports the vision for vastly improved regional and inter-regional bus and rail corridors, which will offer alternatives to driving and alternatives to roadway expansion in environmentally sensitive areas.

The California State Transportation Agency's Transit and Intercity Rail Capital Program (TIRCP) (2015) emphasizes the objective of "Expand[ing] and improv[ing] transit service to increase ridership." In 2020, the TIRCP allocated over \$38 million to capital improvements to the LOSSAN corridor, including new maintenance facilities that will allow for longer trains and more frequent and reliable service on the corridor. The Draft 2018 California State Rail Plan website states: "Californians collectively take billions of trips to millions of destinations each year, and the state needs quality modal choices among cars, transit, air travel, and active transportation to efficiently move people and freight to their destinations." Coastal Commission staff support the expansion of San Diego's commuter rail network and the double tracking of the LOSSAN corridor funded by the Regional Plan, in addition to other infrastructure improvements that encourage faster and more frequent intercity and intracity rail service such as those identified in the TIRCP.

#### ***Central Mobility Hub***

In previous comment letters, Coastal Commission staff have expressed support for the development of an intermodal transit station along the existing rail corridor to provide visitors with direct connections



to Amtrak, COASTER, Trolley, bus services, and the southern terminus for the proposed high-speed train service. The acquisition of land for the Central Mobility Hub and the completion of the automated people mover airport connection in 2035 (Pages A-17 and A-18, Appendix A) will significantly improve alternative access to the airport, thereby reducing the anticipated traffic impacts associated with redevelopment of Terminal 1 on North Harbor Drive, a major coastal accessway. Please note that Coastal Commission staff request to be included in future planning efforts related to the Central Mobility Hub, as well as the associated transportation infrastructure projects (e.g., automated people mover).

***Pacific Beach Trolley Extension and Streetcar***

Finally, the 2019 Draft Federal Regional Transportation Plan identified a trolley extension from Pacific Beach to the El Cajon Transit Center and a streetcar from Mission Beach to La Jolla via Pacific Beach slated for completion by 2050 (Table A.2, Appendix A). Neither of these projects is identified in the 2021 Draft Regional Plan. The popular beach community of Pacific Beach is already heavily impacted by parking and traffic congestion, which will be exacerbated in the future by redevelopment with increased density and the elimination of parking requirements by the City of San Diego for certain developments located near transit. Coastal Commission staff request the re-inclusion of these projects in the Regional Plan, as the transportation improvements identified for Pacific Beach in the 2021 Regional Plan leave large portions of the community without robust alternatives to single-occupant vehicle travel and increasingly strained access to parking, inconsistent with Sections 30212 and 30212.5 of the Coastal Act.

In general, Coastal Commission staff support improvements to transit alternatives that provide access to coastal areas and recreation. Significant gaps in the regional bus network improvements laid out in the Regional Plan exist in the coastal communities of Encinitas, Solana Beach, La Jolla, Pacific Beach, Mission Beach, and Ocean Beach, whereas other coastal communities are slated to enjoy more robust transit improvements. As such, Coastal Commission staff encourage SANDAG to analyze and prioritize transit improvements that improve coastal access in these communities, and particularly improvements that provide these communities with meaningful alternatives to single-occupant vehicles to access the nearby beaches and recreational areas.

Thank you again for the commitment to a bold new transportation vision for the 2021 Draft Regional Plan and for your ongoing work on other elements of San Diego Forward. We look forward to future collaboration and improvements to the transportation system in the San Diego region. If you have questions or ideas for collaboration, please do not hesitate to contact me at the Coastal Commission's San Diego Coast District office.

Sincerely,  
Trevor Hill  
Transportation Program Analyst

cc: Tami Grove, Statewide Development and Transportation Program Manager, CCC  
Karl Schwing, District Director, San Diego Coast District, CCC  
Diana Lily, District Manager, San Diego Coast District, CCC  
Deborah Lee, District Manager, San Diego Coast District, CCC  
Kanani Leslie, Coastal Program Manager, San Diego Coast District, CCC  
Shannon Fiala, Coastal Program Manager, Southern California, CCC

# Memorandum

*Making Conservation  
a California Way of Life.*

**To:** Tessa Lero  
Caltrans - District 8

**Date:** August 6, 2021

**From:** MEHEDI CHOWDHURY  
Division of Transportation Planning  
Office of State Planning, Equity and Engagement

**Subject:** **SAN DIEGO FORWARD DRAFT 2021 REGIONAL TRANSPORTATION PLAN (RTP)  
AND SUSTAINABLE COMMUNITIES STRATEGY (SCS)**

Thank you for the opportunity to review and provide comments on the 2021 Regional Plan/ Sustainable Communities Strategy. OSPEE would like to offer the following comments for your consideration:

**“A Bold New Vision for the 2021 Regional Plan”:**

- With development concentrated at the coastal region, has the scientists' estimates of a 2.5 sea level rise been taken into account for development in this area? (pdf page 9)
- There was a brief mention of the California Transportation Plan 2050 (CTP 2050) in the bulleted list on Page 14. As the State of California's transportation roadmap, it might be pertinent to demonstrate with a few sentences as to how the 2021 Regional Plan meets or aligns with the CTP 2050's Recommendations on Page 6 of the Executive Summary of the CTP 2050 document. Here is language that could be potentially used:
  - Senate Bill 391 (SB 391, 2009) required the California Department of Transportation to prepare the California Transportation Plan (CTP), a statewide to reduce GHG emissions. This system laid out in the CTP 2050 showed reductions in GHG emissions to 1990 levels from current levels by 2020, and 80 percent below the 1990 levels by 2050 as described by AB 32 and Executive Order S-03-05. The CTP 2050 demonstrates how major metropolitan areas, rural areas, and state agencies can coordinate planning efforts to achieve critical statewide goals. SANDAG will work to align with the goals, policies, strategies, and recommendations laid out in the CTP 2050 where applicable.
- Pages 14 and 15 feel a bit out of place and seems like it would be better places after the Table of Contents that is present in the “Forward” section, rather than being right before Chapter 2. The chapter list of Page 15 is essentially the same as the Table of Contents so keeping the nice graphics with the same overview/summary would be good, while having the actual TOC have subsections within the chapters listed, with their corresponding pages as well (5 Big Moves, etc).

**Sustainable Communities Strategy:**

- It may be beneficial to mention how these goals will contribute to California's overall State goal of reducing GHGs, with a mention of AB 32's goal of lowering statewide GHG emissions 80%

below 1990 levels by 2050 as well as SB 32's mid-point goal of lowering statewide GHG emissions 40% below 1990 levels by 2030. Disregard if this was mentioned but overlooked by the reviewer.

**General Comments:**

- On Page 44: "The 2015 update of the regional plan was projected to cost \$130 billion in 2020 dollars. The 2021 Regional Plan is projected to cost \$163 billion. Why the higher cost? As we have detailed in Chapters 1 and 2, the 2021, the Regional Plan completely reimagines our transportation system—". While the 2015 may also be assumed to have taken bold steps to *reimagine the transportation system*, it might be ideal to refer to the appropriate technical Appendix as to why a newer, updated approach is costing \$33 billion more six years later.
- Overall a very good and thorough plan, would just mention of alignment with the CTP 2050.

## California Department of Transportation

DISTRICT 11  
4050 TAYLOR STREET, MS-240  
SAN DIEGO, CA 92110  
(619) 688-6681 | FAX (619) 688-4299 TTY 711  
[www.dot.ca.gov](http://www.dot.ca.gov)



August 6, 2021

Mr. Hasan Ikhata  
Executive Director  
San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92191

Dear Mr. Ikhata:

The California Department of Transportation (Caltrans) appreciates the opportunity to review the San Diego Association of Governments (SANDAG) San Diego Forward: The 2021 Regional Plan including its Sustainable Communities Strategy (SCS) and air quality conformity analysis.

The 2021 Regional Plan presents a data-driven, bold vision that will redefine how people and goods move around the San Diego region. Caltrans, as the owner and operator of the State Highway System, will work in coordination with SANDAG to deliver a world class transportation network that serves all people and respects the environment. It is our seamless partnership that continues to make the region competitive for federal and state funding.

The 2021 Regional Plan will help our region and our state achieve shared goals to provide mobility choices that advance equity and reduce pollution, boost our economy, and make our transportation system accessible for all. SANDAG and Caltrans are currently developing Comprehensive Multimodal Corridor Plans that with input from the public, will further identify and evaluate projects and strategies within transportation corridors defined in the 2021 Regional Plan. Additional refinements to individual corridor project scopes, costs and schedules will be made as these projects are studied under CEQA and NEPA, including any legislative changes needed for the implementation of those projects.

To receive federal transportation funds, SANDAG is required by federal and state law to develop a comprehensive, 20+ year vision of a balanced, multimodal transportation system. A regional plan must be updated at least every four years and allows the region to confirm the transportation plan's validity and consistency with current and forecasted transportation and land use conditions and trends.

Mr. Hasan Ikhata, Executive Director

August 6, 2021

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Caltrans has reviewed the 2021 Regional Plan and found that it has fulfilled all the requirements of the Caltrans 2017 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations pursuant to California Government Code Section 14522. Caltrans offers the following comments:

Climate Action and the Multimodal Network topics

Transportation is the largest source of greenhouse gas (GHG) emissions in the San Diego region; in 2016, on-road light-duty vehicles accounted for 41% of emissions. One strategy to reduce emissions is to reduce Vehicle Miles Traveled (VMT). The Regional Housing Needs Allocation Plan informed development of the SCS land use pattern, and the region's major employment centers and urban core mobility hubs are expected to take on the most housing and job growth in the region over the next 30 years. It is anticipated this development pattern will support VMT reduction from light-duty vehicles by balancing the ratio of jobs to housing land uses. Additionally, the 2021 Regional Plan proposes expansion of the regional transit network such that thirty-minute transit access from mobility hubs to Tier 1 employment centers increases from 13% to 28% for communities of color and increases from 16% to 33% for residents with low incomes by 2050. This improvement will provide important access to economic opportunities to these communities while incentivizing mode shift.

Caltrans supports SANDAG's embrace of new and improved mobility management strategies such as developing a smart intersection system, a comprehensive system to manage cross-border trips, and real-time traffic management solutions (including dynamic truck parking) to manage many modes of transportation, including freight movement.

We encourage SANDAG to continue efforts on a recently funded grant to develop a Sustainable Freight Implementation Strategy. This work will help the region execute a road map for a more efficient, economically competitive, and sustainable freight transportation system, establish a framework to transition to a clean freight system, reduce pollution exposure to environmental justice communities, and help implement state sustainable freight efforts such as the California Sustainable Freight Action Plan, the California Freight Mobility Plan, Governor Gavin Newsom's "Zero-Emission by 2035" Executive Order (N-79-20), and Assembly Bill 617 (C. Garcia, 2017) Community Emission Reduction Program.

Caltrans supports consideration and the development of new mechanisms for viable VMT mitigation options for highway capacity projects, such as exploring statewide and regional VMT mitigation bank concepts and evaluating feasibility and exploring potential expansion of an Advanced Mitigation Program to include GHG/VMT mitigation.

As the 2021 Regional Plan looks to develop performance measures, analyze, and address congestion, please consider presenting data about how travel, delay, and transit use will evolve with the implementation of the plan.

#### Equity and Livability topics

Caltrans is encouraged by the investments outlined in SANDAG's Supporting Policies and Programs. These investments will support programs that complement the capital and operational investments of the transportation system, encourage sustainable growth and development, and implement innovative demand strategies. Please consider inclusion of a program for Highways to Boulevards Conversion or freeway cap/lid/decks to create new park space, housing, or community amenities to help restore and revitalize communities. Proposed locations will be discussed and determined in the future.

Please consider including in the listing of transportation projects, programs, and phasing the San Diego- Coronado Bridge Suicide Prevention Barrier Project. The Coronado Bridge has the highest concentration of death by suicide for a spot location on the state highway system. Without mention in the regional plan, the project may not be able to compete for state or federal funding.

The 2021 Regional Plan illustrates that in addition to Major Corridors, there are several rural corridors primarily in the eastern two-thirds of the region that provide access and connectivity for rural towns and lands to the interstate system. These roadways are to be improved with a focus on safety through shoulder widening, curve straightening, and technology features, such as active transportation and demand management and smart intersections.

Caltrans recognizes the rural areas of our region play a vital role in California's economy. Rural communities are often also the gateway to the state's preserved landscapes that are central to supporting California's tourism industry. Yet, rural communities are already experiencing the impacts of a changing climate— from unprecedented storms to devastating wildfires. While transportation goals are inherently and fundamentally the same no matter the context— to provide safe access to destinations for people and goods - unique local and regional conditions require tailored solutions to advance these goals, and solutions may look different in varying local contexts.

Please consider including additional examples of sustainable transportation solutions that could be applied in rural settings, understanding that these efforts will require collaboration with the local and Tribal governments that serve the locations, such as:



Mr. Hasan Ikhata, Executive Director

August 6, 2021

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- Increasing transit service in a corridor through investments in bus service, vanpools, micro-transit or mobility on demand services, and park-and-ride facilities.
- Roadside land management activities related to wildfire.
- Addressing safety through the multidisciplinary Safe System Approach that employ tools for speed management, such as road diets, conversion of intersections to roundabouts, and signal coordination to slow speeds.
- Improving efforts on coordination for broadband access in transportation and growth, remote work/VMT reduction, economic development, and regional housing strategies. Broadband access remains a critical issue in rural communities and with many Tribal nations.
- Adding and improving connected facilities for walking and bicycling and for first/last-mile connections to local, interregional, and regional transit routes. Rural cores should support walking and biking on commercial corridors and main streets.
- Prioritizing connections to natural areas; Tribal communities may desire access to ceremonial sites outside of the rural core.
- Facilitating emergency evacuations through efficient traffic management strategies, such as the use of contra flow, use of two-way left turn lanes as through travel lanes, construction of full structural sections of shoulders and installation of transportation management systems (TMS) elements, such as closed circuit television (CCTV) cameras, changeable message signs (CMS), and traffic detection equipment.
- Deploying zero-emission vehicle charging or fueling infrastructure—including for battery electric, fuel cell (hydrogen) electric, and other zero-emission vehicle technologies.

Caltrans thanks SANDAG for its leadership and the vision laid out in 2021 Regional Plan. We look forward to working side-by-side in making the San Diego region a place for residents, visitors, and businesses to thrive.

Sincerely,



ANN M. FOX  
Deputy District Director  
Planning and Local Assistance

C: Brenda Caruso, Acting Branch Chief, Office of Regional Coordination, Caltrans Headquarters  
Gilbert Valencia, Assoc. Trans. Planner, Office of Regional Coordination, Caltrans Headquarters  
Seth Cutter, Senior Transportation Planner, Caltrans District 11

August 6, 2021

SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

### **Comments of the Center for Sustainable Energy® regarding SANDAG's Draft 2021 Regional Plan**

The Center for Sustainable Energy® (CSE; [www.energycenter.org](http://www.energycenter.org)) is pleased to provide comments regarding SANDAG's Draft 2021 Regional Plan. CSE commends SANDAG's efforts in developing a comprehensive and holistic vision for the future of transportation in the San Diego region. CSE encourages SANDAG to adopt the Regional Plan and continue collaborating with regional entities to implement clean technology programs that encourage electrification, prioritize equity, and enhance climate action planning.

CSE is a 25-year-old national nonprofit with a single word mission: Decarbonize. We provide program administration, technical assistance, and policy advisement services to a diverse set of stakeholders across the clean energy and transportation sector. As a nonprofit without members or donors, CSE serves as a trusted resource helping government agencies implement successful technology programs that use funds in the best interest of consumers, ratepayers, and the general public.

CSE provides these comments based on our experience designing, implementing, and evaluating statewide electric vehicle (EV) and EV infrastructure incentive programs across multiple jurisdictions. In the San Diego region, CSE is pleased to work with SANDAG on the administration of numerous programs, including the San Diego County Incentive Project under the California Electric Vehicle Infrastructure Project (CALeVIP).

In response to the Draft 2021 Regional Plan, CSE offers the following recommendations:

- Leverage the Mobility Hubs concept to showcase clean energy and transportation technologies;
- Continue to support regional coordination through SANDAG's Energy Working Group and Regional Plan Social Equity Working Group by sharing best practices regarding climate action planning, operationalizing equity, and emergency planning; and
- Ensure that the Next OS platform includes data on EV infrastructure availability and transportation emissions impacts and compiles platform insights onto public-facing dashboards.

CSE's recommendations are discussed in detail below.

### **Leverage the Mobility Hubs concept to showcase clean energy and transportation technologies**

CSE supports SANDAG's proposed Mobility Hubs concept to provide integrated transportation solutions. CSE recommends that SANDAG utilize these Mobility Hubs to showcase a variety of clean energy and transportation technologies. Specifically, Mobility Hubs could raise awareness of zero-emission transportation alternatives, including EVs and zero-emission buses. Additionally, the mere presence of visible public charging infrastructure can influence consumers' willingness to pay for an EV by up to \$5,000.<sup>1</sup> CSE also recommends that additional clean energy technologies be integrated into the Mobility Hubs. For example, EV chargers could be coupled with solar panels and battery storage systems to provide greater utilization of clean electricity. To expand this concept even further, CSE encourages SANDAG to consider deploying microgrids in conjunction with Mobility Hubs. Microgrids can further integrate these technologies to provide additional emissions reductions, while also managing grid impacts and providing resiliency benefits during extreme weather events. Through islanding capabilities, microgrids would enable Mobility Hubs to continue to charge electric fleets during electric grid outages, further alleviating consumers' concerns about all-electric transportation options.

### **Continue to support regional coordination through SANDAG's Energy Working Group and Regional Plan Social Equity Working Group by sharing best practices regarding climate action planning, operationalizing equity, and emergency planning**

CSE is pleased to participate in SANDAG's Energy Working Group (EWG) and strongly supports the EWG's role in coordinating regional climate action planning, particularly through the use of analytical tools such as the Regional Climate Action Planning Framework (ReCAP).<sup>2</sup> CSE encourages SANDAG to continue this work by periodically sharing best practices on climate action planning. For example, CSE suggests that the release of the ReCAP Snapshots be accompanied by targeted policy recommendations for local jurisdictions. Additionally, the EWG is an effective venue for sharing best practices on local climate equity planning initiatives, such as the Climate Equity Index reports prepared by the Cities of San Diego<sup>3</sup> and Chula Vista,<sup>4</sup> and applying these "lessons learned" on a broader regional scale. CSE also recommends SANDAG engage its Regional Plan Social Equity Working Group (WG) to gather feedback and recommendations on how to operationalize equity throughout the agency, using the Regional Plan as a starting point. Lastly, CSE recommends that the EWG and the Social Equity WG seek to collaborate with emergency planning and land use officials from state, regional, and local agencies, who are often not involved in conventional climate action planning activities. This type of information-sharing and collaborative planning across agencies and departments will be critical to mitigate the impacts of extreme weather events including heat

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<sup>1</sup>Jensen, F.A, Cherchi, E., and Mabit, S.L., On the Stability of Preferences and Attitudes before and after Experiencing an Electric Vehicle.

<https://doi.org/10.1016/j.trd.2013.07.006>

<sup>2</sup> SANDAG. Climate Action.

<https://www.sandag.org/index.asp?classid=17&subclassid=46&projectid=565&fuseaction=projects.detail>

<sup>3</sup> City of San Diego. San Diego's Climate Equity Index Report.

[https://www.sandiego.gov/sites/default/files/2019\\_climate\\_equity\\_index\\_report.pdf](https://www.sandiego.gov/sites/default/files/2019_climate_equity_index_report.pdf)

<sup>4</sup> City of Chula Vista. Draft Chula Vista Climate Equity Framework.

<https://www.chulavistaca.gov/home/showpublisheddocument?id=22124>

waves, wildfires, and droughts, which are expected to continue to increase in frequency and severity.

**Ensure that the Next OS platform includes data on EV infrastructure availability and transportation emissions impacts and compiles platform insights onto public-facing dashboards**

CSE supports the development of SANDAG's proposed Next OS platform to incorporate transportation data and streamline individuals' travel patterns. CSE offers a number of recommendations to integrate EVs into this platform and facilitate better understanding of travel behavior and associated emissions impacts.

First, CSE recommends that SANDAG include data on EV infrastructure locations and availability in the Next OS platform. Lack of access to EV charging is often cited as one of the largest barriers preventing consumers from purchasing EVs. Even EV owners often experience difficulty finding a public EV charger given the number of EV service providers (EVSPs) with proprietary software applications. Additionally, CSE encourages SANDAG to consider integrating information regarding EV charger availability to prevent queues from developing at these sites. While some EVSPs have added waitlist functionalities into their software,<sup>5</sup> there is no uniform approach to addressing this challenge. By integrating these factors into the Next OS platform, SANDAG can support current and prospective EV owners and further promote electrified transportation.

Second, CSE recommends incorporating greenhouse gas (GHG) emissions data into the Next OS platform in order to provide individuals with information regarding the estimated emissions intensity of various transportation modes. For example, an individual could use the Next OS platform to choose between taking transit or requesting ride-hailing services, considering the emissions associated with each mode and making their decision based off of this information. Similarly, the platform could compare the emissions intensity of various options within a specified mode of travel. For example, an individual choosing to use ride-hailing services could assess the emissions impacts of single-occupancy vehicle trips versus pooled trips or the difference between rides in an EV versus in an internal combustion engine vehicle. This functionality could increase public awareness of emissions impacts and encourage greater utilization of clean transportation options.

Third, CSE recommends that the key analytical insights obtained through the Next OS platform be compiled and highlighted on public dashboards, either on the platform itself or on SANDAG's website. By its nature, the Next OS platform will collect significant levels of data on individual travel patterns and preferences. Analyzing this data will yield key insights that can further inform regional planning and policymaking. Additionally, highlighting these insights through dashboards and visualizations, and thereby making this data accessible and understandable to the general public, will also enable individuals to better understand their transportation options and impacts. These dashboards should be made available in multiple languages and should be updated at regular intervals.

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<sup>5</sup> ChargePoint. Waitlist.

<https://www.chargepoint.com/products/waitlist/>

## Conclusion

CSE appreciates the opportunity to provide these comments in support of SANDAG's Draft 2021 Regional Plan. We look forward to continued collaboration with SANDAG and other stakeholders in advancing clean transportation and emission reduction goals within the San Diego region.

Sincerely,



Raghav Murali  
Senior Director of Policy and General Counsel  
Center for Sustainable Energy®  
3980 Sherman St., Suite 170  
San Diego, CA 92110  
Tel: (858) 935-4826  
[raghav.murali@energycenter.org](mailto:raghav.murali@energycenter.org)

Kinshuk Chatterjee  
Transportation Policy Analyst  
Center for Sustainable Energy®  
3980 Sherman St., Suite 170  
San Diego, CA 92110  
Tel: (858) 244-1177  
[kinshuk.chatterjee@energycenter.org](mailto:kinshuk.chatterjee@energycenter.org)



August 5, 2021

Mr. Hasan Ikharata  
SANDAG, Executive Director  
401 B St, Suite 800  
San Diego, CA 92101

**Re: Support incorporating *Reconnect Logan, 5 Freeway Lid Project* in the San Diego Association of Governments' (SANDAG) 2021 Regional Plan**

Dear Mr. Ikharata,

My name is Josephine S. Talamantez and my family have been Logan Heights residents since 1906 and the CPMCC have been in the area for 6 years. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities. **Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan (Draft Plan)**

Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know *ReConnect Logan Freeway Lid* will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.

As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.

Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out *ReConnect Logan Freeway Lid* as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:

- The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)



# CHICANO PARK MUSEUM

- Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)
- Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)

Besides being in line with the 2021 Draft Regional Plan, *ReConnect Logan Freeway Lid* is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to **the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.**

If you have any questions, you may contact me at [jstalamantez@gmail.com](mailto:jstalamantez@gmail.com).

Sincerely,



Josephine S. Talamantez  
Board Chair  
(916)847-4569  
PO Box 131128  
San Diego, Ca. 92170



July 21, 2021

Supervisor Nora Vargas,  
Chair, Transportation Committee  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

Dear Transportation Committee Chair Nora E. Vargas,

Chollas Creek Coalition requests SANDAG include Chollas Creek Regional Park active transportation and recreational facilities in the 2021 update of the San Diego Forward Regional Transportation Plan (RTP).

Environmental Justice communities located along the Chollas Creek Watershed have been historically under-invested in and residents are predominantly lower-income people of color with higher-rates of health issues resulting from over-pollution and inequitable access to economic opportunity. These communities bisected by freeways do not have safe mobility connections for people to get around without a car.

The future Chollas Creek Regional Park **included in the 2021 draft of the City of San Diego's Parks Master Plan** has approximately 8 miles of parks, trails, recreational amenities, trees, bikeways and stormwater infrastructure improvements along the north and south forks of the Chollas Creek in need of planning and funding. This trail system once completed would connect City Heights, Southeast San Diego and the communities in between all the way to Barrio Logan and the employment centers along the San Diego Bay.

SANDAG has a once in generation opportunity to make a meaningful investment in the many communities along the Chollas Creek by including the Chollas Creek Regional Park and associated bikeway projects in the RTP. These critical active transportation connections to improve community health, resiliency to climate change and link housing to jobs are many decades over-due. We urge SANDAG to invest in the project to advance equity, climate justice and a historic win for communities who have been ignored for far too long.

Regards,

Chollas Creek Coalition

cc: Hasan Ikhata, Executive Director, SANDAG, [hasan.ikhata@sandag.org](mailto:hasan.ikhata@sandag.org)

Coleen Clementson, Director of Regional Planning, [coleen.clementson@sandag.org](mailto:coleen.clementson@sandag.org)

**Members Affiliated With:**

- Bayview Community Development Corporation • Bike San Diego • Chollas Valley Planning Group • City Heights Area Planning Group • City Heights Community Development Corporation
- City of San Diego Parks and Recreation Board • Climate Action Campaign • Eastern Area Planning Group • Emerald Hills Neighborhood Council • Environmental Health Coalition
- Groundwork San Diego • Oak Park Community Council • Outdoor Outreach • San Diego Canyonlands • San Diego Coastkeeper • San Diego County Bicycle Coalition • Sierra Club
- Southeastern San Diego Planning Group • Webster Community Council



August 4<sup>th</sup> 2021

Dear SANDAG Board & Staff,

We appreciate your efforts to facilitate opportunities for community engagement through the 2021 Regional Plan by hosting open house forums, public hearings, and online public comment. The City Heights Built Environment Team is a community group who wants to see a dignified, equitable, efficient and affordable transportation system in our region.

These are the top priorities our group has identified and would like to see implemented in the 2021 Regional Plan:

- Greater transit frequencies (7 min on peak, and 10 mins all day) in Transit Priority Areas; Collaborate with the Built Environment Team on a Pilot Program to identify and test high ridership routes in City Heights
- Late night and weekend service improvements with 24-hour service on major routes
- Supporting the Purple Line alignment through central City Heights
- Bikeways on major corridors with implementation of Early Action Projects in Mid-City by 2023
- Implementing traffic-calming measures including but not limited to: protected bike lanes, roundabouts, raised crossings to improve to ensure a safer biking experience
- Planting more trees throughout City Heights to foster a healthier urban environment
- Ensuring Youth Opportunity Passes for those aged 24 and under by 2023
- Oppose freeway expansions in City Heights that increase Vehicle Miles Traveled while supporting general purpose lane conversions that prioritize transit
- Improve multimodal beach access for urban-core communities
- Plan and implement Bus Rapid Transit Route 550 on 54<sup>th</sup> St. to be phased for 2025
- Improve and exceed State of California standards for GHG reduction goals
- Maintain transparency with community members by sharing relevant data and progress updates surrounding project phasing, implementation, and funding

We believe these priorities will help build a dignified, equitable, and affordable transportation system in our region.

Sincerely,

Maria Cortez  
Vincent Rivera  
Jair Cortes  
Esperanza Gonzales  
Roddy Jerome  
Marco Montiel

Edwin Lohr  
Bernadette Winter-Villaluz  
Erik Winter-Villaluz  
Cynthia Nguyen  
Guillermina Rice  
Vianney Ruvalcaba

Anastasia Brewster  
Haneen Mohamed  
Stephanie Hernandez  
Randy Torres-Van Vleck



Sept. 30, 2021

San Diego Association of Governments  
401 B street, Suite 800  
San Diego, CA 92101  
Via: [SDForward@sandag.org](mailto:SDForward@sandag.org)

**RE: City of Carlsbad Comments on Draft 2021 Regional Plan**

To whom it may concern,

This letter serves to inform SANDAG that the City does not wish to remove project CB32 from the Regional Arterials Project list.

Please disregard the comment regarding project CB32 from the attached letter sent to SANDAG on Aug. 6, 2021.

Thank you for bringing this to our attention, and please contact me if you have any other questions regarding the 2021 Regional Plan comment letter.

Best Regards,

A handwritten signature in blue ink, appearing to read "Tom Frank".

Tom Frank, PE  
Transportation Director/City Engineer

Attachment A: Letter to SANDAG dated Aug. 6, 2021

cc: Scott Chadwick, City Manager  
Celia Brewer, City Attorney  
Geoff Patnoe, Assistant City Manager  
Ron Kemp, Assistant City Attorney  
Robby Contreras, Assistant City Attorney  
Gary Barberio, Deputy City Manager, Community Services  
Paz Gomez, Deputy City Manager, Public works  
Mike Strong, Assistant Director, Community Development

**Public Works Branch – Transportation Department**  
1635 Faraday Avenue | Carlsbad, CA 92008 | 760-602-2766



cc: Don Neu, City Planner  
Nathan Schmidt, Transportation Planning and Mobility Manager  
Jason Geldert, Engineering Manager  
Eric Lardy, Principal Planner  
Scott Donnell, Senior Planner  
Corey Funk, Associate Planner





Aug. 6, 2021

San Diego Association of Governments  
401 B Street, Suite 800  
San Diego CA 92101  
Via: [SDForward@sandag.org](mailto:SDForward@sandag.org)

**RE: City of Carlsbad Comments on Draft 2021 Regional Plan**

To Whom it May Concern,

The City of Carlsbad appreciates the opportunity to provide comments on the draft 2021 Regional Plan ("Plan"). This is an important plan for this region and will guide the next phase of growth for the member agencies of the San Diego Association of Governments ("SANDAG"). An effectively designed and implemented regional transportation plan would help ensure improved transportation options for area residents, businesses and other community members; meaningful reductions in greenhouse gas ("GHG") emissions; and improved quality of life as we grow our communities.

The City of Carlsbad ("city") is submitting comments based on the policies, projects, programs and other improvements included in the Plan. Our agency's comment letter is divided into two sections. The first section seeks clarity and other considerations that pertain to our agency's review of the Plan. The second section identifies the city's preliminary comments and recommendations.

Implementing the regional transportation network outlined in the Plan requires municipalities to support the regional vision and deliver on local infrastructure and services like the priority bus routes, local bus services, and pedestrian and cycling connections to major transit infrastructure. These components, which are delivered by municipalities, are essential to creating a coherent and comprehensive local transportation network that feeds into regional services. For that reason, an effective public review of the Plan should involve a transparent and thorough process for identifying and evaluating potential hazards, physical changes to the environment and indirect (off-site and cumulative) impacts that might result from implementation activities that may reasonably occur with the Plan.

The city's residents, businesses and other community members will greatly benefit from the involvement and technical assistance from the prospective Draft Environmental Impact Report ("EIR"). Therefore, what follows in this correspondence represents our agency's preliminary comments and recommendations. The city reserves the right to add, amend, change or replace comments and recommendations based on additional review and understanding of the Plan and the environmental analysis provided under the California Environmental Quality Act ("CEQA").

The city thanks SANDAG staff for meeting with city staff on Aug. 2, 2021, to discuss some of these comments in advance of this letter. Following that meeting, SANDAG provided language that they may recommend adding to the Regional Plan for additional clarification on land use authority. The language is, "Land use authority is reserved to local jurisdictions because they are best positioned to effectively implement the objectives outlined in the Plan through understanding of the unique needs of their communities and geographies." This language will be helpful to clarify that land use authority rests with

Transportation & Community Development Departments  
1635 Faraday Avenue | Carlsbad, CA 92008 | 760-602-2710 t



City of Carlsbad Comments on Draft 2021 Regional Plan  
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the local jurisdiction. The city still offers the following comments with the intent to support development of a defensible and realistic regional plan.

#### **SECTION 1: CLARITY AND OTHER CONSIDERATIONS**

City staff have attended the series of workshops that SANDAG hosted during the public review period, and respectfully starts this section with several questions related to the process of the Plan and the Draft EIR. By way of introduction, a jurisdiction's General Plan, such as the city's General Plan, identifies the expected population of the city and any lands outside of the city limits but within their Sphere of Influence where future growth is anticipated to occur. The city's General Plan identifies the subject area adjacent to the McClellan-Palomar Airport for development under the designation for limited and light industrial use.

For future land use planning, land use assumptions must reasonably proxy and be generally consistent with local planning standards and programs, to be considered growth accommodating rather than growth inducing. SANDAG has the authority under Government Code Section 65584 to determine existing and projected housing needs, as well as the share of housing needs to be allocated to cities and counties, but it is unclear if SANDAG has jurisdiction to allocate new housing growth to areas in a manner not consistent with Government Code Section 65584. Attachment 1 includes additional information on the applicable Government Code and standards. Therefore, and as indicated above, the build-out of properties within the Business Park and flight activity zone must be done in accordance with the city's General Plan Land Use Diagram, as amended, in accordance with city approval.

The initial questions on the planning process associated with developing the Plan are provided below:

1. The SANDAG website states, "The SANDAG Sustainable Communities Strategy and Final EIR from its 2015 Regional Plan will remain valid and in compliance for purposes of state funding eligibility and other state and federal consistency purposes until the SANDAG Board of Directors adopts a new Regional Plan and EIR, provided those actions are completed by the end of December 2021." SANDAG needs to clarify how the Draft EIR, Response to Comments and Adoption will be completed this year and what will occur if they are not completed by the end of this year. Additionally, please clarify when the Draft EIR will be available; it is difficult to completely assess the full impacts of this plan when the public review of the documents is piecemealed.
  - a. SANDAG should clarify how public comments on the Plan are going to be addressed in the Draft EIR prior to its release.
  - b. In the Draft EIR, SANDAG needs to clearly articulate the impacts to land use and if the Plan will cause a significant environmental impact due to a conflict with any land use plan, policy or regulation adopted for the purpose of avoiding or mitigating an environmental effect. Appendix F: Regional Growth Forecast and Sustainable Communities Strategy Land Use Pattern appears to be inconsistent with the city's General Plan and rezone program to accommodate the Regional Housing Needs Assessment, as well as the general plans of other jurisdictions such as the cities of Coronado, Del Mar and the County of San Diego. The Draft EIR should clarify how implementation of this Plan can occur if those changes are not made.

2. The city has three mobility hubs, associated with the Employment Centers Published supporting the SANDAG Regional Plan.<sup>1</sup> McClellan-Palomar Airport is the fifth largest employment center in the region, with Carlsbad State Beach and Carlsbad Village as “Tier 3 and Tier 4” employment centers. The city thanks SANDAG for providing data for analysis to determine impacts and provide for accurate comments on the Plan. Attachment 2 shows a summary of the Mobility Hubs and housing units assumed in the Series 14 Growth Forecast for the year 2050. In summary:
- a. The assumptions in the updated Series 14 Growth Forecast contain inconsistencies with the city’s General Plan. The Carlsbad Palomar Major Employment Mobility Hub does include increases in density beyond what the citywide numbers appear to show when they are looked at in more detail.
    - i. There are three locations in which density is shown to be inconsistent with good planning principles, the city’s General Plan and the Airport Land Use Compatibility Plan. The three most problematic areas (shown in Attachment 3) are:
      1. 736 units on parcels immediately adjacent to the McClellan-Palomar Airport runway. The location of the airport within this mobility hub was shared with SANDAG staff multiple times at workshops. This is inconsistent with the regulations provided by the San Diego County Regional Airport Authority and conflicts with standard planning principles for siting housing away from hazards.
      2. 2,755 units on existing developed resort properties and open space dedicated lands adjacent to Legoland.
      3. 65 units in a preserved open space area.
    - ii. SANDAG should provide additional detail why units were assumed in these areas, what planning principles those decisions were based on, and how SANDAG expects this to be implemented.
    - iii. Concentration of units in the mobility hubs alone appears to conflict with the direction received from the California Department of Housing and Community Development (“HCD”) to implement new Affirmatively Furthering Fair Housing (“AFFH”), which seeks to combat housing discrimination, eliminate racial bias, undo historic patterns of segregation, and lift barriers that restrict access in order to foster inclusive communities and achieve racial equity, fair housing choice and opportunity for all Californians. The allocations of land use provided by SANDAG seem to focus all the higher density housing into one area of the city. (This is one of the largest points of analysis that each jurisdiction in the region needs to respond to in order to receive a certified Housing Element.)
  - b. Additionally, looking at the detailed data provided by SANDAG, it is now clear why the citywide numbers only show moderate increases in population. Our analysis has shown that there is an assumed reduction of population by 2,310 persons in the areas within the city but outside of the mobility hubs. This is likely due to assumed reductions in persons per household over time, but SANDAG should clarify the source and reasonableness of this assumption. If housing is not provided consistent with these areas, is it still reasonable to assume persons per household will be reduced in 2050?

<sup>1</sup> SANDAG Website: Employment Centers [SANDAG :: PROJECTS :: San Diego's Regional Planning Agency](#)

## City of Carlsbad Comments on Draft 2021 Regional Plan

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- c. Furthermore, this reduction in population is not limited to the City of Carlsbad. There is an approximately 85,000 reduction in population assumed outside of mobility hubs regionwide. SANDAG needs to address if that is a reasonable assumption and if this will result in other impacts to public and private projects that will rely on this growth forecast, and the associated Activity Based Model (2+) to project future impacts to transportation, GHG, air quality and noise.
    - d. The forecast has decreased in future population based on current trends, but it is not clear if there is enough housing provided with reductions and increases in some jurisdictions. Will the reduced amount of housing that will be provided result in an increased exacerbation of the affordability crisis?
    - e. There is a lack of clarity about how the Plan would be implemented at the municipal level. SANDAG should develop an approach for engaging with municipalities to ensure local support for delivering the regional transportation network. Staff from local jurisdiction have the knowledge and ability to share where there are land use assumptions that conflict with planning and zoning laws. Our analysis focused on the City of Carlsbad, but if these types of assumptions are made regionwide, it presents flaws in the overall analysis. These flaws put the assumed reductions in vehicle miles traveled ("VMT") and ability to implement the Regional Plan into question.
  3. The area designated is controlled for use and activity density and intensity through its spatial association with the McClellan-Palomar Airport. The McClellan-Palomar Airport is defined by the Federal Aviation Administration ("FAA") as a commercial service airport that, in addition to private aircraft, has regularly scheduled commercial flights to Los Angeles International Airport ("LAX"). The McClellan-Palomar Airport Land Use Compatibility Plan ("ALUCP") is prepared according to FAA requirements and adopted by the San Diego County Regional Airport Authority acting as the Airport Land Use Commission for the County of San Diego.
    - a. The ALUCP provides measures to minimize the public's exposure to excessive noise and safety hazards within areas around the airport and identifies areas likely to be impacted by noise and flight activity created by aircraft operations at the airport. These impacted areas include the Airport Influence Area ("AIA"), the Clear Zone and the Flight Activity Zone.
    - b. Within the AIA, the ALUCP establishes six safety zones for the purpose of evaluating safety compatibility of new/future land use actions. The safety zone boundaries depict relative risk of aircraft accidents occurring near the airport and are derived from general aviation aircraft accident location data and data regarding the airport's runway configuration and airport operational procedures. The ALUCP limits development intensities in these zones by imposing floor area and lot coverage maximums, by incorporating risk reduction measures in the design and construction of buildings, and/or by restricting certain uses altogether. For example, all residential and virtually all non-residential uses are considered incompatible land uses in some zones, while considered to be either compatible or conditionally compatible with the airport in other zones. Attachment 4 shows the McClellan-Palomar Airport, noise contours and SANDAG's proposed housing units.
    - c. If the proposed SANDAG land use assumptions are endorsed, an amendment to the city's General Plan would be required to change the land use designation to Mixed-Use Commercial or residential land uses within the existing Business Park in order to effectuate the underlying assumptions of SANDAG staff. This is not a realistic



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- assumption. Further, the protected airspace referenced in the AIA and the ALUCP must also be amended based on SANDAG's regional planning assumptions. (The FAA establishes airspace protection zones in the airspace above and surrounding airports in order to protect aircraft from obstructions such as buildings, towers, etc. in navigable airspace.)
- d. When a General Plan is adopted or amended, the allowable growth pattern of an area is identified and the expansion or updating of the various land uses as specified in the General Plan can occur throughout the planning horizon. Without such growth considerations, the expansion or intensification of existing land uses could be considered "growth inducing." Unplanned and uncontrolled growth may have significant adverse impacts on the environment. CEQA requires a discussion of how a "project" could increase population, employment or housing growth in surrounding areas and the impacts resulting from this growth. The CEQA Guidelines indicate that a "project" would normally have a significant effect on the environment if it would induce substantial growth or a substantial concentration of population.
4. At this point, it is not clear if SANDAG's assumptions adequately contemplate the development patterns included in the Sustainable Communities Strategy ("SCS")/Regional Transportation Plan ("RTP"), and Regional Air Quality Strategy ("RAQS"), local climate action planning business-as-usual estimates, sub-regional traffic modeling, or the airspace assumptions of AIA and the ALUCP.
  5. The city seeks clarity on the Plan's underlying assumptions made to justify the proposed extensive high-speed rail network considering the significant changes in travel behavior which have occurred throughout the region as a result of the COVID-19 pandemic and due to the advancements in disruptive technologies such as telecommuting, autonomous vehicles, microtransit, etc.
    - a. Recent North County Transit District ("NCTD") Coaster ridership data show riders are not returning to riding the Coaster in comparison to other modes of travel as shown in Attachment 5.
    - b. This question is consistent with comments made by SANDAG's panel expert Bob Poole regarding the impact of the COVID-19 pandemic on transit ridership and mega-transit projects. (See comments by Bob Poole during the March 12, 2021 presentation to SANDAG starting at timestamp 1:30 p.m.: [https://youtu.be/q-e6bNY5J\\_8?t=5410](https://youtu.be/q-e6bNY5J_8?t=5410))
  6. The city seeks clarity on why an alternatives analysis was not conducted with consideration of other transit alternatives such as automated /shared vehicle technologies and personalized zero emissions transit programs that are capable of utilizing the existing regional freeway infrastructure in response to these recent developments explained in the above comment.
  7. The city seeks clarity on why the Plan does not incorporate policies to promote roundabouts over signalized intersections and include a budget line item under the Complete Corridors to fund the construction of roundabouts at new locations and to replace signalized intersections when found feasible. This clarification would support the Federal Highway Administration ("FHWA")'s project for [Accelerating Roundabout Implementation in the United States](#) and the [County of San Diego Air Pollution Control Board's support for implementing roundabouts to address GHG and reduce fatalities](#).
  8. The city seeks clarity on the project phasing proposed within the Plan. Specifically, the city is seeking to understand the timing of implementation of unfunded TransNet projects related to

City of Carlsbad Comments on Draft 2021 Regional Plan  
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the new projects presented within the Regional Plan. To support this, the city is requesting that SANDAG input the information requested in Table 1 (Attachment 6).

9. The city seeks specific data on the proposed 200 miles of rail service contemplated in the Plan. To support this, the city is requesting that SANDAG input the information requested in Table 3 (Attachment 7). Specific questions:
  - a. Please provide more information about the scope of the high-speed rail alignments, potential vehicle technologies and their cost estimates.
  - b. Will the Coaster keep the same rail alignment?
  - c. What funding is programmed or planned for the Carlsbad Village railroad trench and the other projects along the current NCTD/Coaster Service right-of-way?
  - d. Will some of the tracks be at grade with fencing and trains traveling at 110 miles per hour speeds?

## SECTION 2: COMMENTS AND RECOMMENDATIONS

In addition to the comments on process and the Draft EIR provided above, city staff remain concerned that there is not enough detail on the feasibility of implementation of this significant shift in transportation strategy. On specific content in the plans, we outline our recommendations and comments below:

### 1. *Paying for the Plan:*

The draft 2021 Regional Plan sets out an ambitious plan to build and operate a region-wide system of transportation projects, programs and other improvements. This is a substantial role for SANDAG to play in supporting both the construction and operation of these projects, programs and other improvements. SANDAG should set annual revenue targets to directly fund everything and should approve any recommended sustainable revenue tools to help meet these targets. Many of the funding strategies will require legislative changes, or voter-approved taxation. SANDAG should clarify what will occur if the funding is not available, if opposition to projects stops them from construction, and if General Plans in the region are not modified to implement the Plan.

### 2. *Appendix D: Sustainable Community Strategy Documentation:*

Appendix D includes the Sustainable Communities Strategy, which outlines assumptions included in the Activity Based Model 2+ ("ABM 2+"), updated for this. This model will be necessary for use by publicly and privately initiated land use projects preparing documents for consistency with VMT/CEQA Guidelines and Traffic Impact Analysis ("TIA") Evaluations. City staff respectfully request direction from SANDAG on how to conduct modeling with the service bureau and how to factor in these assumptions applied to ABM 2+. Specifically, the addition of pricing, parking costs for coastal communities, 10% teleworking and micromobility. SANDAG should provide direction on how this could be worked into General Plans that are updated every 5-20 years.

### 3. *Appendix A: Transportation Projects, Programs, and Phasing:*

Trips to and from school sites result in a significant congestion, VMT generation, and peak hour delay throughout the region. Additional funding and projects should be recommended with a specific focus on improving safety and multimodal access in and around school sites along with programs to incentivize non-single occupancy vehicle trips to schools.



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Table A.11: Given the proven success of the Carlsbad Connector microtransit pilot program, the city agrees with the Plan's recommendations to provide similar on-demand microtransit systems throughout North County at all mobility hub sites and major transit centers.

Table A.13: The segment of El Camino Real between Poinsettia Lane and Camino Vida Roble is proposed to be widened from two to three lanes to prime arterial standards. With the adoption of the city's General Plan, the city has determined that the widening of this portion of El Camino Real is not feasible due to constrained right-of-way and would result in negative impacts to other travel modes. City staff recommend removal of this proposed project recommendation CB32 (that is, a 'do nothing' scenario, or appraise and evaluate different mobility projects and/or alternative designs).

The preferred Interstate-5 freeway alternative identified in the North Coast Corridor ("NCC") Final EIR/EIS is the refined 8+4 Buffer alternative, with four freeway lanes and two managed lanes in each direction and completion by 2035. Appendix A, Table A.5 describes NCC project IDs CC004, 007 - 009 as "8F to 6F+4ML" with completion by 2050. While this might lead to further study, it is not clear why there is a different freeway configuration (i.e., reduction in freeway lanes) proposed. How does a reduction in lanes continue to meet NCC potential project benefits of maintaining or improving traffic operations and improving the safe and efficient regional movement of people and goods?

#### 4. *Active Transportation:*

The city appreciates the Regional Plan's overall approach of providing a connected network of high-quality bicycle facilities throughout the region. Regional bikeways are recommended throughout the city including along Palomar Airport Road which will provide a key east-west connection and El Camino Real which will provide a new north-south bikeway connection through the city. Both roadways are proposed to include "on-street bikeways". Due to the high traffic volumes and vehicle speeds experienced along most of both corridors, the city recommends considering "off-street bikeways" or Class I facilities where feasible in order to stimulate the shift from personal motor vehicle use to people choosing to bike.

It is extremely important that municipal transportation plans align with regional transportation plans to achieve regional goals for land use and transportation and to promote the region working together to build a cohesive regional transportation network. Considering there are currently no mechanisms in place to ensure municipalities coordinate local transportation plans with regional planning documents, the Plan should provide an approach on how SANDAG plans to engage with municipalities, especially in areas of potential disagreement or conflict (as aforementioned in this subsection and others). It is also recommended that the Plan provide additional direction regarding the application of protected bikeways in a variety of applicable contexts. While vertical measures such as soft hit posts may be appropriate in lower volume and lower speed roadways, arterial roadways with high traffic volumes and high speeds warrant much more substantial physical protection from vehicles. In addition, special consideration should be given at intersections and driveways which may be impacted due to the additional width and visibility impacts created by protected bikeways.

City staff look forward to working with SANDAG on improving mobility and land use access in the region and building sustainable, equitable and healthy modes of transportation, and we appreciate the opportunity to comment on the Plan that will help the region realize these goals.



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If you have any questions related to comments on the transportation network, please contact Tom Frank, Transportation Director/City Engineer, at [Tom.Frank@carlsbadca.gov](mailto:Tom.Frank@carlsbadca.gov) or if you need additional information related to comments on the land use assumptions, please contact Eric Lardy, Principal Planner, at [Eric.Lardy@carlsbadca.gov](mailto:Eric.Lardy@carlsbadca.gov).

Sincerely,



*For*

**JEFF MURPHY**  
Community Development Director



**TOM FRANK**  
Transportation Director/City Engineer

Attachments:

1. Government Code 65020 (S.B. 375) Summary
2. City of Carlsbad Mobility Hubs
3. City of Carlsbad – Palomar Airport Road Mobility Hub Analysis
4. Palomar-McLellan Airport Flight Paths
5. Recent NCTD Coaster Ridership Data
6. Table 1 - Project Data Request
7. Table 3 - Detail of Proposed Rail Lines

cc: Scott Chadwick, City Manager  
Celia Brewer, City Attorney  
Geoff Patnoe, Assistant City Manager  
Ron Kemp, Assistant City Attorney  
Robby Contreras, Assistant City Attorney  
Gary Barberio, Deputy City Manager, Community Services  
Paz Gomez, Deputy City Manager, Public Works  
Mike Strong, Assistant Director, Community Development  
Don Neu, City Planner  
Nathan Schmidt, Transportation Planning and Mobility Manager  
Jason Geldert, Engineering Manager  
Eric Lardy, Principal Planner  
Scott Donnell, Senior Planner  
Corey Funk, Associate Planner

## Attachment 1: Government Code 65020 (S.B. 375) Summary

Government Code section (“GOV §”) 65080, also referred to as California Senate Bill 375 (Steinberg, 2008) (“SB 375”), is one area of law that provides SANDAG with guidance to which a regional transportation plan must be developed.

Among other things, the regional transportation plan that is developed “shall be an internally consistent document” (GOV § 65080 (b)) and shall include a “sustainable communities strategy prepared by each metropolitan planning organizations as follows” (GOV § 65080 (b)(2)(B)):

*Each metropolitan planning organization shall prepare a sustainable communities strategy, subject to the requirements of Part 450 of Title 23 of, and Part 93 of Title 40 of, the Code of Federal Regulations, including the requirement to utilize the most recent planning assumptions considering local general plans and other factors. The sustainable communities strategy shall (i) identify the general location of uses, residential densities, and building intensities within the region, (ii) identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan taking into account net migration into the region, population growth, household formation and employment growth, (iii) identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region pursuant to [Section 65584](#), (iv) identify a transportation network to service the transportation needs of the region, (v) gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in [subdivisions \(a\) and \(b\) of Section 65080.01](#), (vi) consider the state housing goals specified in [Sections 65580 and 65581](#), (vii) set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board, and (viii) allow the regional transportation plan to comply with Section 176 of the federal Clean Air Act ( [42 U.S.C. Sec. 7506](#) ).*

The 2021 draft Regional Transportation Plan includes a Sustainable Communities Strategy (“SCS”), as required by SB 375 for the San Diego region (herein after called “draft Regional Plan”). The draft Regional Plan indicates that “SB 375 requires the SCS to include a pattern for forecasted growth and development that accomplishes the following: 1) When combined with the transportation network, the SCS will achieve the regional GHG emission–reduction targets; 2). The SCS accommodates the Regional Housing Needs Assessment (“RHNA”) Determination; and 3) The SCS utilizes the most recent planning assumptions. (Reference p. 19 of the 2021 Regional Plan.)

Predicting the effect of transportation plans or projects on land uses and land use planning is critical to developing context sensitive solutions for transportation projects. Therefore, utilization of the most recent planning assumptions is not only necessary but is required as specifically stated therein GOV § 65080. If inconsistencies are found in the land use assumptions or adverse impacts are anticipated, SANDAG should be actively engaged in the development of measures to address these issues.

The SANDAG Board of Directors approved the final RHNA plan with the final housing unit allocation on July 10, 2020, which was based on the most recent land use planning assumptions and an adopted methodology to allocate housing in accordance with GOV §§ 65584.04(d and m). The City of Carlsbad received a total RHNA allocation of 3,873 units as a result of RHNA plan adoption. The adopted April 6, 2021 city’s Housing Element accommodates its housing needs through current zoning and other programs

## Attachment 1: Government Code 65020 (S.B. 375) Summary

as needed to meet the city's RHNA obligation at all income levels. The land use inputs derived from this local planning document constitutes the most recent land use assumptions. On July 13, 2021 the Department of Housing and Community Development found "the adopted housing element is in substantial compliance with State Housing Element Law (Article 10.6 of the Gov. Code).

The most recent planning assumptions are critical for the development of the draft Regional Plan as the document must comply with other specific state and federal mandates including a SCS per California Senate Bill 375, which achieves GHG emissions reduction targets set by the California Air Resources Board and compliance with federal civil rights (Title VI) requirements, environmental justice considerations, air quality conformity, and public participation. To monitor compliance and attainment of state reduction goals in GHG, GOV § 65080 (b)(2)) requires that:

*(H) Prior to adopting a sustainable communities strategy, the metropolitan planning organization shall quantify the reduction in greenhouse gas emissions projected to be achieved by the sustainable communities strategy and set forth the difference, if any, between the amount of that reduction and the target for the region established by the state board.*

*(J)(i) Prior to starting the public participation process adopted pursuant to subparagraph (F), the metropolitan planning organization shall submit a description to the state board of the technical methodology it intends to use to estimate the greenhouse gas emissions from its sustainable communities strategy and, if appropriate, its alternative planning strategy.*

There is inevitably some uncertainty regarding the use of projected future conditions. However, what is certain is that the project will not operate under the conditions that exist today. There will be new residential and employment growth in the intervening years between now and the proposed build-out of the draft Regional Plan. Nonetheless, projections utilized should represent the best available information assembled by the local agencies with jurisdiction and expertise. Judgments about land use assumptions utilized in the draft Regional Plan should be based on and supported by facts, adopted plans, and "most recent planning assumptions," rather than speculation and personal opinions. The land use assumptions for "uses, residential densities, and building intensities within the region" (as required by GOV § 65080 (b)(2)(B)(i)) should also be the same, as that provided to the state board (as required per GOV §§ 65080 (b)(2)(H and J) in estimating and analyzing GHG from the SCS and the effect on growth and whether the effects of that growth would be significant in the context of the region's plans, natural setting, and growth patterns. Ultimately, the SCS must demonstrate whether SANDAG can meet the per capita passenger vehicle-related GHG emissions targets for 2035 set by the California Air Resources Board ("CARB").

SB 375 directs CARB to accept or reject the determination of SANDAG that its SCS submitted to CARB would, if implemented, achieve the region's GHG emissions reduction targets. CARB's technical evaluation of SANDAG's draft Regional Plan would be based on all the evidence provided, including the models, the data inputs and assumptions, the SCS strategies, and the performance indicators.

The transportation and planning assumptions are also extremely important as it is relied on for other master planning exercises. The Regional Air Quality Strategy ("RAQS") relies on information from CARB and SANDAG for information regarding projected growth in the cities and San Diego County. This in turn is utilized to address other state requirements, including the San Diego portion of the California State Implementation Plan ("SIP") and promulgating their own rules and regulations regarding air quality in the region or to address federal requirements.

## Attachment 1: Government Code 65020 (S.B. 375) Summary

The analysis of land use impacts for transportation projects is guided by FHWA Technical Advisory T 6640.8 and the CEQA Guidelines.

Under the FHWA Technical Advisory T 6640.8 (G)(1), Guidance for Preparing and Processing Environmental, states:

*This discussion [of land use] should identify the current development trends and the State and/or local government plans and policies on land use and growth in the area which will be impacted by the proposed project. These plans and policies are normally reflected in the area's comprehensive development plan, and include land use, transportation, public facilities, housing, community services, and other areas.*

*The land use discussion should assess the consistency of the alternatives with the comprehensive development plans adopted for the area and (if applicable) other plans used in the development of the transportation plan required by Section [23 U.S. Code §] 134. The secondary social, economic, and environmental impacts of any substantial, foreseeable, induced development should be presented for each alternative, including adverse effects on existing communities. Where possible, the distinction between planned and unplanned growth should be identified.*

There is also a requirement to analyze the land use planning inconsistencies per CEQA Guidelines § 15126.2(a), which specifies that an EIR for a proposed project include:

*The Significant Environmental Effects of the Proposed Project. An EIR shall identify and focus on the significant effects of the proposed project on the environment. In assessing the impact of a proposed project on the environment, the lead agency should normally limit its examination to changes in the existing physical conditions in the affected area as they exist at the time the notice of preparation is published, or where no notice of preparation is published, at the time environmental analysis is commenced. Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and changes induced in population distribution, population concentration, the human use of the land (including commercial and residential development), health and safety problems caused by the physical changes, and other aspects of the resource base such as water, historical resources, scenic quality, and public services. The EIR shall also analyze any significant environmental effects the project might cause or risk exacerbating by bringing development and people into the area affected. For example, the EIR should evaluate any potentially significant direct, indirect, or cumulative environmental impacts of locating development in areas susceptible to hazardous conditions (e.g., floodplains, coastlines, wildfire risk areas), including both short-term and long-term conditions, as identified in authoritative hazard maps, risk assessments or in land use plans addressing such hazards areas.*

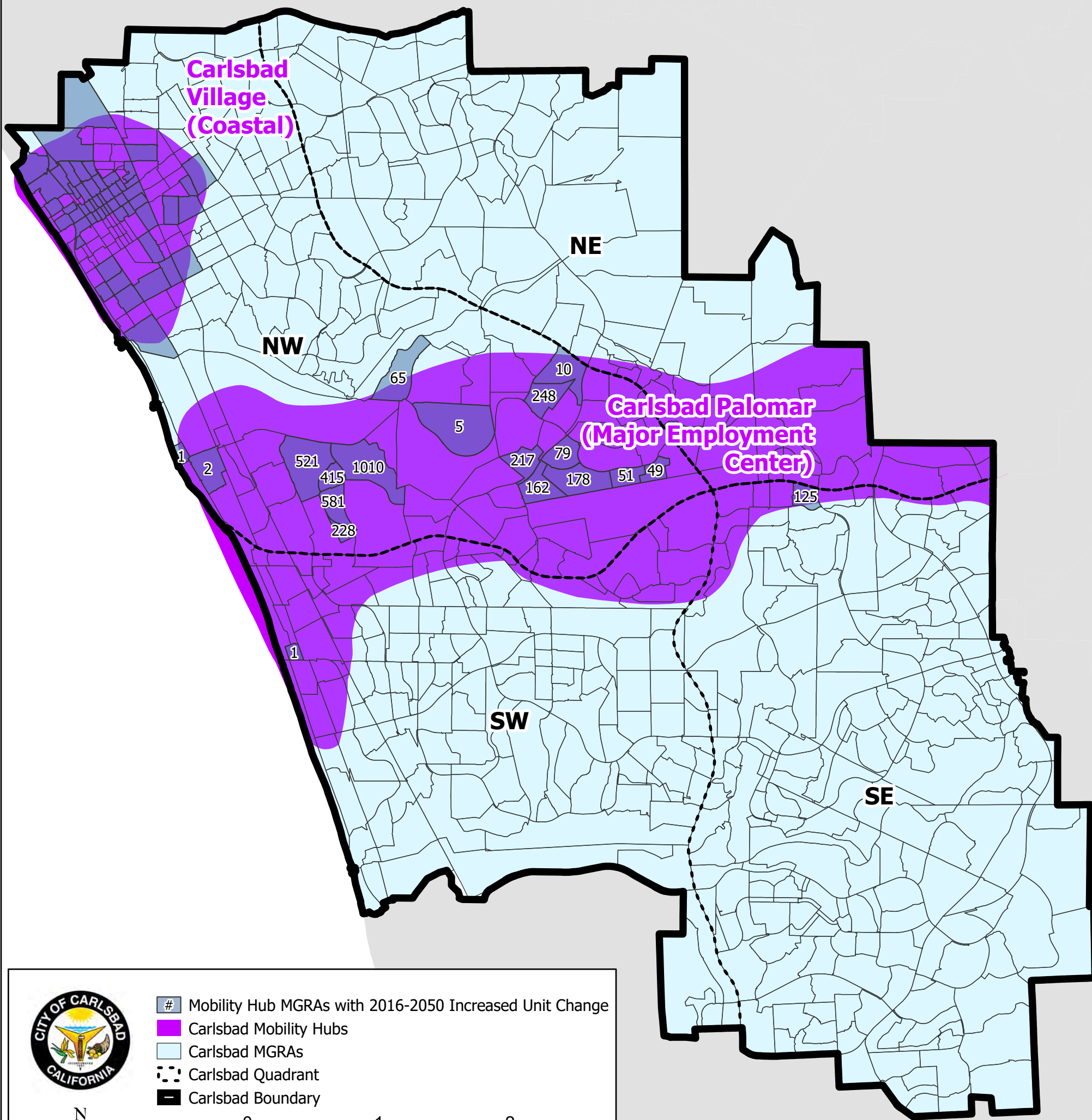
Since the new land use assumptions are being utilized, as described by this letter, the EIR that is prepared shall also analyze any significant environmental effects the project might cause by bringing development and people into the area affected. The following are the basic steps in analyzing land use impacts as part of the community impact assessment process:


## Attachment 1: Government Code 65020 (S.B. 375) Summary

1. Inventory the existing land use patterns (including undeveloped land), development trends, and transportation systems. The inventory of existing land uses should include the following land use types: residential, commercial, industrial, recreational, institutional, public services, community services, emergency services, transportation, utilities, agriculture, and undeveloped land in the study area. The study area should include the surrounding community that is generally associated with the project area within which community impacts could occur. The inventory should also address development trends and identify recent developments in the study area to include the development's name, size, status (planned, built, under construction), and the jurisdiction in which it is located. A map showing the location of existing and planned land uses in the area should also be prepared.
2. Determine whether the project is consistent with local and regional policies that govern land use and development. For the consistency analysis, the policies and programs considered in the analysis should include: transportation plans and programs (MTPs/RTPs and MTIPs/RTIPs), regional growth plans, local General Plans that establish land use and growth management policies for the study area, and any specific or pipeline development proposals. This analysis should also include a discussion of consistency with the Coastal Zone Management Act of 1972, California Coastal Act of 1976, the National Wild and Scenic Rivers Act (16 USC 1271) and the California Wild and Scenic Rivers Act (Pub. Res. Code § 5093.50 et seq.). After preparing a preliminary list of relevant plans to be considered in the analysis, the SANDAG planner should meet with the staff of the various agencies to review the list to determine if it is complete and revise the list as necessary.
3. Assess the changes that would occur in land uses and growth with and without the project.
4. The draft Regional plan and each project alternative should be considered separately since the results may be different.
5. Develop measures to avoid, minimize, and/or mitigate potential adverse effects.

The resulting environmental analysis should identify the current development trends and the State and/or local government plans and policies on land use and growth in the area which will be impacted by the proposed project. These plans and policies are normally reflected in local General Plans. If found to be consistent, then the findings in the EIR should be documented in the report and no further analysis or action is necessary. When found not to be inconsistent with a policy or program, then consideration must be given to modifying the draft Regional Plan alternative to make it consistent, or measures to address the inconsistency must be developed. SANDAG should be actively engaged in the development of measures to address these issues and be prepared to assess the consistency of the draft Regional Plan and alternatives with the comprehensive development plans adopted for the area and (if applicable) other plans used in the development of the transportation plan required by Section 23 U.S. Code § 134. For any new land use growth assumptions, the secondary social, economic, and environmental impacts of any substantial, foreseeable, induced development should be presented for the draft Regional Plan and each alternative, including adverse effects on existing communities. The results should be shared with the public during the public involvement process, e.g., at community meetings, etc. Public input should be considered by SANDAG and if necessary, the findings of the analysis should be revised to reflect information gained through the public involvement process.

# SANDAG Mobility Hubs



 # Mobility Hub MGRAs with 2016-2050 Increased Unit Change  
 Carlsbad Mobility Hubs  
 Carlsbad MGRAs  
 Carlsbad Quadrant  
 Carlsbad Boundary

N

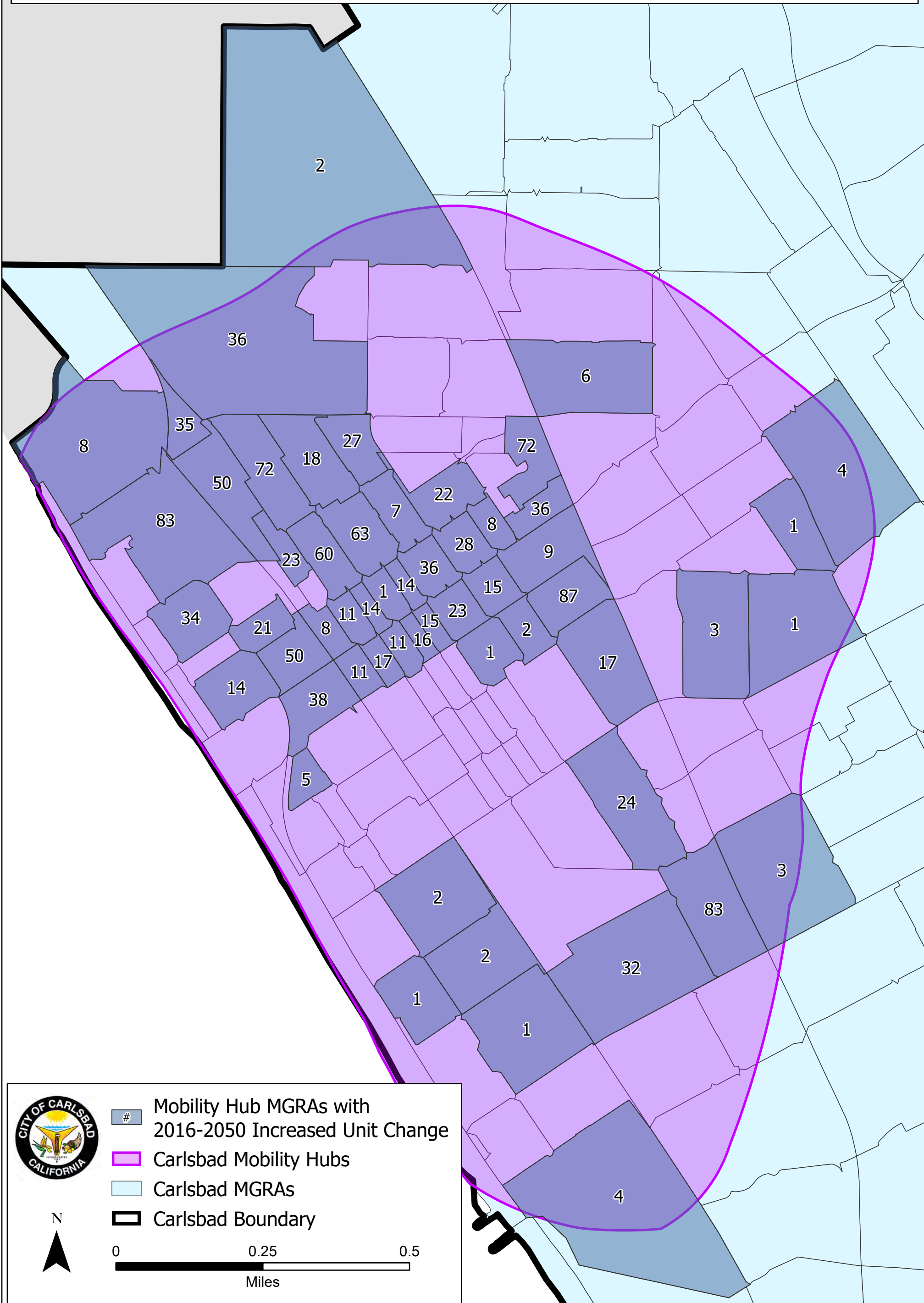
0 1 2  
Miles

Hub Name	Hub Type	Total Population 2016	Total Houses 2016	Total Population 2025	Total Houses 2025	Total Jobs 2025	Total Population 2035	Total Houses 2035	Total Jobs 2035	Total Population 2050	Total Houses 2050	Total Jobs 2050
Carlsbad Village	Coastal	14087	6430	15095	6539	9290	16177	7075	9667	17293	7607	10044
Carlsbad Palomar	Major Employment Center	12853	5475	12275	5461	61074	19465	8503	67005	21080	9265	72900
N/A	Outside of Hubs	86239	34247	88793	35855	13896	84039	35855	14345	83929	35855	14900
N/A	All of Carlsbad	113179	46152	116163	47855	84260	119681	51433	91017	122302	52727	97844

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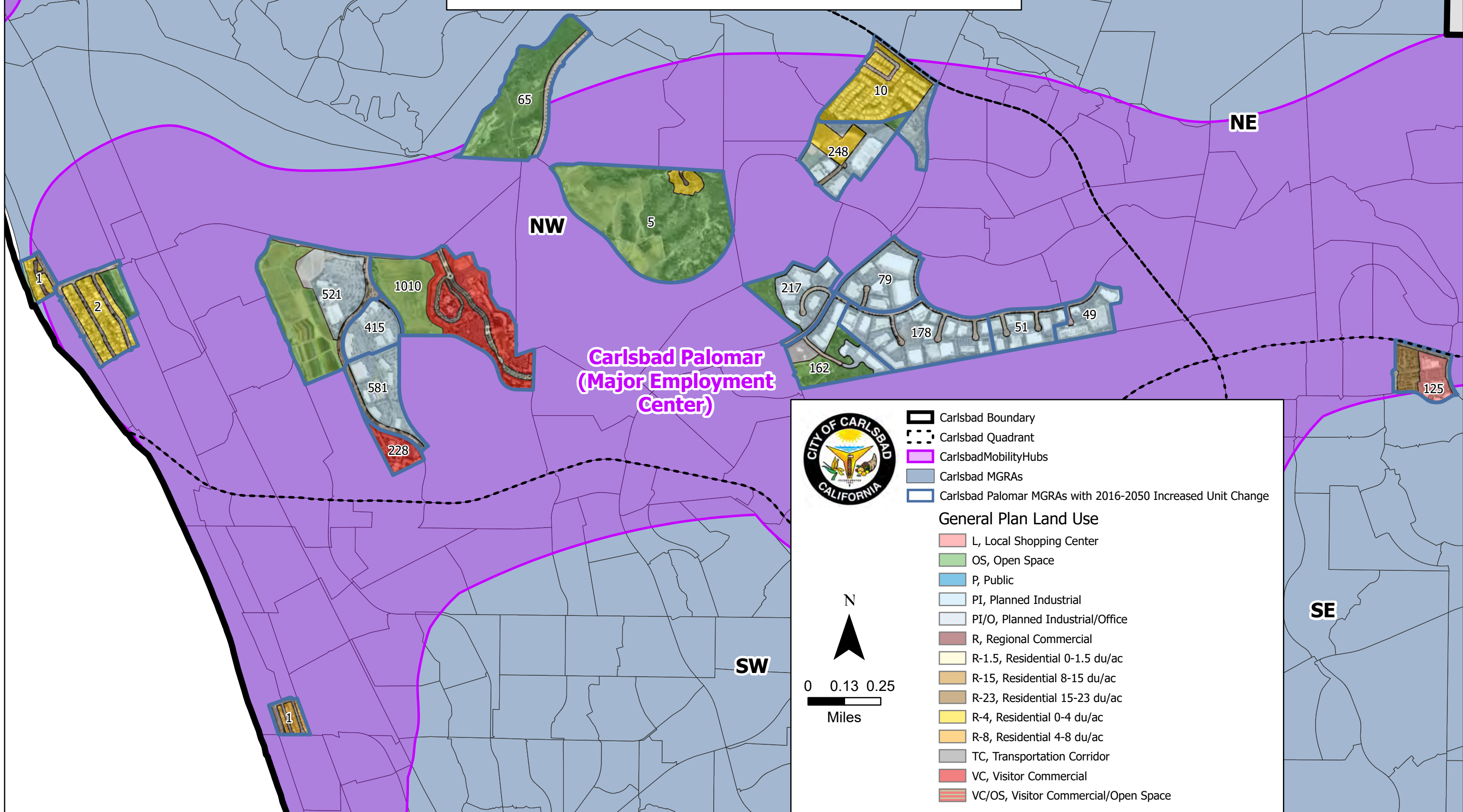

# Carlsbad Village Mobility Hub MGRAs








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










Carlsbad Village (Coastal)

# MGRA Closer Look

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  L, Local Shopping Center
-  OS, Open Space
-  P, Public
-  PI, Planned Industrial
-  PI/O, Planned Industrial/Office
-  R, Regional Commercial
-  R-1.5, Residential 0-1.5 du/ac
-  R-15, Residential 8-15 du/ac
-  R-23, Residential 15-23 du/ac
-  R-4, Residential 0-4 du/ac
-  R-8, Residential 4-8 du/ac
-  TC, Transportation Corridor
-  VC, Visitor Commercial
-  VC/OS, Visitor Commercial/Open Space

**Scale:** 0 0.13 0.25 Miles

**North Arrow:** N

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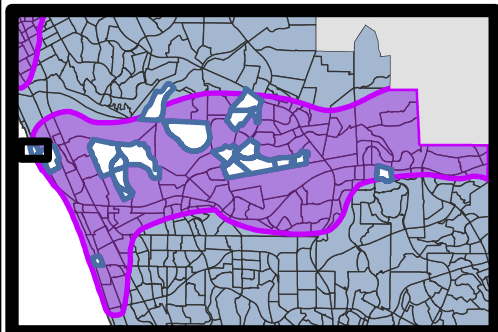


# MGRA: 14249

Carlsbad Palomar  
(Major Employment  
Center)

1 Unit  
Change

2 Unit  
Change



- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

### General Plan Land Use

- OS, Open Space
- R-15, Residential 8-15 du/ac
- R-4, Residential 0-4 du/ac
- VC/OS, Visitor Commercial/Open Space

N



0 0.010.01



Miles

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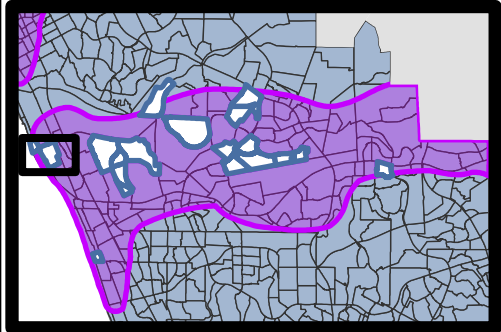








# MGRA: 14251

1 Unit Change






2 Unit Change

Carlsbad Palomar  
(Major Employment  
Center)

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  OS, Open Space
-  R-15, Residential 8-15 du/ac
-  R-4, Residential 0-4 du/ac
-  TC, Transportation Corridor
-  VC/OS, Visitor Commercial/Open Space

N

0 0.02 0.04  
Miles

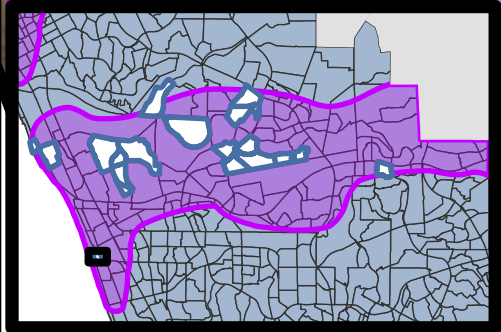

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# MGRA: 14265







**Carlsbad Palomar  
(Major Employment  
Center)**

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  OS, Open Space
-  R-8, Residential 4-8 du/ac
-  TC, Transportation Corridor
-  VC, Visitor Commercial

N

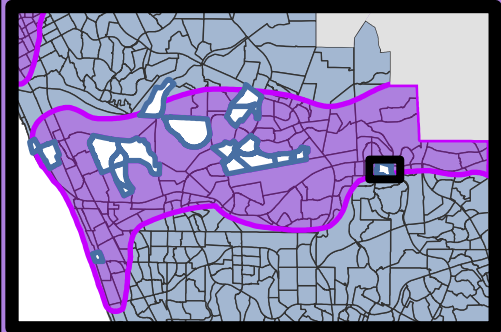
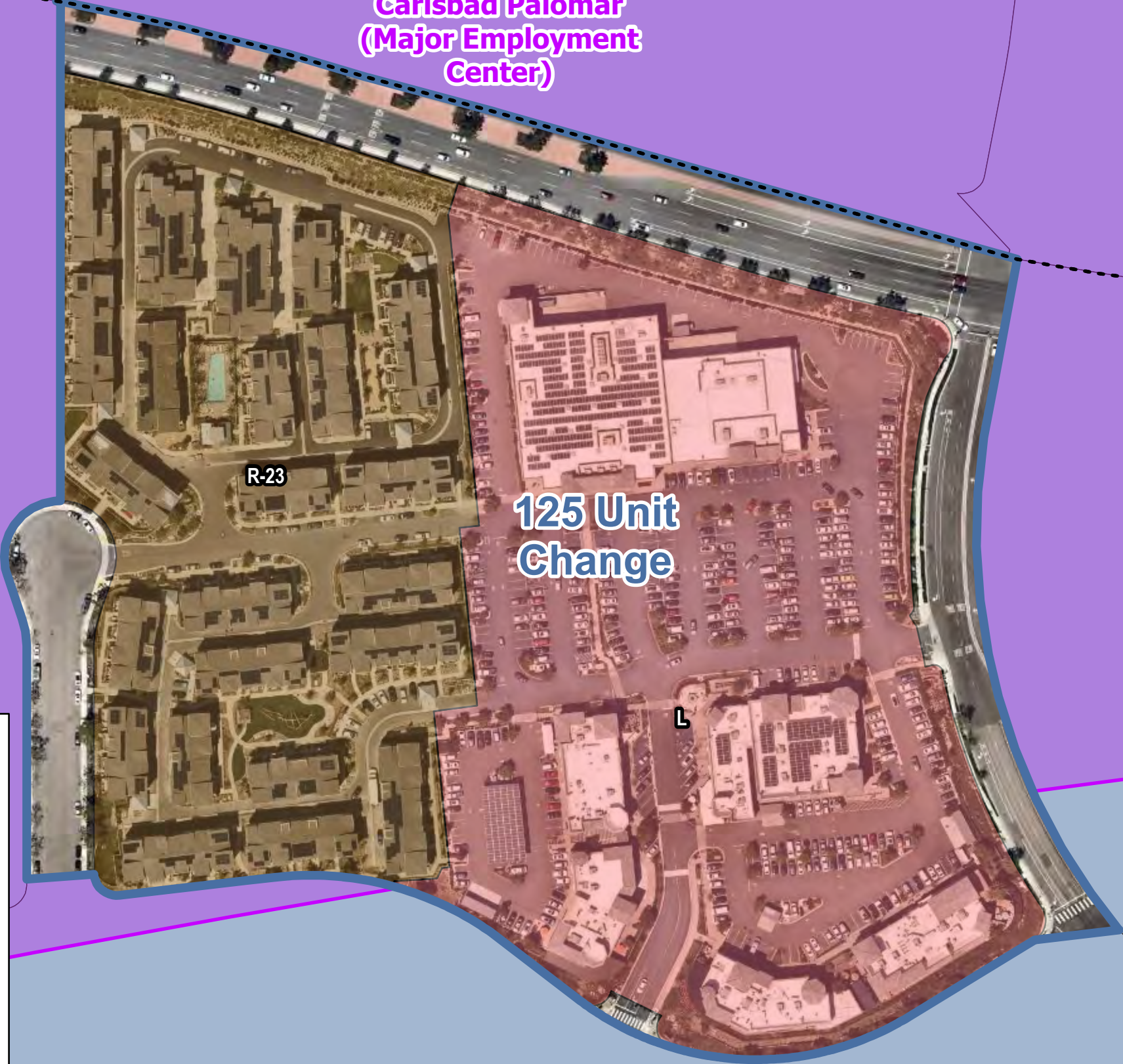

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Miles






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# MGRA: 17984

**Carlsbad Palomar  
(Major Employment  
Center)**

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  L, Local Shopping Center
-  PI, Planned Industrial
-  R-23, Residential 15-23 du/ac

N

0 0.01 0.02  
Miles

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# MGRA: 22902

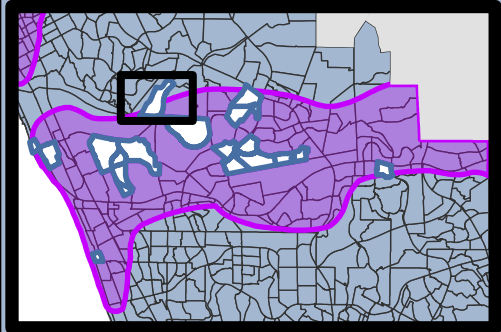

Majority owned by State of CA






65 Unit Change

Small portion owned by Kelly Land Co. and Agua Hedionda Lagoon Foundation



Carlsbad Palomar (Major Employment Center)

5 Unit Change

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  OS, Open Space
-  R-15, Residential 8-15 du/ac

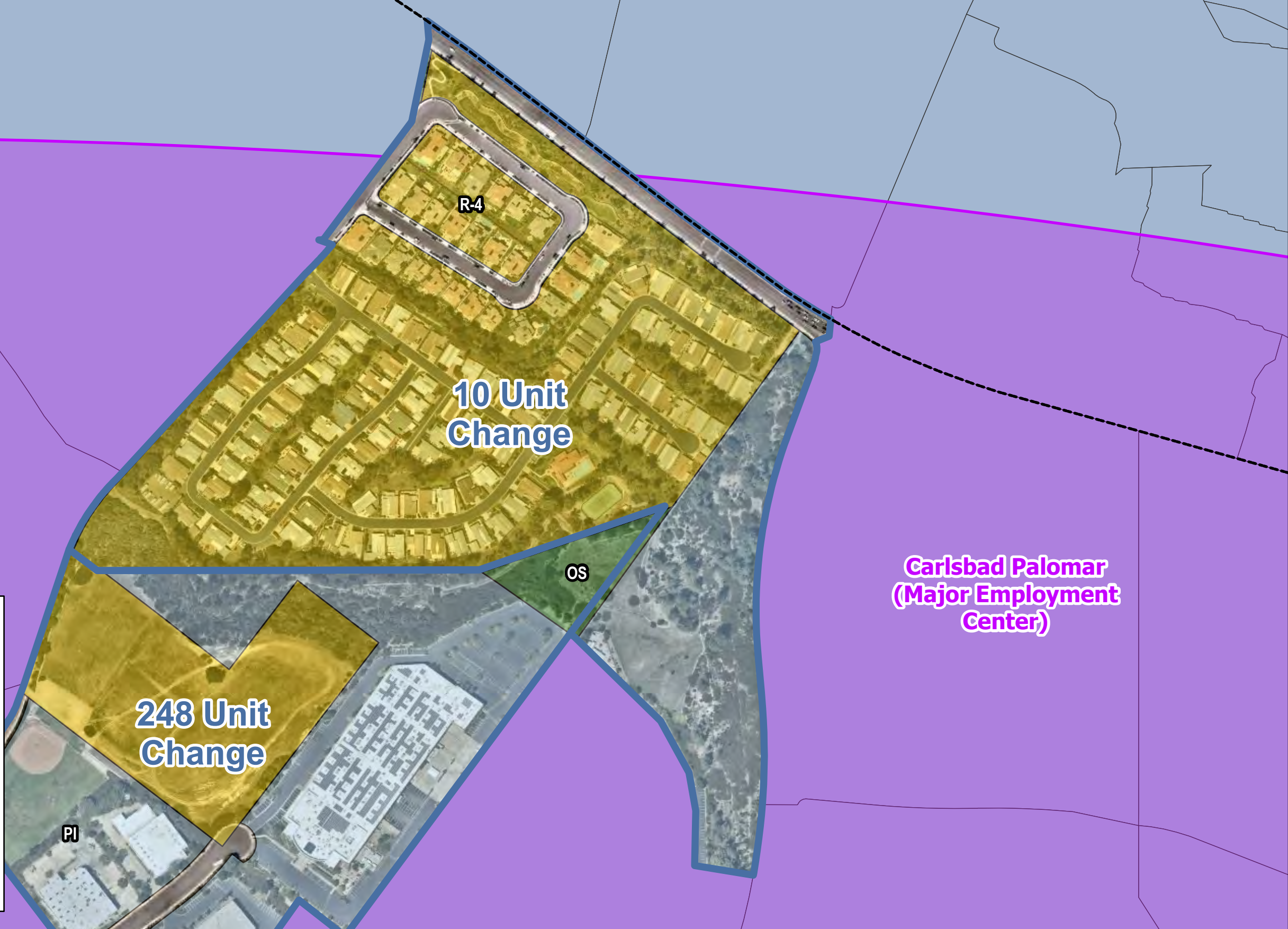
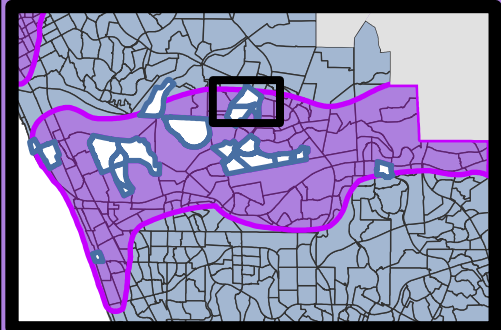

N






0 0.02 0.04  
Miles

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# MGRA: 22906

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  OS, Open Space
-  PI, Planned Industrial
-  R-4, Residential 0-4 du/ac

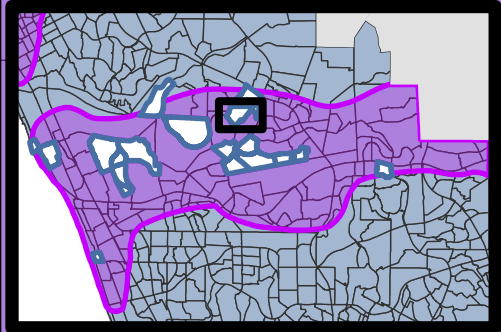
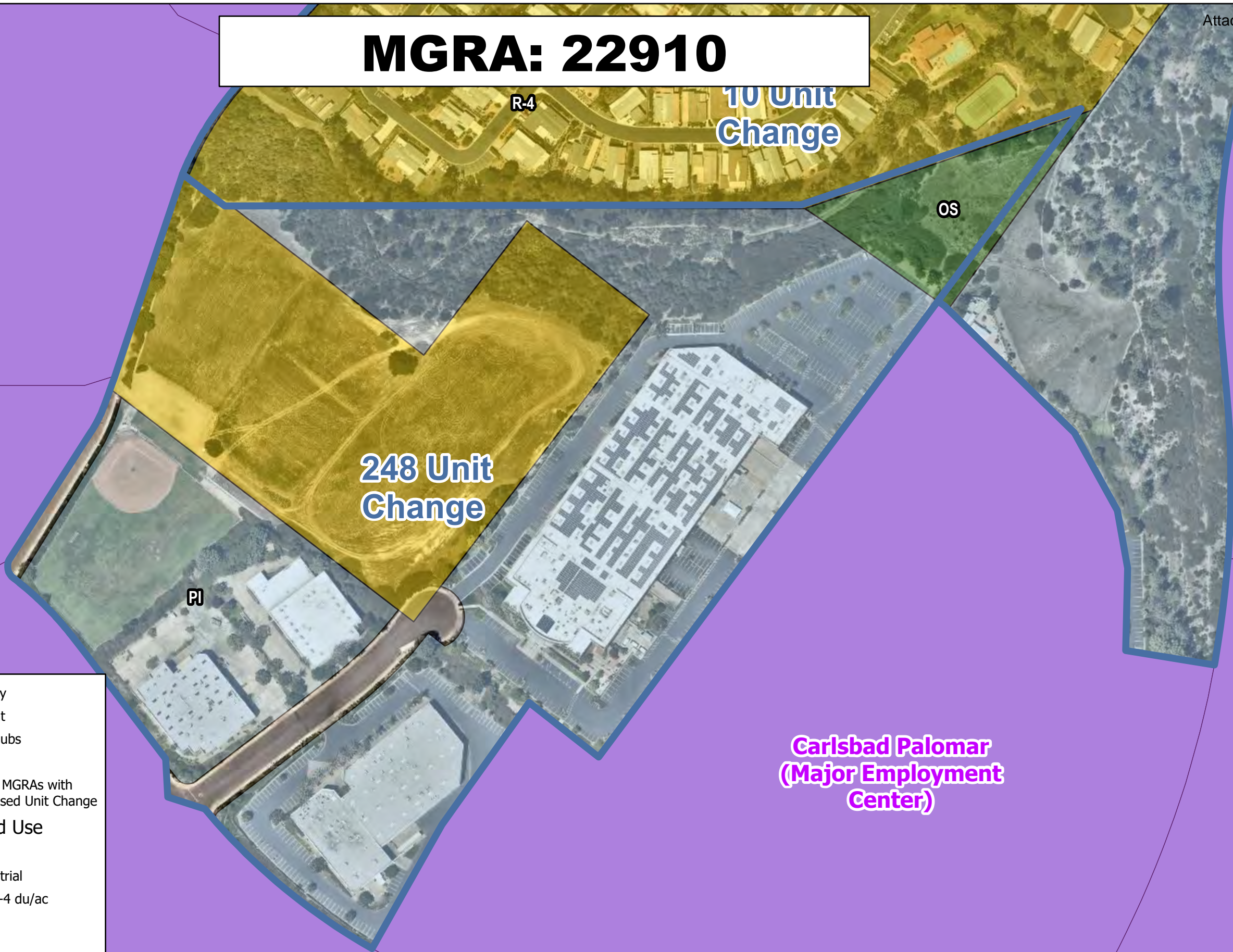

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Miles

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# MGRA: 22910

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  OS, Open Space
-  PI, Planned Industrial
-  R-4, Residential 0-4 du/ac

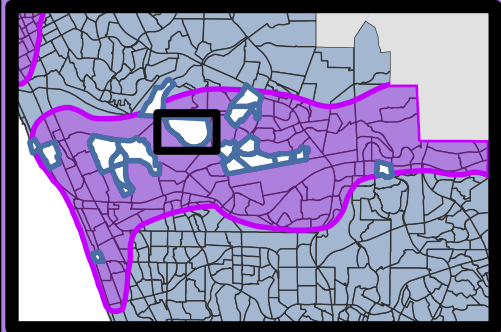
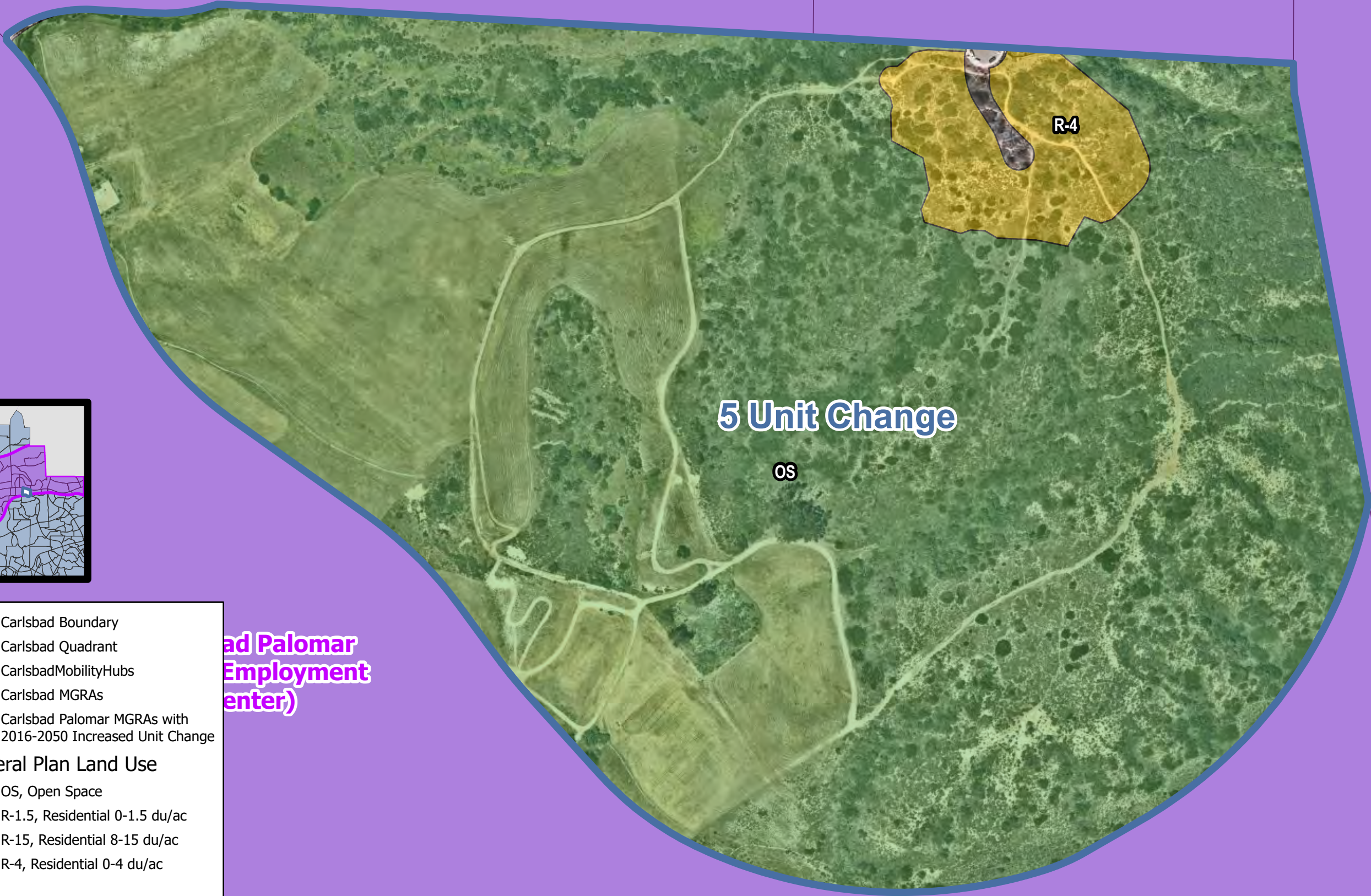

N






0 0.01 0.03  
Miles

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



# MGRA: 22917

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  OS, Open Space
-  R-1.5, Residential 0-1.5 du/ac
-  R-15, Residential 8-15 du/ac
-  R-4, Residential 0-4 du/ac

N

0 0.02 0.04  
Miles

Carlsbad Palomar  
Employment  
(center)

217 Unit  
Change

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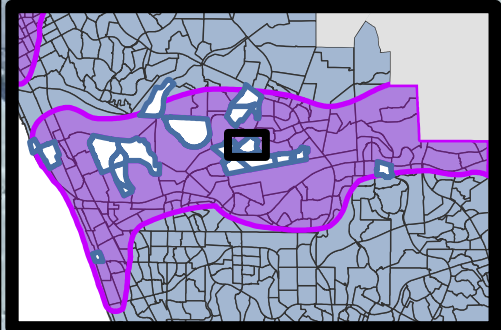








# MGRA: 22925

**Carlsbad Palomar  
(Major Employment  
Center)**



**79 Unit  
Change**

**178 Unit  
Change**

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  OS, Open Space
-  PI, Planned Industrial

N

0 0.01 0.03  
Miles

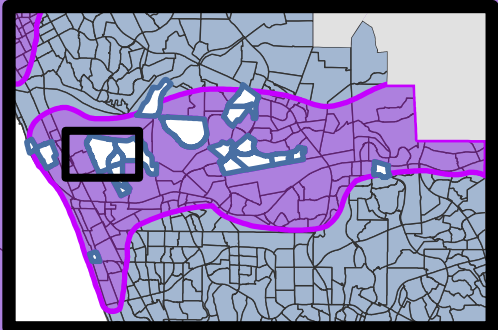
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# MGRA: 22926

Owned by  
CB Ranch  
Enterprises

Owned by Gemological Institute  
of America



Carlsbad Palomar  
(or Employment  
Center)

521 Unit  
Change

OS  
1010 Unit  
Change

415 Unit  
Change

581 Unit  
Change

VC

OS

PI



- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

### General Plan Land Use

- OS, Open Space
- PI, Planned Industrial
- R, Regional Commercial
- VC, Visitor Commercial

N



0 0.03 0.05



Miles

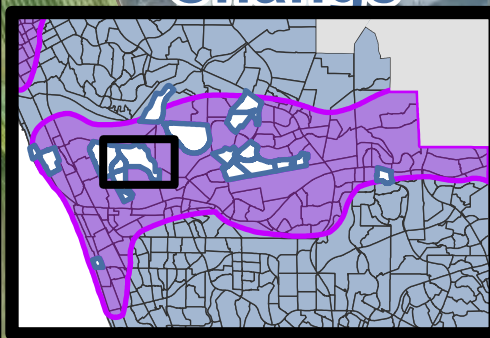
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# MGRA: 22928

Owned by M and A Gabae

Carlsbad Palomar (Major Employment Center)



**CITY OF CARLSBAD CALIFORNIA**

- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

- OS, Open Space
- PI, Planned Industrial
- VC, Visitor Commercial

0 0.02 0.04 Miles

Owned by Grand Pacific Carlsbad LP

VC designation does not allow residential uses

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# MGRA: 22930

5 Unit Change  
OS

217 Unit Change

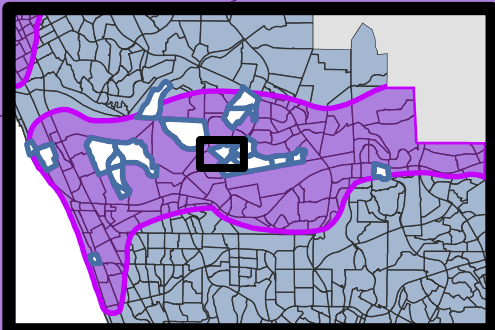
79 Unit Change

178 Unit Change  
PI

162 Unit Change

OS

PI/O



Carlsbad Palomar  
Employment Center



- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

### General Plan Land Use

- OS, Open Space
- PI, Planned Industrial
- PI/O, Planned Industrial/Office

N



0 0.01 0.03



Miles

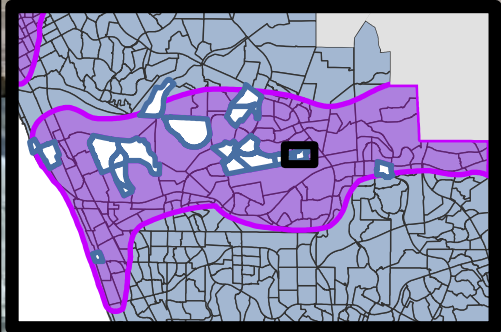

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# MGRA: 22931


**Carlsbad Palomar  
(Major Employment  
Center)**

**49 Unit  
Change**

-  Carlsbad Boundary
-  Carlsbad Quadrant
-  Carlsbad Mobility Hubs
-  Carlsbad MGRAs
-  Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

-  PI, Planned Industrial

N

0 0.01 0.02  
Miles

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# MGRA: 22933

217 Unit Change

79 Unit Change

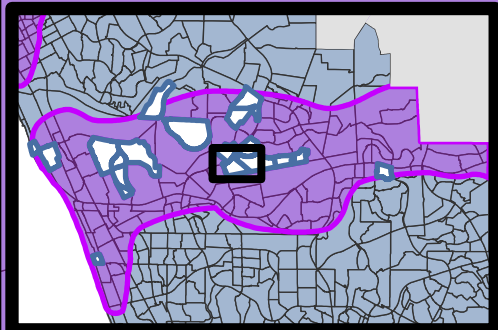
162 Unit Change

178 Unit Change

PI/O

PI

OS



- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

### General Plan Land Use

- OS, Open Space
- P, Public
- PI, Planned Industrial
- PI/O, Planned Industrial/Office

N



0 0.01 0.03

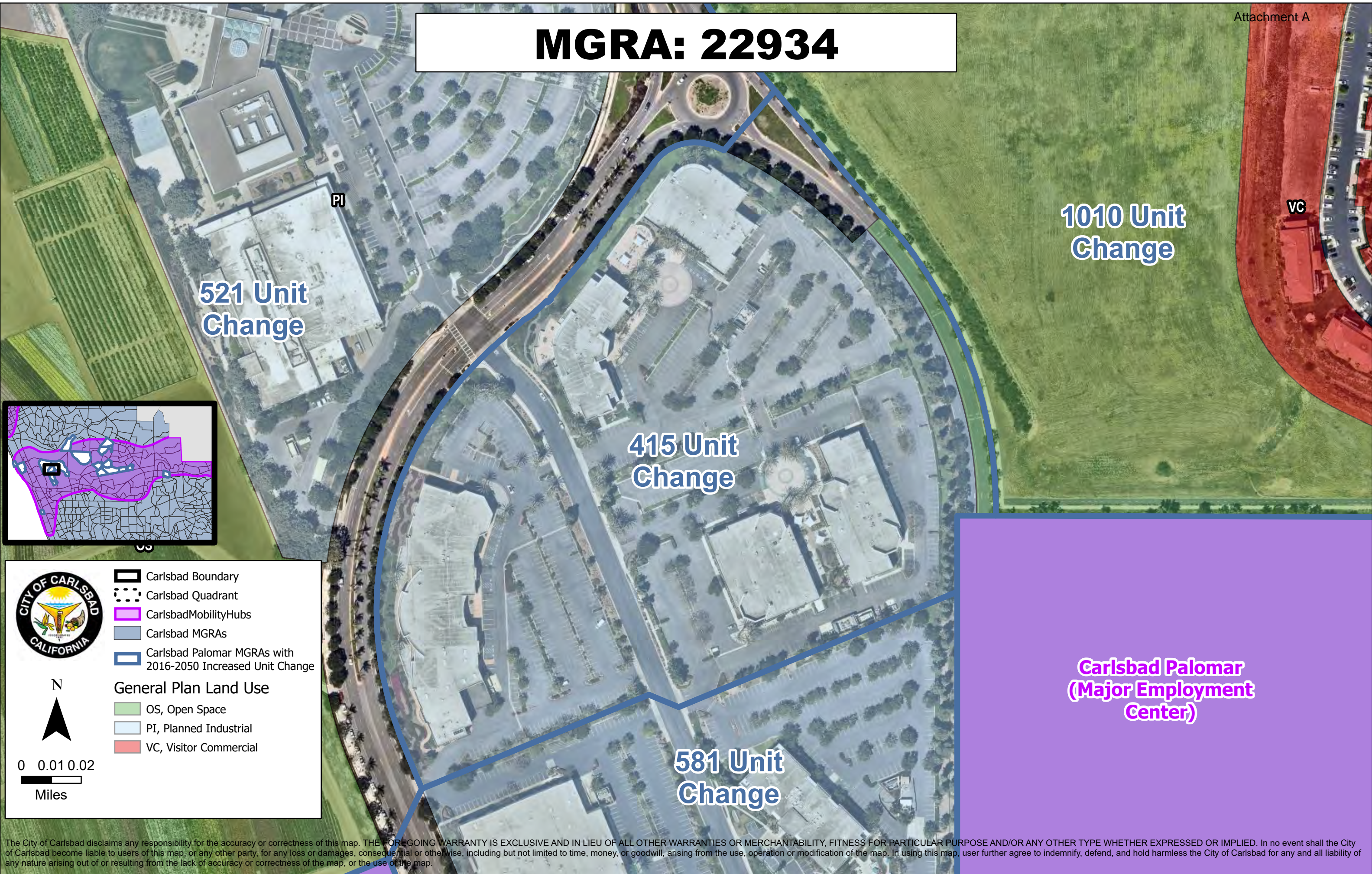


Miles

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# MGRA: 22934



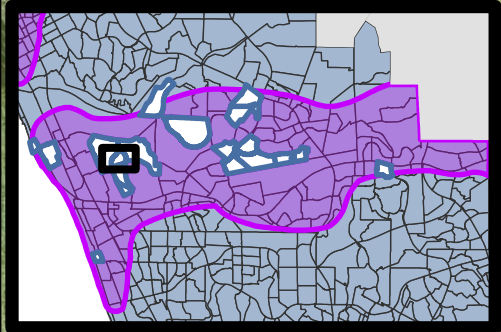
521 Unit Change

1010 Unit Change

415 Unit Change

581 Unit Change

Carlsbad Palomar  
(Major Employment Center)



**CITY OF CARLSBAD CALIFORNIA**

- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

- OS, Open Space
- PI, Planned Industrial
- VC, Visitor Commercial

0 0.01 0.02 Miles

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# MGRA: 22936

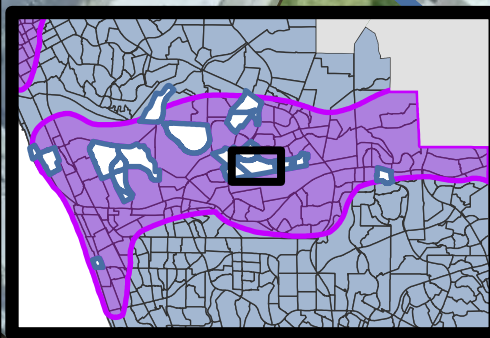
217 Unit Change

79 Unit Change

178 Unit Change

51 Unit Change

162 Unit Change



- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

### General Plan Land Use

- OS, Open Space
- P, Public
- PI, Planned Industrial
- PI/O, Planned Industrial/Office

N



0 0.01 0.03



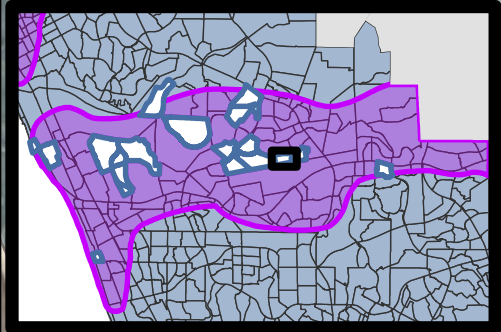
Miles

**Carlsbad Palomar  
(Major Employment Center)**

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# MGRA: 22937



**CITY OF CARLSBAD CALIFORNIA**

- Carlsbad Boundary (thick black line)
- Carlsbad Quadrant (dotted black line)
- Carlsbad Mobility Hubs (pink shaded area)
- Carlsbad MGRAs (light blue shaded area)
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change (thick blue outline)

**General Plan Land Use**

- P, Public (light blue shaded area)
- PI, Planned Industrial (light blue shaded area)

N

0 0.01 0.01 Miles

**Carlsbad Palomar  
(Major Employment Center)**

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# MGRA: 22941

Change

1010 Unit Change

VC

521 Unit Change

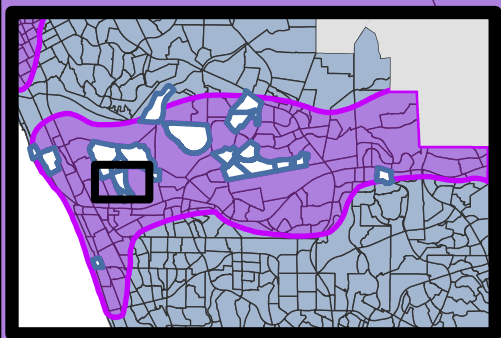
581 Unit Change

PI

Carlsbad Palomar  
(Major Employment Center)

228 Unit Change

VC



- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

### General Plan Land Use

- OS, Open Space
- PI, Planned Industrial
- R, Regional Commercial
- VC, Visitor Commercial

N



0 0.02 0.04

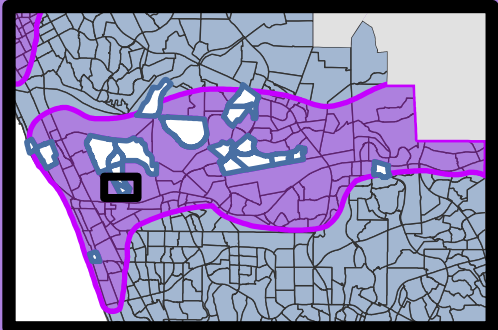
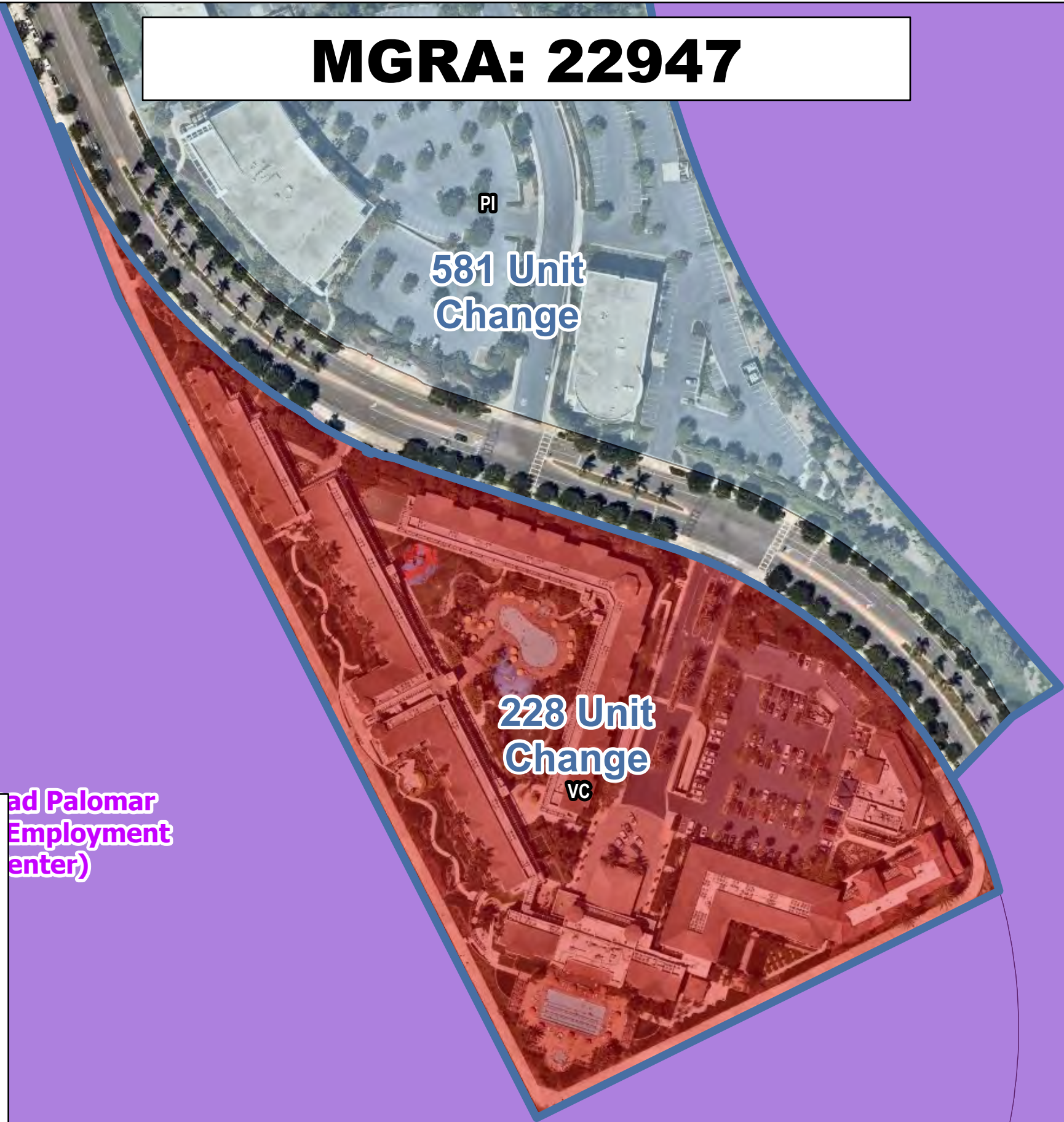


Miles

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# MGRA: 22947



**CITY OF CARLSBAD CALIFORNIA**

- Carlsbad Boundary
- Carlsbad Quadrant
- Carlsbad Mobility Hubs
- Carlsbad MGRAs
- Carlsbad Palomar MGRAs with 2016-2050 Increased Unit Change

**General Plan Land Use**

- OS, Open Space
- PI, Planned Industrial
- VC, Visitor Commercial

N

0 0.01 0.02 Miles

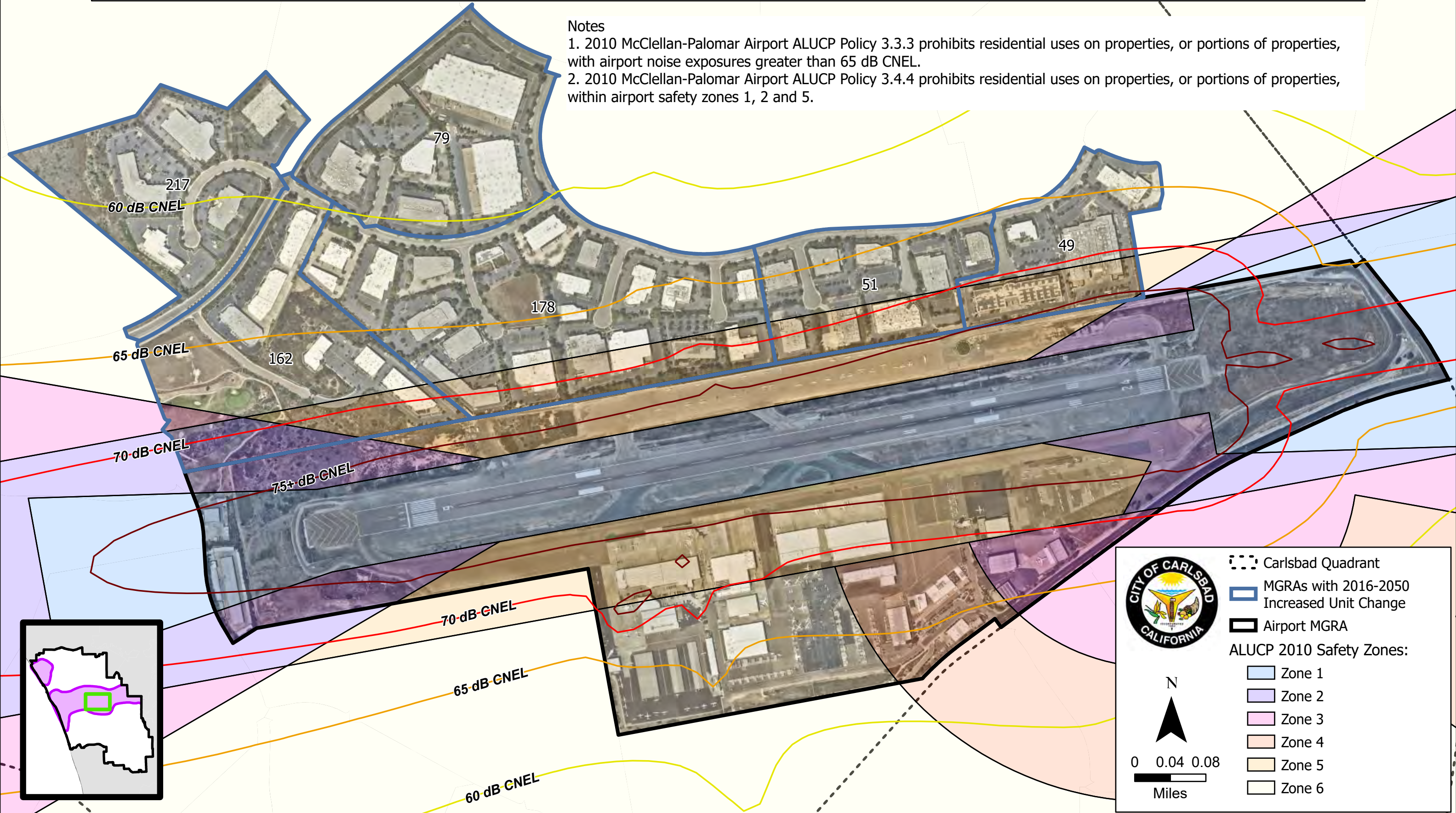
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# Carlsbad Palomar Mobility Hub MGRAs Near Airport

### Notes

1. 2010 McClellan-Palomar Airport ALUCP Policy 3.3.3 prohibits residential uses on properties, or portions of properties, with airport noise exposures greater than 65 dB CNEL.
2. 2010 McClellan-Palomar Airport ALUCP Policy 3.4.4 prohibits residential uses on properties, or portions of properties, within airport safety zones 1, 2 and 5.



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## PLEASE NOTE: PRELIMINARY RIDERSHIP DATA - UNAUDITED AND SUBJECT TO ADJUSTMENTS

Month	COASTER - TOTAL RIDERSHIP			
	FY21	FY20	Variance	%
July	10,263	149,515	(139,252)	(93.1%)
Aug	9,412	133,482	(124,070)	(92.9%)
Sept	10,020	114,233	(104,213)	(91.2%)
Oct	10,968	111,045	(100,077)	(90.1%)
Nov	9,232	94,551	(85,319)	(90.2%)
Dec	7,519	83,951	(76,432)	(91.0%)
Jan	6,848	98,791	(91,943)	(93.1%)
Feb	7,866	91,845	(83,979)	(91.4%)
Mar	11,203	46,510	(35,307)	(75.9%)
Apr	15,184	5,244	9,940	189.5%
May	19,214	6,207	13,007	209.6%
June**	44,978	8,734	36,244	415.0%
YTD Total	162,707	0	(781,401)	
FY Total	162,707	944,108		

\*\*Not final as of July 19, 2021

Month	COASTER - WEEKDAY			
	FY21	FY20	Variance	%
July	10,263	131,218	(120,955)	(92.2%)
Aug	9,412	112,100	(102,688)	(91.6%)
Sept	10,020	92,159	(82,139)	(89.1%)
Oct	10,968	105,601	(94,633)	(89.6%)
Nov	9,232	80,912	(71,680)	(88.6%)
Dec	7,519	75,534	(68,015)	(90.0%)
Jan	6,848	89,920	(83,072)	(92.4%)
Feb	7,866	84,613	(76,747)	(90.7%)
Mar	11,203	44,368	(33,165)	(74.7%)
Apr	15,184	5,244	9,940	189.5%
May	17,221	6,207	11,014	177.4%
June**	35,192	8,734	26,458	302.9%
YTD Total	150,928	0	(685,682)	
FY Total	150,928	836,610		

\*\*Not final as of July 19, 2021

Month	COASTER - SATURDAY			
	FY21	FY20	Variance	%
July	-	9,415	(9,415)	(100.0%)
Aug	-	14,348	(14,348)	(100.0%)
Sept	-	8,449	(8,449)	(100.0%)
Oct	-	3,247	(3,247)	(100.0%)
Nov	-	8,385	(8,385)	(100.0%)
Dec	-	4,387	(4,387)	(100.0%)
Jan	-	3,218	(3,218)	(100.0%)
Feb	-	5,181	(5,181)	(100.0%)
Mar	-	665	(665)	(100.0%)
Apr	-	0	0	
May	1,387	0	1,387	
June**	5,881	0	5,881	
YTD Total	7,268	0	(50,027)	
FY Total	7,268	57,295		

\*\*Not final as of July 19, 2021

Month	COASTER - SUNDAY			
	FY21	FY20	Variance	%
July	-	8,882	(8,882)	(100.0%)
Aug	-	7,034	(7,034)	(100.0%)
Sept	-	13,625	(13,625)	(100.0%)
Oct	-	2,197	(2,197)	(100.0%)
Nov	-	5,254	(5,254)	(100.0%)
Dec	-	4,030	(4,030)	(100.0%)
Jan	-	5,653	(5,653)	(100.0%)
Feb	-	2,051	(2,051)	(100.0%)
Mar	-	1,477	(1,477)	(100.0%)
Apr	-	0	0	
May	606	0	606	
June**	3,905	0	3,905	
YTD Total	4,511	0	(45,692)	
FY Total	4,511	50,203		

\*\*Not final as of July 19, 2021

## ATTACHMENT 6 – Project Data Request

**Table 1: Project Information Request**

Project	Estimated Total Project Cost	Current Planned Year of Construction	Draft RTP Assumed Year of Construction	Assumed Federal/State Matching Funding (%)
San Dieguito Lagoon Double Track and Platform				
Batiquitos Lagoon Double Track and Bridge Replacement				
Eastbrook to Shell Double Track				
Carlsbad Village Trench				
La Costa to Swami Double Track				
San Onofre Bridge Replacements				
Rose Canyon Bridge Replacements				





## CITY OF CORONADO

1825 STRAND WAY  
CORONADO, CA 92118  
WWW.CORONADO.CA.US

(619) 522-7335  
FAX (619) 522-7846

July 21, 2021

Philip Trom  
Senior Regional Planner  
Attn: 2021 Regional Plan  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

**Via USPS and Email:** [SDForward@sandag.org](mailto:SDForward@sandag.org)

**Subject:** Comments on the San Diego Forward: 2021 Regional Plan

Dear SANDAG staff:

Thank you for the opportunity to review the San Diego Forward: 2021 Regional Plan (2021 Regional Plan). The City of Coronado (City) appreciates SANDAG's ambitious plan to improve the San Diego region's mobility options, reduce greenhouse gas emissions, address traffic congestion, advance technology related to transportation services, and improve regional transportation infrastructure. While the City is generally supportive of the 2021 Regional Plan, there are several areas of concern, including the inclusion of a mobility hub in the Orange Avenue Business District / village area, the potential for housing unit allocation to increase given the inclusion of a mobility hub, the assumption that the 2021 Regional Housing Needs Allocation (RHNA) is final, the depiction of new mixed use areas in the City, and the strategy of minimum zoning near transit. These main concerns are summarized below.

First, and most notably, during the South Bay to Sorrento Comprehensive Multimodal Corridor Plan (CMCP) engagement process, City staff expressed concern about the Orange Avenue Business District / village area being designated a Mobility Hub without meaningful engagement with City residents and the City Council. It is highly unlikely the City would agree to construction of a new mobility hub in the Orange Avenue corridor. Therefore, the City requests the mobility hub be removed from both the South Bay to Sorrento CMCP and the 2021 Regional Plan.



As stated in the City's "Comments on the South Bay to Sorrento Comprehensive Multimodal Corridor Plan" letter dated July 7, 2021, the City has about 23,639 residents (ACS 2019) and a compact, fully developed village area covering about two square miles surrounded by the San Diego Bay and the Pacific Ocean. The City is highly constrained and does not have additional development capacity or any buffer zones to establish a mobility hub in our village area. While the City is supportive of on-demand travel options, it is difficult to imagine where facilities for the "Flexible Fleets" and "Transit Leaps" might be sited, such as ride hailing zones, electric vehicle charging stations, micro-mobility parking areas, parcel delivery lockers, and sidewalk delivery bots. The description of mobility hubs also includes drone technology, which is a concern given the proximity to Naval Air Station North Island (NASNI).

The designation of the City's village as a mobility hub is also concerning as it relates to the future of housing allocations for Coronado. Presumably, given the State and SANDAG's priority to increase housing density in transit rich areas, mobility hubs and related transportation investment may have a significant adverse impact in Coronado's village area. The 2021 Regional Plan refers to mobility hubs as areas "to concentrate future development." The City is concerned that the designation of the village area as a mobility hub will lead to continued increased regional housing needs allocations, which will negatively impact the City's character, in addition to the challenge of space and regulatory limitations to accommodate more high-density housing.

In the event that the village area continues to be designated as a mobility hub, the City asks that the use of drone security be removed from the plan due to privacy and safety concerns, that the use of e-bikes or scooters be limited and orderly, and that new facilities not block or impede pedestrian movement. Finally, before any strategies are implemented within the village area, more public outreach and interagency collaboration will be required to inform Coronado residents of the plan.

In addition to the City's concern for a mobility hub in the village, the City finds that the 2021 Regional Plan presupposes that 2021-2029 RHNA is finalized although there is pending litigation related to the RHNA. To address this issue, the City asks that the following language be inserted as a footnote on p.33 of the 2021 Regional Plan, after the sentence: "The SANDAG Board of Directors adopted the RHNA Plan on July 10, 2020, with the final housing unit allocation" to read:

*In September 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court challenging, among other things, the Board's adoption of the RHNA Plan. SANDAG demurred to the cities' Petition and the demurrer was sustained by the court in February 2021. The petitioning cities have appealed the ruling on the demurrer to their Writ Petition, and that appeal remains pending in the Fourth District Court of Appeal.*



In addition, the City proposes to add the the following paragraph to the end of p.14 of Appendix K:

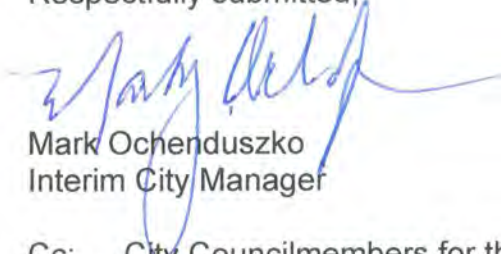
*On September 24, 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court, Case No. 37-2020-00033974-CU-MC-CTL, against SANDAG and SANDAG's Board of Directors seeking an order requiring that SANDAG give those cities a fair hearing on their RHNA appeals and decide the cities' appeals in a legal manner without bias and without the use of the weighted voting mechanism. Specifically, the petitioning cities asked the court to order: (1) that the final RHNA allocation approval by SANDAG be rescinded; (2) that SANDAG's denial of the cities' RHNA appeals be rescinded; (3) that the appeals be remanded to SANDAG for fair consideration; and (4) that SANDAG be prohibited from utilizing a weighted vote on the cities' RHNA appeals. On February 5, 2021, SANDAG's demurrer to the Petition for Writ of Mandate was sustained by the Superior Court. The petitioning cities have appealed the ruling on the demurrer to their Writ Petition. That appeal remains pending in the Fourth District Court of Appeal. So long as the litigation is pending, the Board's adoption of the RHNA Plan cannot be considered final.*

Aside from the main concerns of the village area as a potential mobility hub and the presupposition of a finalized RHNA, the City has additional comments about the 2021 Regional Plan:

- A new Rapid route is depicted from Downtown to NASNI. The City would be interested in extending this route further into the commercial village area.
- The description of the Transportation Demand Programs includes language that suggests that employers will be required to provide transportation benefits. The City does not support requiring local businesses to provide specific benefits and would not enforce this or any other mandatory regulatory actions.
- Appendix A identifies a new off-street bike path on Glorietta Boulevard. The City's Active Transportation Master Plan does not identify such a future improvement, the Bayshore Bikeway Plan recommends no changes to this area, and there is already a bike lane on Glorietta Boulevard. Please update A.12 and A.13.
- In Appendix B one of the strategies to increase housing affordability is to minimize zoning near transit. Since most of the village area is near transit, the City would not implement strategies that adversely alters its community character through reduced zoning requirements or eliminated single family zoning.
- In the land use maps in Appendix F, there are some areas of Coronado shown as mixed use. Although there is some existing, non-conforming mixed-use development in the City, there are no areas in the City that are zoned for mixed use, and there are no plans to zone additional areas for new mixed-use.
- The City generally supports improvements to the public transportation system, but encourages SANDAG to do so in a manner that does not compromise necessary road maintenance and improvement projects.
- The City also supports new waterborne transportation options, such as ferry routes, and encourages SANDAG to prioritize the financing and expansion of waterborne transportation options in its regional planning documents.

Once again, thank you for the opportunity to comment on the 2021 Regional Plan. We look forward to seeing an amended plan in the future.

Respectfully submitted,

A handwritten signature in blue ink, appearing to read "Mark Ochendusko", with a long horizontal flourish extending to the right.

Mark Ochendusko  
Interim City Manager

Cc: City Councilmembers for the City of Coronado



# CITY OF OCEANSIDE

DEVELOPMENT SERVICES DEPARTMENT / PLANNING DIVISION

August 6, 2021

San Diego Association of Governments (SANDAG)  
401 B Street, Suite 800  
San Diego, CA 92101

RE: San Diego Forward: The Regional Plan

The City of Oceanside Planning Division appreciates the opportunity to provide comment on the Draft 2021 Regional Plan.

- **Chapter 1: A Bold New Vision for the 2021 Regional Plan**

- We applaud SANDAG for prioritizing public safety, solutions to traffic congestion, social equity, GHG emission reduction, and air quality. We recommend that SANDAG also acknowledge open space and natural habitat preservation as a key priority of the Regional Plan. The long-term sustainability of the San Diego region, along with the quality of life of its residents, depends on the preservation of these resources. How will the San Diego region help to further the state's "30 by 30" goal, as outlined in Executive Order EO N-82-20?
- We encourage SANDAG to consult with the scientific community on the most recent sea level rise projections for the region's coastline. It is our understanding that NASA now projects sea level rise of less than one foot by 2050, based on roughly three inches of sea level rise over the past decade. While there are many factors that could contribute to significantly greater sea level rise over this period, we believe it important to base regional planning efforts on the most likely sea level rise scenario.
- The modest goals for mobility mode shift over the planning period (reducing SOV commutes by 18% and increasing transit ridership by 10%) do not seem commensurate with the major changes the Five Big Moves would bring to the region. What are the main impediments to achieving more ambitious mobility mode shift goals? What strategies, if any, are available to overcome these impediments?
- The regional population forecast for this iteration of the regional plan shows substantially less population growth through 2050 than that projected in prior forecasts. Should this most recent growth forecast prove accurate, there will inevitably be less tax and user fee revenue to support the region's transportation system. To what extent has lower population growth, and concomitant lower regional funding, been factored into the economic analysis of the Five Big Moves?
- It is noted that over the next three decades 60% of the region's population growth will be among those who are 75 years old and older. How well do we understand the current and evolving mobility needs and preferences of this demographic, and

how will transportation infrastructure and services be designed to accommodate these needs and preferences? How will the region's elderly population benefit from active transportation improvements? How will the elderly access transit? What accommodations will need to be made to ensure that the elderly have equal access to the region's mobility network?

- **Chapter 2: Sustainable Communities Strategy (SCS)**

- The Draft SCS establishes the overarching goal of a fast, fair, and clean mobility network. It will be important to devise and consistently apply appropriate metrics for evaluating how mobility improvements and services further this goal.
  - With regard to the relative speediness of new or enhanced mobility options, it would be worthwhile to consider how travel times associated with alternative modes compare with those associated with SOV automobile trips.
  - In addition to evaluating the fairness of a particular improvement or service in terms of access, cost, and functionality, it would be worthwhile to also consider the relative safety and comfort of mobility options as experienced by different user groups.
  - While air quality and GHG emissions are fundamental considerations in determining the cleanliness of the mobility network, so too are water quality, soil quality, hazardous materials, and solid waste management.
- While user fees are both an important revenue source and a potentially powerful means of encouraging more sustainable modes of transportation, it is important that such fees not create financial hardship for lower-income households. To avoid a regressive and inequitable user fee regime, subsidies should be provided to those with both limited financial means and limited mobility options.
- The efficient movement of goods into and through the San Diego region is essential to the health and stability of the regional economy. Assessment of the efficiency of goods movement should consider how delivery systems contribute to overall VMT and how these systems can further evolve to minimize their environmental impacts, including their contributions to traffic congestion, air pollution and GHG emissions, roadway wear-and-tear, and noise.
- Preparation and implementation of the sub-regional Comprehensive Multimodal Corridors Plans (CMCPs) is identified as a priority in the Draft Regional Plan. Oceanside staff has been participating in task force meetings on the North County CMCP. In these meetings, we have noted that Caltrans facilities that extend through Oceanside often serve as barriers to active transportation and connectivity between neighborhoods. For example, SR 76 bifurcates neighborhoods in the San Luis Rey Valley, separating residents from commercial areas, recreational facilities, and other community assets. The absence of grade-separated crossings on SR 76 contributes to the highway's impact as a physical and psychological



barrier. The Planning Division recommends that improvements to SR 76, SR 78, and I-5 incorporate new and upgraded pedestrian and bicycle facilities that enable safer and more convenient crossings of these roadways.

- To a large extent, the success of mobility hubs will depend on the level of comfort and engagement they provide to those who travel through them. The design of mobility hubs should therefore emphasize safety, security, accessibility, visual quality, and a strong sense of place. Mobility hubs have the potential to serve as gathering spaces, cultural venues, and entertainment districts. Improvements and services within mobility hubs should contribute to, and not detract from, the character and appeal of these areas.
- It is noted that the Draft Regional Plan considers air pollution exposure reduction strategies promulgated by AB 805 and other state legislation and guidance. While most of these strategies rightly focus on underserved communities, it is important to note that as smart growth takes hold in the region and new housing is built in closer proximity to major roadways and transit facilities, residents across the socioeconomic spectrum could be exposed to excessive levels of air pollution. As we facilitate cleaner forms of transportation, we can also consider ways to enhance both indoor and outdoor air quality in highly urbanized areas through landscaping, ventilation systems, weather-stripping, etc.
- State Route 76 is identified in the SCS as a “rural corridor.” While much of this highway extends through rural areas, most segments of SR 76 in Oceanside abut urbanized areas. Accommodating both pass-through and local trips, these segments of SR 76 could benefit from some of the same improvements and programming slated for other highways in the region.
- Consider Oceanside as a testing ground for the piloting of Next OS technologies, particularly those that serve lower-income residents and those who reside in areas with limited transit options.
- In partnership with the Orange County Transit Authority (OCTA) and NCTD, consider rapid bus service between southern Orange County and the Oceanside Transit Center.
- The SCS calls for implementation of “innovative demand and system management” programs. The City of Oceanside has recently adopted TDM standards for new non-residential development of certain types and scales. The City is also exploring possible incentives for TDM in existing non-residential development. Regional funding and/or technical support for TDM plans would be a powerful incentive for existing businesses to consider ways to promote alternative commuting options.
- As other local jurisdictions have done, the City of Oceanside intends to reduce lanes and implement roundabouts within one of its major commercial corridors (Coast Highway). One of the biggest challenges to implementing “road diets” is maintaining adequate right-of-way for buses and ample curb space for flex fleet service. Regional guidance on road diet design that supports alternative mobility



options, developed in partnership with regional transit and flex fleet providers, would be helpful.

- The proliferation of warehousing and distribution facilities in the San Diego region has major implications for land use, economic development, and climate mitigation. These facilities tend to occupy large tracts of land while providing relatively few jobs per acre. Vehicle trips generated by these facilities can contribute significantly to VMT and associated GHG emissions. We encourage SANDAG to consider guidelines and incentives that promote innovation in the warehousing and distribution sector (e.g., more efficient land use, zero-emission vehicle fleets, etc.).
- Value pricing of public parking facilities is key to facilitating efficient use of these resources, generating revenue for local transportation improvements, encouraging alternative modes of transportation, and motivating efficient use of private parking facilities. While parking pricing is largely within the authority of local jurisdictions, SANDAG can support localities in navigating the technical and political challenges of implementing value pricing programs.
- **Chapter 3: Paying for the Regional Plan, Forming Partnerships and Taking Action, and Monitoring How the Plan Performs**
  - Performance monitoring, as illustrated in Table 3.1, should include public health benchmarks, particularly those that provide insight on the public health impacts of air pollution, lack of access to healthy food, sedentary lifestyles, etc.
- **Appendix A: Transportation Projects, Programs, and Phasing**
  - In Figure A.1, SR 76 and SR 78 are not identified as significant corridor geographies, while SR 56, SR 94, and SR 125 are identified as such. The Planning Division recommends that these two important regional roadways be identified in the same manner as other east-west highways in the region.
  - As identified in Table A.11, the Inland Rail Trail (IRT) through Oceanside is not shown as being implemented until 2035. The IRT is a crucial component of the North County bicycle trails network, facilitating access to NCTD Sprinter rail and Breeze bus services, connecting cyclists to the Coastal Rail Trail, activating north-south bikeways (e.g., El Camino Real, College Boulevard), and contributing to complete streets improvements within the Oceanside Blvd corridor. The Planning Division thus recommends that the Draft Regional Plan commit to implementation of this segment of the IRT by 2025.
  - The Planning Division recommends that acquisition of land in mobility hub areas be identified as a higher priority, as property aggregation will be key to efficient redevelopment of many of these areas.
  - The extension of Melrose Drive and the interchange at Highway 78 and Rancho del Oro are not listed among the arterial improvements in Table A.13. Both of these

improvements are listed in the City's Circulation Element (CE). While the City is currently contemplating removal of the extension from Santa Fe Avenue to Spur Avenue from the CE, the unconstructed segment between North River Road and State Route 76 will remain.

- **Appendix B: Implementation Actions**

- Implementation Action 9 calls for expansion of regional programs on low-carbon transportation options, roadway safety and maintenance, and nature-based climate solutions. While the Planning Division supports nature-based climate solutions where feasible, we note that certain stretches of the region's coastline face imminent threat from coastal hazards and are not amenable to nature-based solutions. The Planning Division encourages SANDAG to support near-term coastal adaptation measures that address urgent local conditions and buy time for the development and implementation of long-range adaptation strategies.
- In addition to the enumerated strategies to increase housing availability and affordability (p. 19), the Planning Division encourages SANDAG to consider gap financing for inclusionary housing projects that do not qualify for tax credit financing and/or other federal and state subsidies. In determining eligibility for gap financing, SANDAG should consider key sustainability metrics – e.g., proximity to transit, employment, and essential services, energy efficiency and renewable energy sourcing, pedestrian-oriented design, resilient building materials, etc.
- The Planning Division applauds SANDAG for recognizing that the relatively low resale value of certain electric vehicles presents an opportunity for lower-income households to enter the electric vehicle market. SANDAG can further support EV ownership in low-income and historically disadvantaged communities by coordinating with dealerships in the region on marketing and financing programs.
- The “Fix It First” implementation strategy is described as “bringing transit and road infrastructure back to optimal performance.” The Planning Division questions the notion that the region's mobility infrastructure has ever demonstrated “optimal performance.” Perhaps a better catch-phrase here would be something akin to “Build Back Better,” as this speaks to more than just perpetuating the status quo.
- In its consideration of tools and strategies that provide for the effective operation and management of regional infrastructure as a coordinated system, SANDAG should work closely with local jurisdictions to identify, enhance, and integrate local data collection and traffic management programs into a regional whole. The City of Oceanside maintains a Traffic Management Center that, with adequate staffing, has the potential to provide real-time traffic data to support signal optimization and other efficiencies.

- **Appendix F: Regional Growth Forecast and Sustainable Communities Strategy Land Use Pattern**
  - The Planning Division is concerned that the most recent iteration of the regional population forecast may significantly underestimate Oceanside’s capacity for additional population, housing, and employment. We understand that the statewide forecast prepared by the Department of Finance shows considerably less growth in the San Diego region over the next three decades than previously anticipated, and we acknowledge that population and housing growth in Oceanside has been declining over the past 20 years. Nevertheless, housing demand in Oceanside remains strong, and the City is still one of the most affordable housing markets in the San Diego region. Moreover, the local employment base continues to grow, particularly in the manufacturing, health care, and hospitality sectors. We believe Oceanside has the potential to accommodate significant growth through infill and redevelopment, and that the revitalization of the City’s urban corridors will draw new residents and employers. The City’s outdated General Plan has likely contributed to low growth projections over the past three forecast periods (2008, 2012, and 2016). The City is currently in the process of updating its General Plan, with the intent to incentivize infill and redevelopment through new zoning standards, a streamlined review process, CEQA clearance, and targeted infrastructure improvements.

The City of Oceanside Planning Division again thanks SANDAG for the opportunity to comment on the Draft Regional Plan. Planning staff looks forward to working with SANDAG on the refinement and implementation of this important document. Questions and comments can be directed to Russ Cunningham at [rcunningham@oceansideca.org](mailto:rcunningham@oceansideca.org) or (760) 435-3525.

Sincerely,



Russ Cunningham, Principal Planner  
[rcunningham@oceansideca.org](mailto:rcunningham@oceansideca.org)  
760-435-3525



# CITY OF OCEANSIDE

## PUBLIC WORKS DEPARTMENT

**August 4, 2021**

San Diego Association of Governments (SANDAG)  
401 B Street, Suite 800  
San Diego, CA 92101

**RE: San Diego Forward: The 2021 Regional Plan**

The City of Oceanside Traffic Engineering Division appreciates the opportunity to provide comment on the Draft Regional Plan.

1. The SANDAG website states, "The SANDAG Sustainable Communities Strategy and Final EIR from its 2015 Regional Plan will remain valid and in compliance for purposes of state funding eligibility and other state and federal consistency purposes until the SANDAG Board of Directors adopts a new Regional Plan and EIR, provided those actions are completed by the end of December 2021." SANDAG needs to clarify how the Draft EIR, Response to Comments and Adoption will be completed this year and what will occur if they are not completed by the end of this year. SANDAG should also clarify how comments on the plan are going to be addressed in the Draft EIR prior to its release.
2. Looking at the detailed data provided by SANDAG it is not clear why the citywide numbers only show moderate increases in population. See comments provided by the City's Planning Division.
3. In *Appendix A: Transportation Projects, Programs, and Phasing*, it should be noted that Trips to and from school sites result in a significant congestion, VMT generation, and peak hour delay throughout the region. Additional funding and projects should be recommended with a specific focus on improving safety and multimodal access in and around school sites along with programs to incentivize non-single occupancy vehicle trips to schools.
4. Considering FHWA's project for Accelerating Roundabout Implementation in the United States, and the County of San Diego Air Pollution Control Board's support for implementing roundabouts to address GHG and reduce fatalities, the Plan should incorporate policies to promote roundabouts over signalized intersections and include a line item under the Complete Corridors to fund the construction of roundabouts at new locations and replace signalized intersections when found feasible.

Specific Comments on the Appendices

**Appendix A: Transportation Projects**

Descriptions of the following projects are insufficient. In order to provide comments, the City requests that SANDAG provide more detailed project description, information and clarifications for the following projects:

Oceanside Active Transportation Projects

1. **AT030: Coastal Rail Trail Oceanside- Alta Loma Marsh Bridge 2035.**

The Regional Plan's cost estimate is \$4 million. The actual estimate prepared by the City is \$9 million. Please clarify or correct.

2. **AT031: Coastal Rail Trail Broadway to Eaton 2035.**

The project cost is estimated at \$1 million. The Regional Plan recommends trail extension to Eaton Street, with Eaton providing connection to the existing Coastal Trail segment on Coast Hwy. The City's preferred routing is to extend this trail to the south end of Broadway, then obtain easement from the Buena Vista Audubon Society to continue the trail along the lagoon to connect to the Carlsbad section of the Coastal Rail Trail. We recommend the project description be amended accordingly. We also believe that a higher cost estimate needs to be included; \$1M is not an accurate cost estimate for this project.

3. **AT049: Inland Rail Trail 2035.**

The project cost is estimated at \$68M. It is difficult to evaluate the accuracy of this cost estimate without a preliminary engineering study of the potential alignments and the actual field conditions. It is likely the cost of this project will exceed \$70M.

4. **AT074: Coastal Rail Trail-Oceanside Segment 1ALT 2050.**

The project cost is estimated at \$6 million, with on-street routing from Neptune/Pacific to the NCTD station. It is difficult to assess this potential trail routing and the project's impacts potentially creating a need for street widenings in that area.

5. The City requests that the following two projects be added to the Regional Plan:

A. **A connection between the west and east side of I-5 at the SR-78 interchange for bicycle and pedestrian traffic.** Under existing conditions, there is no safe access for bicyclists and pedestrians across I-5 in this area.

B. **Bike infrastructure improvements on SR-76,** as repeatedly requested by Caltrans and the City of Oceanside.

**Appendix L: Oceanside Workshop**

The recommendations made in this section are the results of a conceptual community workshop on what might be considered, and the following recommendations mentioned in this appendix as

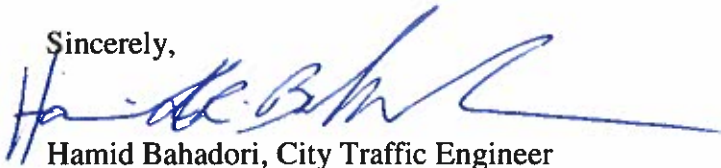


a result of this workshop shall by no means be construed as the City of Oceanside's official request and/or recommendations:

- Oceanside Boulevard reduced to two lanes with protected bikeways.
- The Strand closed to vehicle traffic and available only for bikes and pedestrians.

The City of Oceanside Traffic Engineering Division welcomes the chance to work with SANDAG staff and other stakeholders to ensure that the City's mobility needs and concerns are adequately addressed in the updated Regional Plan.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Hamid Bahadori', with a long horizontal flourish extending to the right.

Hamid Bahadori, City Traffic Engineer

[hbahadori@oceansideca.org](mailto:hbahadori@oceansideca.org)

760-435-5114

## Nikki Zanchetta

---

**From:** David De Vries <DDeVries@poway.org>  
**Sent:** Thursday, August 5, 2021 10:34 AM  
**To:** SDFORWARD  
**Cc:** Bob Manis  
**Subject:** 2021 Regional Plan Comments - City of Poway

**CAUTION: This email originated from outside of SANDAG. Do not click links or open attachments unless you are expecting the content.**

Thank you for allowing us to submit comments on the Draft 2021 Regional Plan.

Regarding Scripps Poway Parkway, the City of Poway would like to see vehicle, bike, pedestrian and transit infrastructure improvements and connections to be added from the Highway 67 through Scripps Poway Parkway to the I-15 Freeway. I have spoken to several property and business owners within the South Poway Business Park (SPBP) including Geico and parking is a constant issue. There is currently no public transit route into the SPBP. Having public transit, bike, pedestrian and highway/road improvements/connections providing better more efficient access to the SPBP is essential for future employment growth in the area. Many workers in the Poway area live in Ramona and East County and this is a vital connection for the City and the Region. SANDAG has also identified Scripps Poway as a Tier 3 employment center in their draft Employment Center analysis. Construction is also underway to add thousands of more employees in the SPBP. To be clear, we are recommending that Scripps Poway Parkway become a critical connection and a multimodal corridor ([https://www.sandag.org/uploads/publicationid/publicationid\\_4720\\_28341.pdf](https://www.sandag.org/uploads/publicationid/publicationid_4720_28341.pdf)).

Regarding the Hwy 67, please note that the City of Poway's General Plan Transportation Element includes a multi-use path on the west side of SR-67 (reference p. 3 <http://docs.poway.org/weblink/0/doc/50446/Electronic.aspx>). This multi-use path would include a separated two-way bike path and a fenced DG equestrian trail. The multi-use path provides a critical and safe pathway for hikers, bikers, runners, walkers, children, and equestrians. A multi-use path also creates a necessary loop between the City's Iron Mountain trailhead and other destinations (e.g., Mt. Woodson, Lake Poway) which is also a goal within the Transportation Element. We recommend the San Vicente corridor plan is consistent with the City's plans.

State Route 67 is also designated as a scenic roadway by the Poway General Plan. As a part of the General Plan requirements, a 50-foot wide landscape open space easement is required from adjacent property owners from the ultimate right-of-way line along State Route 67 when development is proposed. This easement shall be landscaped and modified as needed to enhance the scenic quality of the area as discussed in the General Plan Transportation Element Policy B – Scenic Roadways. Providing scenic roadway elements to the design will also help the corridor be more compatible with surrounding open space. To contribute to the General Plan goals, we would suggest that the right-of-way incorporate design elements consistent with a scenic roadway (e.g., naturalized decorative solid walls, native landscaped medians and shoulders, additional landscape areas and trees where feasible, earthen berms).

As a part of the San Diego Forward Plan and the 5 Big Moves Plan, SANDAG established the SR-67 corridor as a Comprehensive Multimodal Corridor Plan (CMCP) calling for a multimodal road along the SR-67 ([https://www.sdforward.com/docs/default-source/default-document-library/agenda-june-5-2020.pdf?sfvrsn=891afe65\\_4](https://www.sdforward.com/docs/default-source/default-document-library/agenda-june-5-2020.pdf?sfvrsn=891afe65_4)). As stated on p. 6-2 of the 2050 RTP, "Our region has consistently supported a multimodal approach to transportation that looks at the overall system and improvements that benefit all modes, rather than prioritizing one over the other. This approach gives all of the transportation system users choices traveling within and through the region." Further, "A well designed and thoughtfully integrated multimodal transportation system will give people choices, allowing them to select the transportation mode that is best suited for a particular trip. In an area as large and diverse as the San Diego region, this approach is necessary to make the best use of our limited

transportation resources.” As discussed, a multi-modal transportation system provides users transportation options and choices and thereby reduces traffic congestion and ghg emissions. Regional multi-use paths have been a great asset to communities across the country. Here in San Diego, the SR-56 Bike Path is separated from the highway and is often used by runners, walkers, and equestrians. In contrast, it is uncommon to see bikers, walkers, and equestrians in a bike route adjacent to a highway (for instance, SR-76). A multi-use path is also kid friendly because of the separation from the highway and kids are often seen on the SR-56 Bike Path and not commonly seen within bike routes adjacent to a Highway. The multi-use path also accommodates a more rural aesthetic and is safer for users. Multi-use paths have become a critical component to the transportation system and are treasured by the communities they are a part of. The addition of the multi-use path along Hwy 67 is more consistent with the goals and policies of the 2050 RTP. We recommend the San Vicente corridor plan provides a separated mixed-use path throughout the full length of the corridor.

Lastly, during the workshop portion for the Draft 2021 Regional Plan, workshops were provide by area (North, East, Central, etc.). Based on the mapped areas shown, Poway residents and community stakeholders were not represented as a part of any region and that outreach with appropriate comment period should be provided prior to moving forward with Draft. I'd be happy to assist you with what an appropriate outreach should be.

Thank you for considering our comments. Please feel free to reach out to me with any questions.

Thank you,

**David De Vries, AICP**

City Planner

Development Services

City of Poway | 13325 Civic Center Drive | Poway, CA 92064

Phone (858) 668-4604 | Fax (858) 668-1211

[ddevries@poway.org](mailto:ddevries@poway.org)



## Planning Department

August 6, 2021

Coleen Clementson  
Director of Regional Planning  
San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92101

Dear Ms. Clementson,

Subject: San Diego Forward: The 2021 Regional Plan

I am writing to express the City of San Diego's support for SANDAG's San Diego Forward: The 2021 Regional Plan (2021 Regional Plan). The 2021 Regional Plan is a major step towards reducing vehicle miles traveled by single occupant vehicles and greenhouse gas (GHG) emissions in the region by incorporating five transformational strategies which will be critical to enabling the City of San Diego to implement its Climate Action Plan. The City applauds SANDAG's commitment to making infrastructure and technological investments in the mobility system with a greater emphasis on accessibility, transit, bicycling, and walking as well as innovative and bold strategies to manage demand on regional roadways prioritizing safety and aligning with the City's commitments to Vision Zero. The City's General Plan is consistent with the 2021 Regional Plan as both focus on development within vibrant mixed-use village centers served by high frequency transit. The City supports the 2021 Regional Plan's intent to preserve open space from non-sustainable development. The City looks forward to closely working with SANDAG to implement the strategies described in the 2021 Regional Plan.

The City supports the 2021 Regional Plan's vision to improve the transportation network in the region especially the planning and implementation of a complete network of efficient, convenient, and reliable transit services that connect people from where they live to where they work or go to school. The development of a dynamic management system of traffic flow and transit services, facilities for bicycles, scooters, pedestrians, and flexible micro transit, offer an equitable approach to first and last-mile connections to transit, a vision zero strategy to address safety, and implementation of the City's Climate Action Plan.

The City also supports the 2021 Regional Plan's development of mobility hubs throughout the region. As part of our land use planning efforts, the City is providing policies to support the implementation of mobility hubs as vibrant centers of activity where future housing and employment growth are connected by transit. The San Ysidro and Central mobility hubs are critical transportation facilities and having a direct connection to the U.S.-Mexico Border and San Diego International Airport is a vital step towards having a transit system that meets the needs of residents and visitors.

The City shares the 2021 Regional Plan's goal to provide better transit access and housing opportunities in employment centers. Over the past two years, the City has adopted updated Mission Valley and Kearny Mesa Community Plans to accommodate more housing and existing and future transit improvements in

August 6, 2021  
Ms. Coleen Clementson  
Page 2

high employment centers. We are also in the process of updating our community plans for University and Mira Mesa (Sorrento Mesa) which include major high-tech and biotech employment centers. These plans focus additional housing opportunities along existing and planned transit lines needed to support continued economic prosperity. Downtown San Diego has experienced a high level of residential growth as well as a recent resurgence of employment growth. The success of future housing and job growth in these employment centers is predicated on the implementation of rail transit, managed lanes, and bicycle networks, and the technological improvements to our regional arterials. These investments into our infrastructure will also provide jobs for the region's skilled labor force.

The City strongly supports efforts to increase mobility options including the development of high frequency transit in communities of concern with increased transit infrastructure and service needed to provide convenient access to job centers. The City recommends that SANDAG identify the planning and engineering of the commuter rail (purple line) between San Ysidro and Sorrento Valley, separation of existing light rail at-grade crossings, dedicated and/or flex lanes for Rapid Bus routes within the City, as well as double tracking the LOSSAN corridor as shovel ready projects for future state and federal funding.

The San Ysidro and Barrio Logan communities are affected by truck emissions due to their proximity to the U.S.-Mexico border crossing and the Port of San Diego respectively. The 2021 Regional Plan addresses the needs for air, rail, and port goods movement and smarter border strategies to support trade and international commerce. The City supports San Diego Forward's goals and policies to reduced air pollution which are needed to meet federal air quality conformity requirements and improve some of our most underserved, low-income communities.

The City has a long history of planning together with SANDAG to creating a land use pattern and transportation network that facilitates greater mobility and increased connectivity between employment and housing. The City encourages SANDAG to continue funding the Smart Growth Implementation Program which provides needed grant funding for planning and capital projects that support the implementation of the Regional Plan. We have included additional recommendations attached to this letter for SANDAG's consideration and look forward to partnering with SANDAG on its new Housing Incentive Program to achieve the goals of the Regional Housing Needs Assessment Plan. We are committed and look forward to a continued partnership with SANDAG on the long-term implementation of the San Diego Forward: The 2021 Regional Plan.

Sincerely,



Mike Hansen  
Director, Planning Department

MH/tg

Attachment: City of San Diego's Specific Recommendations



August 6, 2021

Ms. Coleen Clementson

Page 3

cc: Brittney Bailey, Senior Policy Advisor, Mayor's Office  
Randy Wilde, Senior Policy Advisor, Mayor's Office  
Adrian Granda, Director of Governmental Affairs  
Dion Akers, Regional Governmental Affairs Manager  
Alyssa Muto, Director, Mobility Department / Interim Director, Sustainability Department  
Tom Tomlinson, Assistant Director, Planning Department  
Heidi Vonblum, Deputy Director, Planning Department  
Seth Litchney, Program Manager, Planning Department  
Tait Galloway, Program Manager, Planning Department  
Maureen Gardner, Senior Mobility Engineer, Mobility Department

### **City of San Diego's Specific Recommendations to the San Diego Forward: The 2021 Regional Plan**

- The City supports the planning and implementation of future rail projects identified in the 2021 Regional Plan. Appendix A, page A-15 on the note on the bottom of the page, please clarify if the purple commuter rail should be route 582 and not 581 as noted. Commuter rail route 581 as identified on page A-29, project TL-01 is Downtown to/from La Mesa projected to be in the 2050 transit network.
- The future purple commuter rail connection would provide access for people throughout the communities within the southern and central portion of the City to employment centers in Kearny Mesa, University, and Sorrento Mesa. The City recommends considering alignment and station options that would serve the Mid-City communities and SDSU West at Mission Valley. We look forward to working with SANDAG in reviewing ridership information/forecasts based on different proposed alignments for the entire line including with and without stations serving the Mid-City communities and SDSU West.
- The City looks forward to working with SANDAG in evaluating options for grade separation of existing light rail at-grade crossings within the City.
- The City recommends implementing near-term operational improvements such as the use of restriping for providing dedicated and/or flex lanes for Rapid Bus routes while planning for long-term capital improvements. We look forward to working with SANDAG in evaluating near-term and long-term options for dedicated and/or flex lanes for Bus Rapid routes.
- The City recommends including the Via Las Cumbres/I-8 Interchange/Hotel Circle North & South/Fashion Valley Road project in the list of proposed projects in Appendix A. As a regionally significant project that provides freeway and active transportation connections to two light rail transit stations and the San Diego River Trail. This will support the recently adopted Mission Valley Community Plan which increasing housing opportunities near the existing light rail stations.
- While the City supports increasing the amount of Transit Priority Areas (TPAs), the City requests that the existing TPAs be maintained in the 2021 Regional Plan. The TPAs are a critical part of the City planning process for future development to help meet our Climate Action Plan goals for the reduction of vehicle miles traveled. Maintaining future transit routes and the TPAs provides consistency in our land use and mobility planning efforts.



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## CITY OF SOLANA BEACH

635 SOUTH HIGHWAY 101 • SOLANA BEACH, CA 92075 • (858) 720-2400 • Fax (858) 720-2455

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[www.cityofsolanabeach.org](http://www.cityofsolanabeach.org)

August 5, 2021

Attn: 2021 Regional Plan  
SANDAG  
401 B Street, Suite 800  
San Diego CA, 92101

Via Email: [SDForward@sandag.org](mailto:SDForward@sandag.org)

### **SUBJECT: DRAFT 2021 REGIONAL PLAN**

The City of Solana Beach appreciates the opportunity to review and comment on the San Diego Association of Governments (SANDAG) Draft 2021 Regional Plan (Draft Plan). It is clear that much time and effort went into this important document. Submitted for your consideration are the following comments:

- **Mobility Hubs** – Page 19 of Chapter 2 of the Draft Plan, the Sustainable Communities Strategy (SCS), describes planned “Mobility Hubs” as areas or communities in the region with “a high concentration of people, destinations, and travel choices” that “offer on-demand travel options and supporting infrastructure that enhance connections to high-quality Transit Leap services.” While the SCS seems to acknowledge that these Mobility Hubs can vary both in size and transit availability and can “span one, two or a few miles based on community characteristics,” the SCS and the Draft Plan do not separately categorize or discuss these Mobility Hubs based on these unique characteristics despite having done so previously as well as in Appendix T (Network Development and Performance). Pages 15 through 18 of Appendix T of the Draft Plan – Network Development and Performance – contains a Propensity Analysis for both Transit Leap Services and Mobility Hubs. These analyses identified which transit routes were most likely to meet the needs of transit riders now and in the future and which communities were most suitable for Mobility Hubs. While it should be noted that Solana Beach ranked at the lower end of both (see Figures 12 and 14), these analyses resulted in the apparent establishment of five (5) distinctive types of Mobility Hubs – Coastal, Gateway, Major Employment Center, Suburban and Urban Core – with Solana Beach identified in Figure 15 as a Coastal Mobility Hub. However, the SCS contains no meaningful discussion of these distinctive and unique Mobility Hub areas referring to them only in Figure 2.5 of the SCS where projected future growth is illustrated. The dramatic difference in projected future growth for each of these distinct Mobility Hub Areas, with Coastal Mobility Hubs well below the other four Mobility Hub Areas in both the percentage of future housing and future jobs (5% and 2%, respectively), clearly demonstrates their

uniqueness with respect to jobs, housing and access to high-quality transit and the extent to which each area should be relied upon (or not) to satisfy the region's future growth.

The adopted 2021 Regional Transportation Plan (Adopted Plan) and the SCS should contain a detailed discussion of the five (5) Mobility Hub Areas and a description of the unique characteristics and transit needs for each – both now and in the future.

Additionally, by virtue of the fact that the Solana Beach Train Station is within 2 ½ miles of the cities of Del Mar, Encinitas and San Diego and the County of San Diego, this regional Coastal Mobility Hub Area in the Adopted Plan should, for purposes of planning for future housing and job growth, extend into and cover the City of Del Mar and the Del Mar Fairgrounds and areas of the cities of Encinitas and San Diego and the County of San Diego immediately adjacent to Solana Beach.

- **Transit Leap Services** – As noted above, the Propensity Analysis discussed in Appendix T for both Transit Leap Services and Mobility Hubs determined that Solana Beach and its Train Station were at the lower end in the region both in meeting the needs of transit riders now and in the future and for suitability as a Mobility Hub. While the City acknowledges that the presence of the Train Station in Solana Beach might make it reasonable to include as a potential future Mobility Hub in the Adopted Plan, during the recent Regional Housing Needs Assessment (RHNA) allocation process, the City also made it clear that, both now and in the near term, the Train Station does not currently provide adequate Coaster or Amtrak headways, nor does it provide meaningful connections to other transit services to be considered a Mobility Hub now. Indeed, despite the North County Transit District (NCTD) Board recently voting to increase Coaster service beginning in October 2021, such a designation is still largely aspirational. While, again, the City acknowledges that the Draft Plan and the Adopted Plan are just that – a plan for the future – Appendix A of the Draft Plan – Transportation Projects, Programs, and Phasing – appears to support this position. Table A.5 (Interstate 5 North Coastal Corridor) identifies one Transit Leap project (TL40) – *Rapid 473* – for implementation in the year 2035. Similarly, Table A.9 (State Route 56) identifies one Transit Leap project (TL026) – *Rapid 103* – for implementation in the year 2050. These 15 to 30-year forward-looking Transit Leap projects, while helpful for the future, do not appear to satisfy the near-term objectives of a Coastal Mobility Hub.

In order to justify the designation of the Solana Beach Train Station as a Coastal Mobility Hub, both now and in the future, more immediate Transit Leap service connections should be considered for inclusion in the Adopted Plan.

**Appendix B: Implementation Actions** – Appendix B provides detail on commitments and key actions to implement elements and strategies of the Draft Plan. Key to this objective is the involvement of and coordination with each member agency as they are most knowledgeable of the needs of their respective communities. Indeed, Near-term Implementation Action No. 2 in Table B.1 identifies the need to partner with local governments to develop five initial Comprehensive Multimodal Corridor Plans (CMCPs). Therefore, the City requests that the following minor edits to Appendix B (page 16) under “Land Use and Regional Growth” be included:

“The 2021 Regional Plan vision for land use focuses on development and growth in ~~Mobility Hub areas~~ urbanized areas near jobs to preserve San Diego’s open space and support transportation investments by reducing vehicle miles traveled (VMT). Mobility Hubs are ~~the~~ an opportunity to provide housing to address the Regional Housing Needs Assessment. Land use authority is reserved to local jurisdictions because they are best positioned to effectively implement the objectives outlined in the 2021 Regional Plan through understanding of the unique needs of their communities and geographies. Because land use authority is reserved to local jurisdictions, SANDAG will leverage partnerships with cities and the county through the Smart Growth Incentive Program and other grants to provide funds for transportation-related improvements and planning efforts that support smart growth in Mobility Hubs to realize ~~this their~~ their vision for their communities. SANDAG will continue its existing grant programs, partner with member agencies on state funding opportunities, and provide data and technical support to assist local jurisdictions with land use planning efforts in line with the 2021 Regional Plan.”

- **Regional Housing Needs Assessment** – Following adoption of the Draft RHNA allocation by the SANDAG Board in September 2020, appeals of the allocation were filed by the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach. In order that these appeals are correctly noted for the record, there are two locations in the Draft Plan to which a clarifying footnote and additional language should be added to the Adopted Plan. Specifically, the City requests the following for the Adopted Plan:

- On page 33 of the Draft Plan, after the sentence: “The SANDAG Board of Directors adopted the RHNA Plan on July 10, 2020, with the final housing unit allocation” the following footnote should be added:

*\* In September 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court challenging, among other things, the Board’s adoption of the RHNA Plan. SANDAG demurred to the cities’ Petition and the demurrer was sustained by the court in February 2021. The petitioning cities have*



*appealed the ruling on the demurrer to their Writ Petition, and that appeal remains pending in the Fourth District Court of Appeal.*


- o On page 14 of Appendix K (Regional Housing Needs Assessment Plan), the following paragraph should be added to the end of this page/section:

*On September 24, 2020, the cities of Coronado, Imperial Beach, Lemon Grove and Solana Beach filed a Petition for Writ of Mandate in San Diego Superior Court, Case No. 37-2020-00033974-CU-MC-CTL, against SANDAG and SANDAG's Board of Directors seeking an order requiring that SANDAG give those cities a fair hearing on their RHNA appeals and decide the cities' appeals in a legal manner without bias and without the use of the weighted voting mechanism. Specifically, the petitioning cities asked the court to order: (1) that the final RHNA allocation approval by SANDAG be rescinded; (2) that SANDAG's denial of the cities' RHNA appeals be rescinded; (3) that the appeals be remanded to SANDAG for fair consideration; and (4) that SANDAG be prohibited from utilizing a weighted vote on the cities' RHNA appeals. On February 5, 2021, SANDAG's demurrer to the Petition for Writ of Mandate was sustained by the Superior Court. The petitioning cities have appealed the ruling on the demurrer to their Writ Petition. That appeal remains pending in the Fourth District Court of Appeal. So long as the litigation is pending, the Board's adoption of the RHNA Plan cannot be considered final.*

Once again, the City of Solana Beach greatly appreciates the opportunity to review and comment on the Draft Plan. We also appreciate SANDAG's consideration of our comments and requested changes for inclusion in the Adopted Plan as noted above.

If you have any questions or comments, please feel free to contact Community Development Director Joseph Lim at [jlim@cosb.org](mailto:jlim@cosb.org) or 858-720-2434 or me at [gwade@cosb.org](mailto:gwade@cosb.org) or 858-720-2444.

Sincerely,



Gregory Wade  
City Manager

C: Lesa Heebner, City of Solana Beach Mayor and SANDAG Board Member  
David Zito, City of Solana Beach Council Member and SANDAG Board Alternate  
Joseph Lim, City of Solana Beach Community Development Director



# SAVE OUR FOREST AND RANCHLANDS



May 26, 2021

***Via E-mail***

SANDAG Board of Directors  
401 B Street  
San Diego, CA 92101  
[clerk@sandag.org](mailto:clerk@sandag.org)

**RE: Transportation Network Scenarios for the 2021 RTP**

Save Our Forest and Ranchlands (“SOFAR”) and the Cleveland National Forest Foundation (“CNFF”), two organizations dedicated to progressive land use planning and the protection of vital natural resources, are submitting comments for the draft transportation network scenarios for the 2021 Regional Transportation Plan Update. We recognize that SANDAG, under its new leadership and with new board members, has undergone a tectonic shift towards building a regional transit system to serve the urbanized western section of San Diego County. The focus of this letter is centered on the required first step towards building a 21<sup>st</sup> Century regional mobility system, i.e., a first phase area- complete transit, bike, walk system in the urban core that is competitive with the auto.

Therefore, SOFAR and CNFF urge the SANDAG Board of Directors to include a Climate, Housing, Transit Alternative in the 2021 RTP update—an alternative focused on meeting both the housing needs and greenhouse gas (“GHG”) reduction goals for a qualified land use area that have been set collectively by the State of California, the City of San Diego, and SANDAG:

- 40% reduction in GHG below 1990 levels by 2030 (California AB 32 and SB 32)
- 80% reduction in GHG below 1990 levels by 2050 (Governors Schwarzenegger and Brown)
- 25% reduction in per capita GHG from passenger cars and trucks relative to 2005 by 2035 (California SB 375; California Air Resources Control Board<sup>1</sup>)
- 14.3% reduction in total daily VMT per capita, and 16.8% reduction in total light-duty VMT per capita, relative to 2015-2018 average by 2050 (California Air Resources Board)<sup>2</sup>
- 50% transit, walk and bike mode share for commuters within ½ mile of a major transit stop in City of San Diego by 2035 (Climate Action Plan, City of San Diego)<sup>3</sup>
- 150% increase in transit mode share (SANDAG’s *Urban Area Transit Study*)<sup>4</sup>

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<sup>1</sup><https://ww2.arb.ca.gov/resources/documents/carb-2017-scoping-plan-identified-vmt-reductions-and-relationship-state-climate>

<sup>2</sup>[https://ww2.arb.ca.gov/sites/default/files/2019-01/2017\\_sp\\_vmt\\_reductions\\_jan19.pdf](https://ww2.arb.ca.gov/sites/default/files/2019-01/2017_sp_vmt_reductions_jan19.pdf)

<sup>3</sup> <https://www.climateactioncampaign.org/wp-content/uploads/2018/02/CAP-Report-Card-2nd-Edition.pdf>

- Adequately plan to meet the housing needs of everyone in the community (California)<sup>5</sup>
- SB 743 VMT reduction goals

Meeting these goals is not only reasonable, but also urgently required if we are going to solve some of the unrelenting challenges faced by residents of San Diego. Indeed, SANDAG’s prior RTP was found to be deficient for failing to discuss an alternative which could significantly reduce total vehicle miles traveled (“VMT”) (*Cleveland National Forest Foundation v. San Diego Association of Governments*. (17 Cal.App. 5th 413, 435-437 (2017))). Heretofore, the San Diego region has met these challenges with clever words, not deeds. These goals are achievable *only* if land use and transportation are addressed together.

These synergies are recognized in SANDAG’s *Urban Area Transit Strategy* and the City of San Diego’s *General Plan Housing Element* which includes this goal:

*Ensure the provision of sufficient housing for all income groups to accommodate San Diego’s anticipated share of regional growth ...in a manner consistent with the development pattern of the Sustainable Communities Strategy (SCS), that will help meet regional GHG targets by improving transportation and land use coordination and jobs/housing balance, creating more transit-oriented, compact and walkable communities, providing more housing capacity for all income levels, and protecting resource areas.*<sup>6</sup>

The Climate, Housing, Transit Alternative would pick up where SANDAG’s Urban Area Transit Strategy left off in 2011.

### Housing + Transportation Affordability (H+T)

There is a huge amount of attention on housing affordability but too little focus on housing and transportation (“H+T”) affordability. Outlying housing may be cheaper in the short run than housing in the region’s core because of supply and demand – but any savings often are eaten up by increased transportation costs. Dispersed housing requires more cars per household and more VMT and GHG emissions per household.

The Center for Neighborhood Technologies has modeled H+T costs relative to income for the entire U.S. with support of the U.S. Department of Housing and Urban Development. Figure 1 shows the H+T affordability results for the San Diego region for households with the regional typical household income of \$64,309.

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<sup>4</sup>2050 RTP/SCS Appendix U.17 *Urban Transit Strategy*, San Diego Association of Governments (SANDAG) and Parsons Brinckerhoff, October 2011.

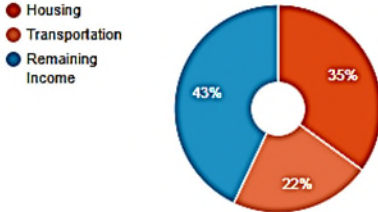
<sup>5</sup><http://www.hcd.ca.gov/community-development/housing-element/index.shtml>

<sup>6</sup><https://www.sandiego.gov/sites/default/files/legacy//planning/genplan/heu/pdf/housingelementfull.pdf>

Figure 1: H+T Costs as a Percent of Income<sup>7</sup>

Average Housing + Transportation Costs % Income

Factoring in both housing *and* transportation costs provides a more comprehensive way of thinking about the cost of housing and true affordability.



Transportation Costs

In dispersed areas, people need to own more vehicles and rely upon driving them farther distances which also drives up the cost of living.

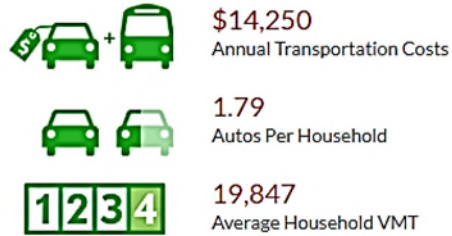
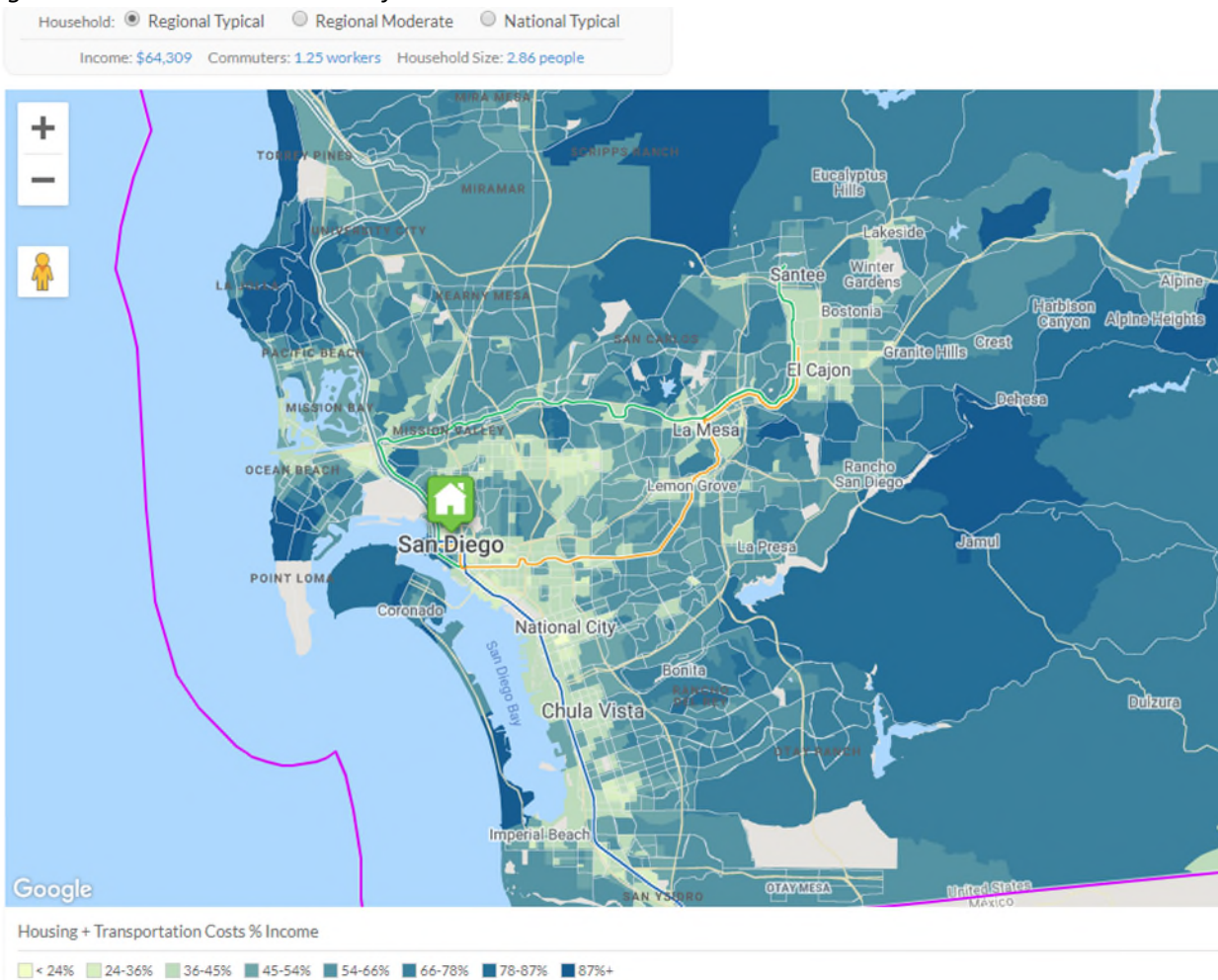


Figure 1 shows that, on average, transportation costs are about two-thirds as large as housing costs. However, transportation costs vary greatly across the region. Figure 2 maps H+T affordability.

Figure 2: H+T Costs as a Percent of Income<sup>8</sup>



<sup>7</sup> Center for Neighborhood Technologies. <https://htaindex.cnt.org/fact-sheets/?focus=cbsa&gid=42>

<sup>8</sup> Center for Neighborhood Technologies. <https://htaindex.cnt.org/>

As shown in Figure 2, when both housing and transportation costs are considered, the most affordable areas are in the light-colored areas primarily in the region's core and along major transit corridors. The housing affordability problem cannot be solved by building new housing in the darker-colored areas because high transportation costs make those areas inherently unaffordable. The areas in the more remote locations in San Diego County (i.e., even further from the City center) are not shown in order to make the map more readable, but these areas also tend to be more unaffordable when taking into account H+T.<sup>9</sup>

Real estate developers and their allies are currently pressuring San Diego County to retain its unlawful and inaccurate thresholds for assessing VMT impacts under SB 743, claiming that mitigation for VMT impacts will make housing in more remote parts of the County unaffordable. But housing in these areas is already unaffordable when transportation costs—that is, costs of driving long distances from locations not served by transit—are taken into account. SANDAG can help facilitate a better approach through the RTP, one that encourages the County to plan for housing in areas where transportation costs are low rather than allowing developers to build in remote areas and then trying to “mitigate” for the resulting VMT.

**The answer to housing affordability is H+T affordability. It is building more housing in the H+T affordable light-colored areas and in expanding the supply of H+T affordable areas through increased transit service.**

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<sup>9</sup>Transportation costs—both in absolute terms and as a percentage of income—are even higher in many North County and East County communities (for example, transportation costs alone range from 25% of income in Alpine and Fallbrook to 27% of income in Borrego Springs and 28% of income in Julian and Pala). See <https://htaindex.cnt.org/fact-sheets/>.

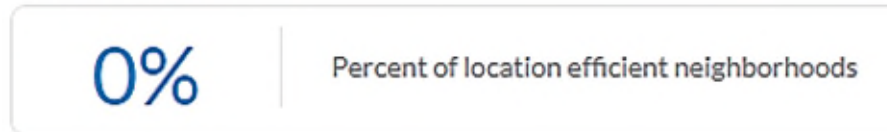


As shown in Figure 3, the San Diego region currently scores extremely low on location efficient neighborhoods which are defined as “compact, close to jobs and services, with a variety of transportation choices.”

Figure 3: Location Efficiency Metrics for the San Diego Region<sup>10</sup>

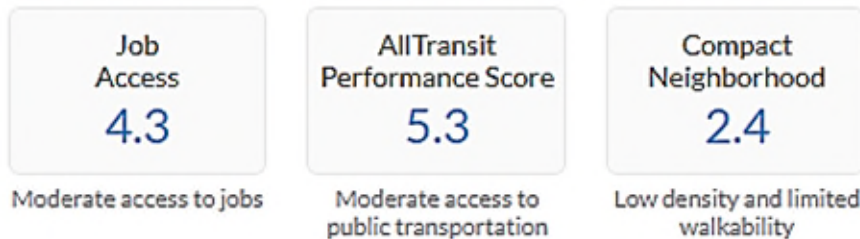
### Location Efficiency Metrics

Places that are compact, close to jobs and services, with a variety of transportation choices, allow people to spend less time, energy, and money on transportation.



### Neighborhood Characteristic Scores (1-10)

As compared to neighborhoods in all 955 U.S. regions in the Index

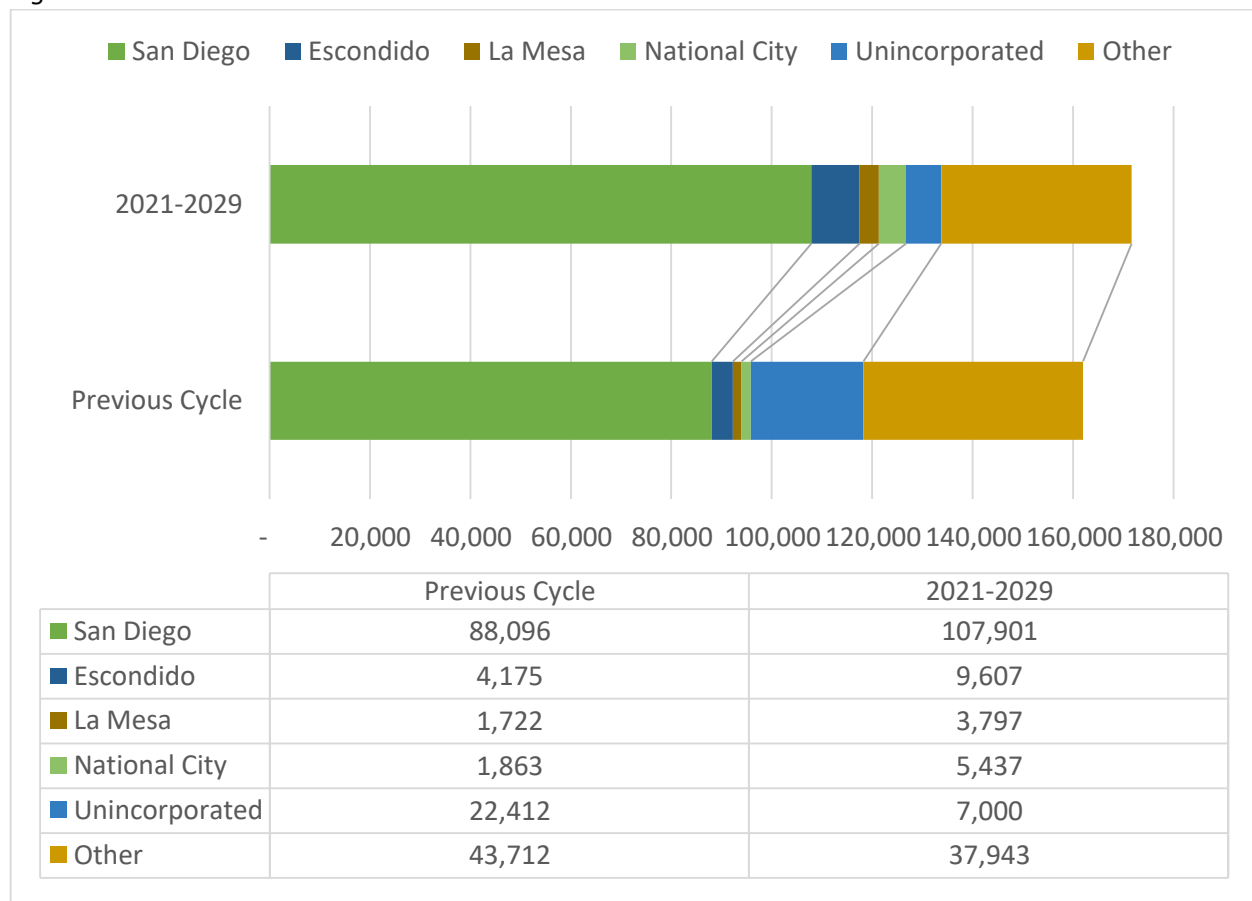


Increasing this score will require more housing and jobs in areas served by transit today. It will also require a significant expansion of transit infrastructure and a substantial increase in service. The State of California, SANDAG and the County’s municipalities are working towards increasing the supply of housing in location efficient neighborhoods, but more can and should be done.

The Regional Housing Needs Allocation (“RHNA”) Determination, provided by the California Department of Housing and Community Development (“HCD”) in July 2018, requires the San Diego region to plan for 171,685 housing units in the 6th Housing Element Cycle (2021-2029). This 6<sup>th</sup> Element Cycle gives significant weight to transit availability. As shown in Figure 4, the 6<sup>th</sup> Element Cycle makes a substantial shift relative to the previous 5<sup>th</sup> Element Cycle away from the unincorporated areas and into the cities served by transit including San Diego, Escondido, La Mesa, and National City.

<sup>10</sup> Center for Neighborhood Technologies. <https://htaindex.cnt.org/fact-sheets/?focus=cbsa&gid=42>

Figure 4: RHNA Allocations 2020-2029 and 2010-2019<sup>11</sup>



The City of San Diego’s share of the total has risen from 54% of the total in the previous cycle to 63% in the new cycle. The City has ample capacity for this housing. It has identified capacity to construct 164,142 housing units or 56,241 more than required.<sup>12</sup> A large percentage of this capacity is in transit corridors.

These are positive changes. However, in the past, the housing allocations have been aspirational but not enforced. The State has signaled that it plans to be more aggressive about enforcement during this cycle. SANDAG can help the municipalities achieve their housing goals by shifting all transportation spending towards transit and non-motorized (walk and bike) infrastructure. These investments, which will facilitate getting people out of the cars, will also help the region increase density without large impacts on neighborhoods.

In addition to personal savings on car ownership (e.g., acquisition, registration, and insurance) and costs associated with driving (e.g., gasoline, replacement parts, and repairs), municipalities are beginning to recognize that neighborhoods served by transit require fewer parking spaces. Last year, the City of San Diego passed a parking reform package that eliminated parking requirements for sites located within

<sup>11</sup> Center for Neighborhood Technologies. <https://htaindex.cnt.org/>

<sup>12</sup> City of San Diego General Plan Housing Element 2021-2029 (March 2020 Draft), p. HE-38.

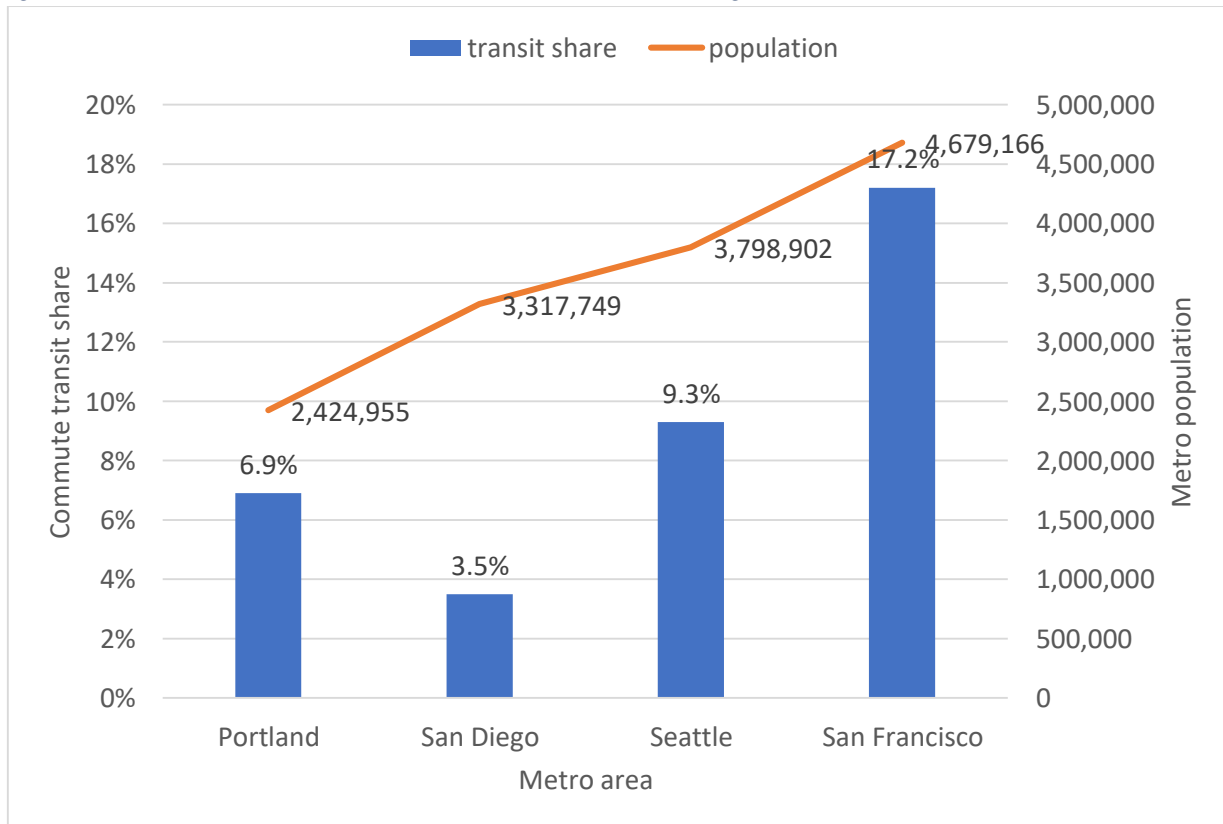
1/2-mile of a transit stop. This is a tremendously important reform for housing affordability because construction of parking can cost as much as \$90,000 per space in structures.<sup>13</sup>

Building a **Real**Regional Transit System - the Climate, Housing, Transit Alternative  
 SANDAG’s Executive Director Hasan Ikhata said:

***I don’t buy the debate that transit doesn’t work. Transit doesn’t work now because it’s not designed to work. You know, if you come from the border to downtown and it takes you, you know... it’s about 20 some miles... it takes you an hour in transit, that’s not real transit, as far as I’m concerned.***<sup>14</sup>

The San Diego region’s transit system performs much more poorly than its west coast peers. As shown in Figure 5, a much smaller share of the region’s workers commute by transit than other west coast regions.

Figure 5: Transit Work Mode Share in Four West Coast Regions



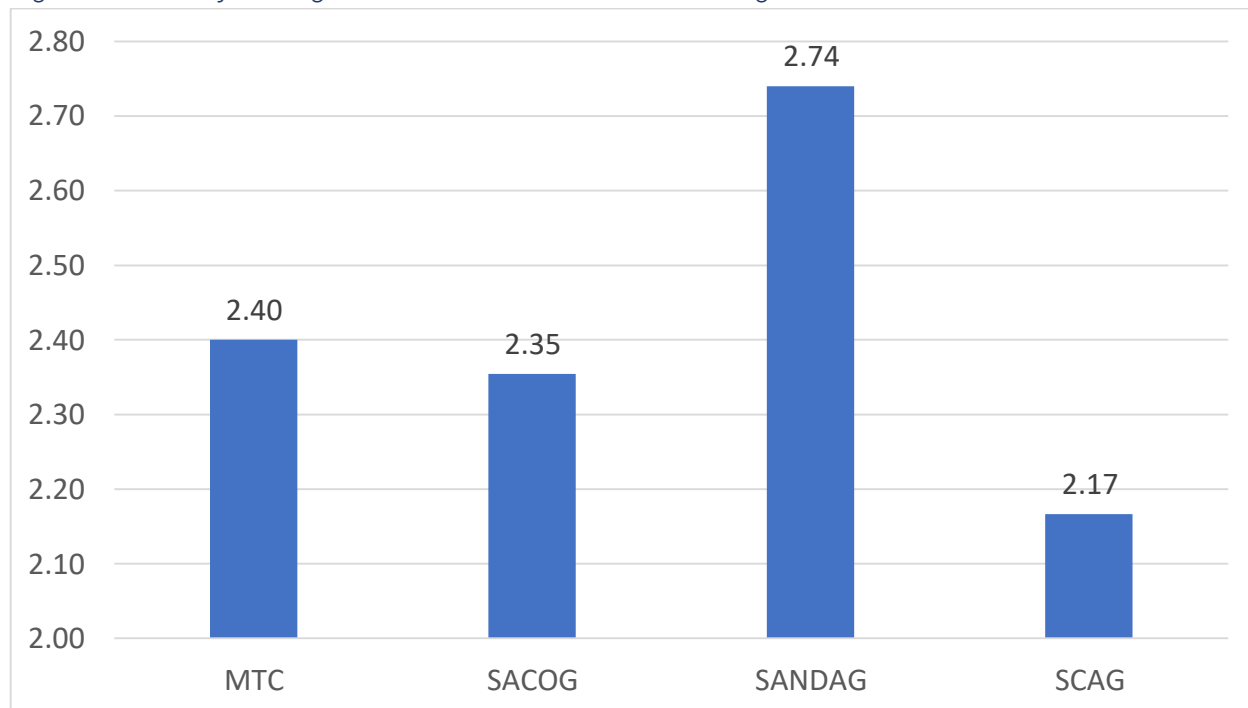
Source: U.S. Census American Community Survey

<sup>13</sup><https://timesofsandiego.com/politics/2019/03/04/san-diego-city-council-votes-to-repeal-minimum-parking-requirements-for-new-housing/>

<sup>14</sup>San Diego Tribune, February 27, 2019. <https://www.sandiegouniontribune.com/opinion/commentary/sd-utbg-sandag-ikhata-transit-interview-20190227-story.html>

Those who do commute by transit in the San Diego region suffer an enormous travel time penalty relative to the other large regions in California (Figure 6).

Figure 6: Ratio of Average Transit Commute Time to Average Auto Commute Time



Source: California Household Travel Survey

Improving the regional transit system is not a new idea in the San Diego region; there just has not been enough follow through. Almost a decade ago, SANDAG prepared the *Urban Area Transit Strategy* (“UATS”) as part of its 2011 RTP to connect regional housing needs with transit infrastructure:

*The overarching goal of the UATS was to create a world-class transit system for the San Diego region in 2050, with the aim of significantly increasing the attractiveness of transit, walking, and biking in the most urbanized areas of the region.*

*The vision called for a network of fast, flexible, reliable, safe, and convenient transit services that connect our homes to the region’s major employment centers and destinations. Achievement of this vision would make transit a more appealing option for many trips, reducing the impact of vehicular travel on the environment and on public health. Other key goals included:*

- *Making transit more time-competitive with automobile travel;*
- *Maximizing the role of transit within the broader transportation system; and*
- *Reducing vehicle miles traveled and greenhouse gas emissions in the region.* (p. TA 7-5)<sup>15</sup>

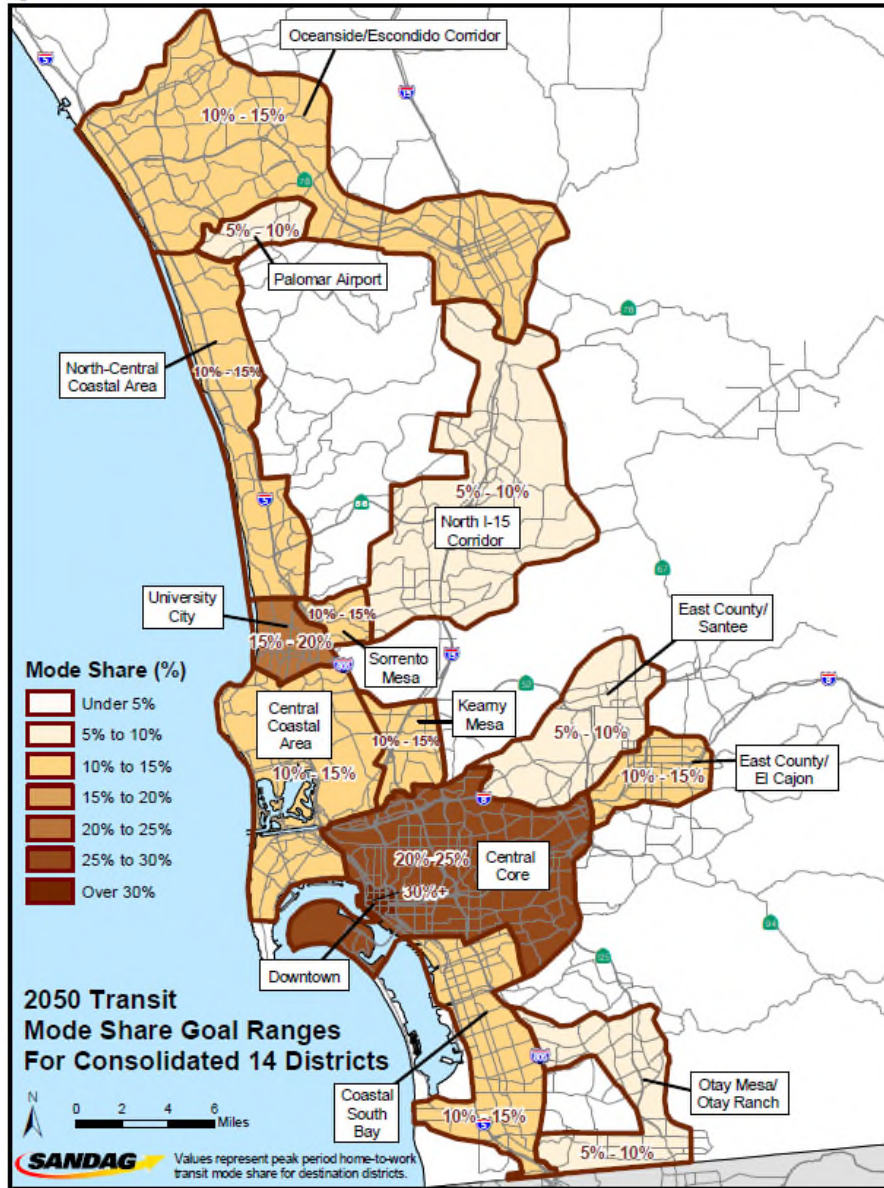
<sup>15</sup> SANDAG. Urban Area Transit Study.

<http://www.sandag.org/index.asp?projectid=368&fuseaction=projects.detail>

The UATS showed a high potential for transit ridership in the region's urban core (Figure 7).

Figure 7: SANDAG Urban Area Transit Study Figure TA 7.8

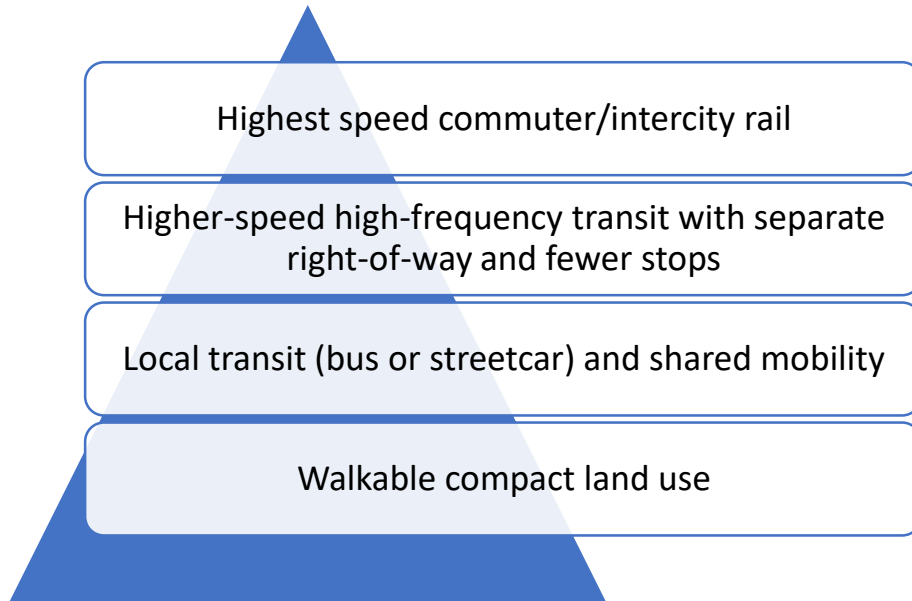
Figure TA 7.8





For transit to become time-competitive with the automobile, the Climate, Housing, Transit Alternative will require much more than a few isolated projects. It will require comprehensive investments at each of the four levels shown in Figure 8.

Figure 8: Complete Transit System



At the top level, improving rail service in the Los Angeles to San Diego (“LOSSAN”) corridor is a top priority. To this end, an important study by Caltrans and CNFF has just been completed regarding the potential transit ridership on the LOSSAN rail corridor between San Diego and Los Angeles. This study arose as a result of litigation filed by CNFF challenging the planned expansion of the I-5 freeway between La Jolla and Oceanside as inconsistent with California’s GHG emission targets. CNFF and Caltrans reached a settlement that focused on the potential to improve rail service on the LOSSAN corridor. In particular, the parties agreed to study the feasibility of constructing a double-track rail tunnel through Miramar Hill to facilitate transit on the corridor. The parties believed that the Miramar tunnel could reduce travel times and provide improved connections to local transit services in the University Town Center (UTC) area.

The recently-completed study concludes that the Miramar tunnel and rail line straightening would add a critical link to the LOSSAN rail corridor. *See Exhibit #1 (Miramar Tunnel Feasibility Study)*. Critically, it finds that the feasibility criteria for the Miramar tunnel have been satisfied. Its specific findings include the following:

1. The project would increase discretionary passengers by 1,300 to 1,700 per day, thereby reducing annual VMT 200 million to 240 million miles and GHG by 70,000 to 84,000 tons.
2. The project would provide competitive travel times, including a transit system average clock time that is approximately 3% faster than the automobile.
3. The project would be cost competitive, with transit riders cost at \$180/month versus automobile costs of \$507/month.
4. The project has no fatal engineering flaws.

The study further acknowledges a prior federal study that found construction of the Miramar tunnel along with other corridor improvements would reduce travel time between San Diego and Los Angeles to two hours. In short, construction of the new tunnel, which would provide enhanced access to downtown and the airport, would be a key transportation improvement for the region and the state. As the study notes, the LOSSAN rail corridor— together with the I-5 freeway – is the second-most traveled route in North America. The Miramar tunnel must be considered a key component of the Climate, Housing, Transit Alternative.

At the next level is a network of higher-speed, high frequency transit lines with separate rights of way and fewer stops. In many regions, a light rail service fills this niche, but in the San Diego region the Trolley has not filled this niche well. It operates too slowly and service is not frequent enough. Improvements are needed in both these dimensions. Achieving the required level of service in this higher-speed tier will require a rethinking of the system. As part of the Climate, Housing, Transit Alternative, SANDAG should evaluate speeding up the existing lines through grade separations and eliminating stops, as well as creating new higher-speed lines.

Express buses on managed lanes currently do not serve this higher-speed niche well because they connect freeway interchanges instead of land uses. A typical trip using these express buses will be unattractive because it also will involve connecting bus service on one or more circuitous routes. Express buses and managed lanes can work well for some park-and-ride travelers traveling to major destinations but cannot serve a significant portion of the region’s population well.

Both the regional rail and higher-speed high-frequency tiers need to be well connected. The Climate, Housing, Transit Alternative must include an inter-modal terminal (Grand Central) connecting San Diego’s urban core, the Airport, the LOSSAN corridor, the Sprinter corridor, and the Trolley system.

The Climate, Housing, Transit Alternative must also include efficient connections with frequent local buses (which could possibly be automated in the future). To this end, SANDAG must grapple with the first mile/last mile issue as this reflects a failure in land use and the existing transit system. While higher income travelers may have a choice of Uber-type services to solve this problem, this should not be viewed as a remedy for the average traveler.

Finally, the goal of a functional transit system is to serve an area-complete bike and walkable land use because no trip begins or ends on a transit vehicle. Most transit trips begin and end with a walk trip. In regions with high transit use, there are generally about twice as many walk trips as transit trips. Investments in walk and bike infrastructure should be a top priority. Consistent with the City’s Climate Action Plan, the Climate, Housing, Transit Alternative must model a 50% transit, walk and bike mode share for residents in the central core.

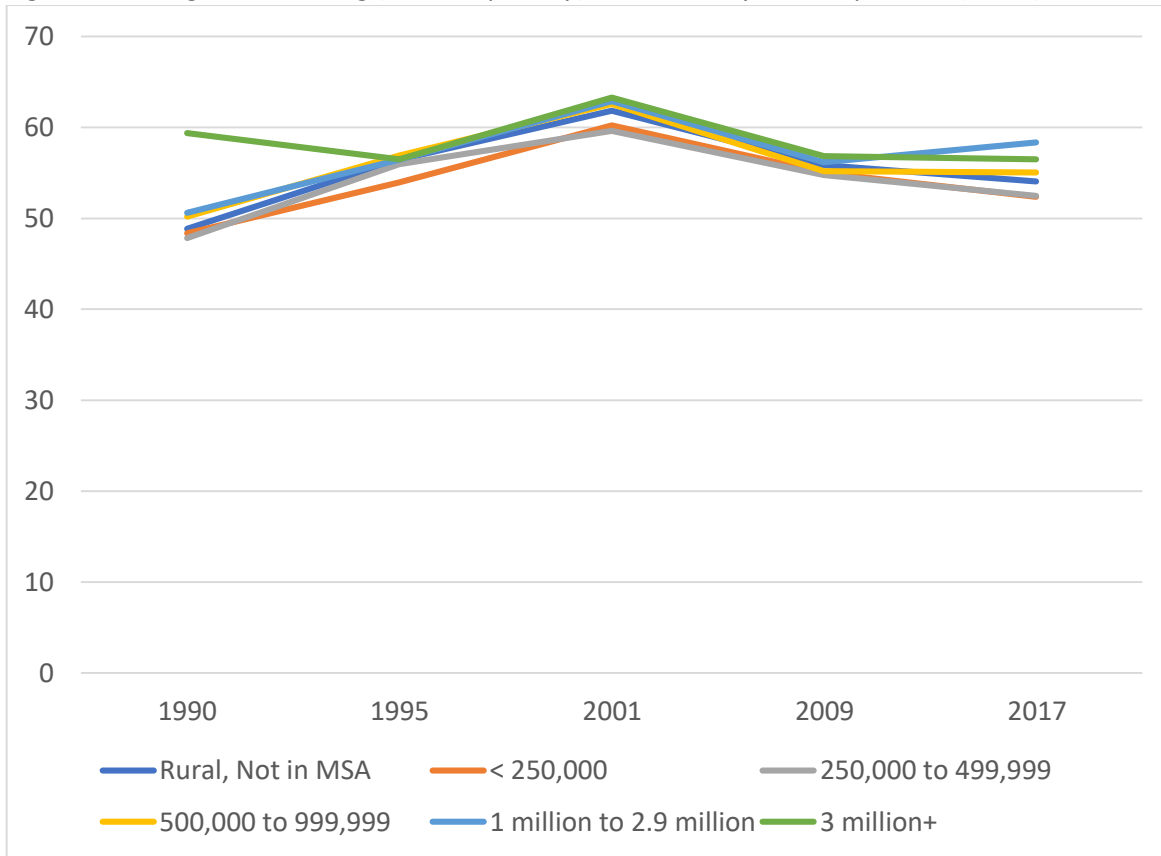
### Stop Expanding Freeways

Building a real regional transit network will require all the region’s transportation investment dollars for the foreseeable future. **The Climate, Housing, Transit Alternative must not include any freeway expansion.**

The billions of dollars spent on freeway expansion the past 20 years have A) failed to reduce congestion, B) caused a substantial increase in VMT and GHG emissions, and C) resulted in a severe housing shortage. The transportation models used to justify these freeway expansion projects have been wrong

on all counts. These models - both in the San Diego region and in regions throughout the U.S. – forecast dire increases in travel time if freeways are not widened, and substantial increases in travel time even if they are widened. In fact, as shown in Figure 9, travel time has stayed remarkably constant in the U.S. for decades.

Figure 9: Average Time Driving (minutes per day) 1990-2017 by MSA Population (NHTS)



Source: National Household Travel Survey.

Figure 9 shows the “average time spent driving a private vehicle in a typical day.” There was an increase during the 1990s, a time when many women were joining the labor force, but since 2000 there has been little change. Time spent driving also is very similar across differently sized regions. There is evidence that people have a “travel time budget”. If travel speeds drop, they (on average) will adapt to travel a shorter distance.

In contrast, if travel speeds increase, people (on average) will travel longer distances. This phenomenon is known as “induced travel”. In work for the California Air Resources Board (“CARB”), researchers at the University of California and the University of Southern California reviewed the literature on induced travel and concluded:

*Thus, the best estimate for the long-run effect of highway capacity on VMT is an elasticity close to 1.0, implying that in congested metropolitan areas, adding new*

*capacity to the existing system of limited-access highways is unlikely to reduce congestion or associated GHG in the long-run.*<sup>16</sup>

The SANDAG regional transportation model fails to account properly for induced travel although there now are newer algorithms that could address this deficiency.<sup>17</sup>

Senate Bill 743 establishes VMT as the appropriate metric for determining the impacts of transportation projects. This has made properly accounting for induced VMT critical in the regulatory process. The Office of Planning and Research's ("OPR") *Technical Advisory on Evaluating Transportation Impacts in CEQA* recommends:

*Whenever employing a travel demand model to assess induced vehicle travel, any limitation or known lack of sensitivity in the analysis that might cause substantial errors in the VMT estimate (for example, model insensitivity to one of the components of induced VMT described above) should be disclosed and characterized, and a description should be provided on how it could influence the analysis results. A discussion of the potential error or bias should be carried into analyses that rely on the VMT analysis, such as greenhouse gas emissions, air quality, energy, and noise.*<sup>18</sup>

The National Center for Sustainable Transportation at the University of California at Davis has produced an *Induced Travel Calculator*<sup>19</sup> to help address the deficiencies in the models. Recently, Caltrans also has issued new draft guidance on accounting for induced travel. It recommends following the OPR recommendations:

*Caltrans recommends using the VMT analysis approaches recommended in OPR's advisory when evaluating the transportation impacts of projects on the State Highway System (SHS).*<sup>20</sup>

Neither expanding freeways nor not expanding freeways will have any effect on regional congestion or average travel times. However, expanding freeways will cause significant increases in VMT and GHG emissions, and will continue to starve the transit system of needed investments.

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<sup>16</sup> Handy, Susan and Marlon G. Boarnet. "Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions: Policy Brief" prepared for California Air Resources Board, September 30, 2014.

<sup>17</sup>Marshall (2018). Forecasting the impossible: The status quo of estimating traffic flows with static traffic assignment and the future of dynamic traffic assignment. *Research in Transportation Business & Management*. **29**, 85-92 (2018)

<sup>18</sup> California Office of Planning and Research. Technical Advisory on Evaluating Transportation Impacts in CEQA, p. 29, December 2018. [http://opr.ca.gov/docs/20190122-743\\_Technical\\_Advisory.pdf](http://opr.ca.gov/docs/20190122-743_Technical_Advisory.pdf)

<sup>19</sup><https://ncst.ucdavis.edu/research-product/induced-travel-calculator>

<sup>20</sup> Caltrans. Draft Transportation Analysis Framework: Induced Travel Analysis, March 2020. <https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-04-13-taf-a11y.pdf>

## A Completely New Direction is Needed

Given that transit in the San Diego region has been and continues to be severely under-funded and under-built compared to roadway projects, as discussed above, the Climate, Housing, Transit Alternative must exclude roadway/freeway funding and expansion. Heretofore, SANDAG's planning has arbitrarily segmented freeway and transit projects. This artificial segmentation is not only irrational, it is fatal in achieving sustainable housing goals because **transit, bike, and walk mobility and auto-based mobility serve contradictory land use purposes**. SANDAG's failure to historically recognize this fundamental truth is the Achilles heel of its planning and lies at the doorstep of the agency's on-going inability to deliver a plan that truly unites our community on an ecologically sustainable foundation.

It is abundantly clear that SANDAG's past planning efforts have not only been deficient but have repeatedly failed to heed the ominous warnings from the courts, the public, and the planet itself. With California literally on fire due largely to climate change induced drought and high temperatures, SANDAG has failed the public by not aggressively pursuing a transportation scenario that would meet the State's GHG and VMT reduction goals.<sup>21</sup> The Climate, Housing, Transportation Alternative would help achieve targets set in legislation, the California Air Resources Board's Climate Change Scoping Plan, and relevant Executive Orders.

Similarly, with regard to the local housing crisis, it is inconceivable that SANDAG's prior RTPs have not called for a 50% transit, bike, and walk mode share alternative necessary to activate infill housing, especially since the urban core is already zoned for such housing. Here too, the Climate, Housing, Transit Alternative would facilitate this infill housing and help the City of San Diego achieve the targets set forth in its Climate Action Plan.

Additionally, the County's continued business-as-usual approach to planning makes the need for SANDAG to strengthen guidance regarding future development in the region all the more pressing. In spite of all the talk of a new direction, the County recently unveiled a plan update for the forest community of Alpine which can only be described as a VMT and ecosystem catastrophe. This planning contradiction was noted in Shute Mihaly's comment letter on the Alpine plan<sup>22</sup>. The tectonic shift in regional transit mobility mentioned in the opening paragraph of this letter must become a reality soon to avoid irreversible damage to our wild lands and a missed opportunity for the region.

Faced with these pressing social and environmental challenges, SANDAG's new regional direction can be strengthened by following established judicial, executive, and local legislative guidelines designed to meet the housing and climate crises. The public urgently deserves to see what it would take for the region to build a world-class transit system and to develop reasonably priced infill housing. Common sense dictates that the Climate, Housing, Transit Alternative would necessarily begin with a complete, first phase transit, bike, and walk system with an inter-modal terminal connecting the Airport, the Central Core, the LOSSAN Corridor, the Sprinter corridor, and the Trolley system. It is important to note that the Climate, Housing, Transit Alternative would not only be the "environmentally superior alternative", it would also be the socio-economic superior alternative because a true transit, bike and walk system reduces both the cost and shortage of housing and the cost of driving.

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<sup>21</sup> <https://abcnews.go.com/Politics/climate-change-make-wildfires-spread-factor/story?id=56937704>

<sup>22</sup> <https://drive.google.com/file/d/1Nt6sc7weFGbHCNIHsNOiMFCiQKjCvFP/view>



In conclusion, in the face of a severe, entrenched housing crisis endangering the public welfare and the severe climate crisis endangering the planet, SANDAG owes the public nothing less than a transit alternative that immediately meets these life threatening challenges rather than artificially prolonging them.

Duncan McFetridge

A handwritten signature in cursive script that reads "Duncan McFetridge".

Director, CNFF

President, SOFAR

Exhibit #1: Miramar Tunnel Feasibility Study



August 2, 2021

SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

**RE: Climate Action Campaign Comments, SANDAG's Draft 2021 Regional Plan**

Climate Action Campaign is a climate and environmental nonprofit organization based in San Diego and Orange County with a simple mission: stop the climate crisis through effective policy action.

We thank SANDAG staff and Board for their work on the draft 2021 Regional Plan, and are encouraged by the agency's bold new direction to start the process of transforming the San Diego region's transportation system so it is more sustainable and equitable.

Please see below for our comments to strengthen the draft plan to secure a transportation future that is climate-safe and climate-just:

***Putting the Region on the Path to Zero Carbon***

The most up to date climate science, including the landmark 2018 UN IPCC Special Report on Global Warming, says that we must eliminate greenhouse gas emissions by mid-century to stave off the most devastating impacts of the climate crisis, such as wildfires, extreme heat, drought, flooding, and more.<sup>1</sup>

California's strongest climate goal, Executive Order B-55-18, calls for carbon neutrality as soon as possible, and no later than 2045.<sup>2</sup> Meanwhile, CARB's mandated emissions reduction target for SANDAG, per SB 375, is a 19% reduction of per capita greenhouse gas emissions from cars and light duty trucks below 2005 levels by 2035. Page 13 of Chapter 1 states that the 2021 Regional Plan will achieve a 20% reduction, exceeding the MPO's state mandate.

Transportation accounts for nearly half of the region's emissions. To remain on track to achieve carbon neutrality, as climate science says is necessary, SANDAG must go further in exceeding CARB's target. We believe a reduction from transportation by at least 30% by 2035 is achievable and needed to ensure a climate-safe Zero Carbon future, and urge SANDAG to map out the strategies needed to achieve that target.

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<sup>1</sup><https://www.ipcc.ch/sr15/>

<sup>2</sup><https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf>

## ***Youth Opportunity Passes: No-Cost Transit for Youth 24 and Under***

Page A-51 of Appendix A proposes “subsidies to reduce the fares paid by transit riders.” Appendix A should be amended to include an explicit commitment to Youth Opportunity Passes (YOP)—no-cost transit passes for youth 24 and under—and should be implemented immediately following the adoption of the 2021 Regional Plan. SANDAG should also commit to overseeing YOP in partnership with MTS and NCTD, to ensure successful implementation by the local transit operating agencies.

Community based organizations have been fighting for YOP for nearly a decade, as it is an essential investment in our region’s youth, providing access to education and early career opportunities, while fostering the next generation of sustainable transportation riders.<sup>3</sup> We urge you to make YOP a top priority in the 2021 Regional Plan.

## ***Mode Shift Projections in Transit Priority Areas***

Attachment 6 of Appendix T (Network Development and Performance), includes the “Performance Measure Results Tables.” Page T6-6 includes mode share projections for the 2021 Regional Plan for the benchmark years 2025, 2035, and 2050 for peak period work trips, all day work trips, and all trips.<sup>4</sup>

We request this same set of projections, but specifically for Transit Priority Areas, to be able to compare Climate Action Plan’s mode shift targets with the mode shift that will be achieved through the buildout of the plan.

For example, the City of San Diego’s Climate Action Plan (CAP) set ambitious targets for the percentage of commuters travelling by bike, walk, and transit in Transit Priority Areas (18% by bike, 7% by walk, and 25% by transit by 2035)<sup>5</sup>, and we want to ensure our regional transportation goals and local transportation targets are meaningfully aligned.

## ***Expedite Transit Leap Timelines, Prioritizing Investments in Communities of Concern***

To maximize mode shift away from fossil fuel cars and towards bike, walk, and transit, Transit Leap timelines must be expedited, and prioritized in the early years of the plan over Managed Lanes and Managed Lane Connector, which will yield an increase in vehicle miles travelled.

Investments in commuter rail, light rail, and bus rapid transit infrastructure should be prioritized in Communities of Concern, to increase access to sustainable mobility options and connections to the region’s job centers. The climate crisis and environmental injustice have and will impact Communities of Concern first and worst. Historically underinvested communities are exposed to

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<sup>3</sup><https://www.midcitycan.org/aboutyop>

<sup>4</sup>[https://sdforward.com/docs/default-source/2021-regional-plan/appendix-t---network-development-and-performance.pdf?sfvrsn=6243fd65\\_2](https://sdforward.com/docs/default-source/2021-regional-plan/appendix-t---network-development-and-performance.pdf?sfvrsn=6243fd65_2)

<sup>5</sup>[https://www.sandiego.gov/sites/default/files/final\\_july\\_2016\\_cap.pdf](https://www.sandiego.gov/sites/default/files/final_july_2016_cap.pdf)

the region's most dangerously polluted air from cars and trucks, and are left with disconnected transit trips or long, expensive car commutes. As such, we support the inclusion of "Social Equity Early Action Transit Pilots" as a mechanism to streamline immediate investments in the communities on the frontlines of these crises.

### ***Expedite Completion of the Del Mar Tunnel***

Page A-26 of Appendix A states that the Del Mar tunnel will be complete by 2035. Currently, the 1.6 mile stretch of LOSSAN tracks in Del Mar is located dangerously close to the edge of the bluffs, and several bluff failures within feet of the tracks have occurred over the past 2 years alone.

With the bluffs eroding at approximately 6 inches per year, and the ever-intensifying threat of sea-level rise due to the climate crisis, these incredibly dangerous bluff failures will only increase in severity and frequency, putting lives seriously at risk.

Moving the tracks off the bluffs is essential to securing a long-term solution for the LOSSAN corridor, while preventing increased air pollution from shipping trucks, and ensuring economic prosperity for the region. To secure a climate-safe transportation system, we urge you to make the Del Mar tunnel a top priority, and urge for completion as soon as possible, no later than 2025-2030.

### ***Conclusion***

Thank you for the opportunity to provide comment on this critically important document. The 2021 Regional Plan is a key opportunity for climate action, justice and equity for Communities of Concern, and good union jobs. We look forward to continued engagement with SANDAG on the plan this year.

Sincerely,

Noah Harris  
Policy Advocate  
Climate Action Campaign



# County of San Diego

LAND USE AND ENVIRONMENT GROUP  
1600 PACIFIC HIGHWAY, ROOM 212, SAN DIEGO, CA 92101  
(619) 531-6256  
[www.sdcounty.ca.gov/lueg](http://www.sdcounty.ca.gov/lueg)

**SARAH E. AGHASSI**  
DEPUTY CHIEF ADMINISTRATIVE OFFICER

August 6, 2021

Hasan Ikhata  
Executive Director  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

**Sent via email to:** [SDForward@sandag.org](mailto:SDForward@sandag.org)

## **REQUEST FOR COMMENTS ON THE DRAFT 2021 REGIONAL PLAN FOR THE SAN DIEGO ASSOCIATION OF GOVERNMENTS (SANDAG)**

Dear Mr. <sup>Hasan</sup>Ikhata,

Thank you to the San Diego Association of Governments (SANDAG) for your efforts to create a Regional Comprehensive Plan and Sustainable Communities Strategy (Regional Plan) to help design a regional transportation system that is fast, fair, clean and reduces greenhouse gas emissions. As County staff, we are committed to working with SANDAG staff on our shared goals of implementing programs and services to improve the quality of life of our residents as we determine where and how we grow, connect people and places, protect the environment, and provide opportunity for all of our region's residents.

This comment letter outlines areas within the Regional Plan for which County staff would like to request further clarification, exploration, and consideration. Attachment A provides additional comments from County staff for your consideration and incorporates additional information related to County-specific plans or policies that may further inform the Regional Plan.

### **LAND USE, TRANSPORTATION PLANNING, AND SMART GROWTH**

Land use and transportation planning in the San Diego region is evolving to better address the most pressing issues of today, including climate change, quality of life, attainable housing, and social and economic inequities. The County has several planning efforts underway which prioritize addressing these issues, including the Regional Decarbonization Framework, the Climate Action Plan Update, the Electric Vehicle Roadmap, Office of Environmental and Climate Justice, and establishment of VMT thresholds. While independent of the Regional Plan, these efforts are aligned with the goals of the Regional Plan. County staff is interested in further understanding the regional growth modeling assumptions used within the Regional Plan and alignment with these County efforts.



## **PLANNING FOR THE UNINCORPORATED AREAS**

The County represents more than 500,000 residents who live within 34 unincorporated communities throughout the region. County staff would like to better understand how the Regional Plan will address transportation options outside of proposed mobility hubs for those communities. The unincorporated community of Ramona, for example, has a population of 36,000 residents, which is a larger population than the incorporated communities of Imperial Beach, Lemon Grove, Coronado, Solana Beach, and Del Mar.

Less than 1% of the unincorporated area is within the proposed mobility hubs, which is where transit and on-demand travel infrastructure investment will be focused. The unincorporated north and east county communities represent a significant population with higher-than-average VMT in the region. Investment in public transit and other transportation options will make it easier for people to drive less, which results in decreased GHG emissions. However, investment outside of mobility hubs appears to be limited, which would make it difficult for unincorporated residents to use new transit service.

To promote greater equity, County staff see opportunities to expand the proposed mobility hubs to include adjacent unincorporated communities. When we overlay the proposed mobility hubs with the County's VMT efficient areas (using both the unincorporated and regional averages), North County Metro, Lakeside, and Spring Valley (Attachment B) are adjacent to what appear to be proposed mobility hubs. These unincorporated communities would benefit from additional access and investment associated with inclusion in adjacent mobility hubs, as these communities have few existing alternative options to driving.

County staff is also interested in understanding how Regional Housing Needs Assessment (RHNA) allocations would be assigned. For the current 6<sup>th</sup> RHNA cycle, which covers 2021 – 2029, SANDAG allocated 6,700 units for the unincorporated area, with a total housing forecast in the Regional Plan of 7,419 units through 2050 for the unincorporated area. This forecast projects the County's RHNA allocation of 6,700 units being met by 2029, with an additional growth of 719 units by 2035, and projects no further growth in the unincorporated area through 2050. Based on this forecast, it appears that beyond 2035, all future housing needs in the region from RHNA cycles would be allocated to and met by growth in incorporated cities.

In order to fulfill the goals of the Regional Plan in providing access to affordable, reliable, and safe mobility options for everyone in the region, County staff would like to work with SANDAG to ensure consideration is given to future investments and incentives within the unincorporated area that would result in expanded options for transit and active transportation, and to encourage shorter and fewer automobile trips, including locations of mobility hubs, transit leap, flexible fleets, and complete corridors.

## **COMMUTER PATTERNS AND MOBILITY IN THE UNINCORPORATED AREA**

The Regional Plan focuses on five key investment opportunities: Next Operating System (OS), Complete Corridors, Transit Leap, Mobility Hubs, and Flexible Fleets. Many of the Regional Plan investments would be contained within proposed mobility hubs and along identified complete corridors. The majority of infrastructure improvements appear to support a shift to new rail and trolley line infrastructure, largely along the coastal areas. However, Ramona, Lakeside, Spring Valley, and other unincorporated east and north county communities represent a significant population that would benefit from similar consideration for infrastructure improvements as that proposed for the coastal communities with less population. According to SANDAG's "Commuting Patterns in the San Diego Region" study, a majority of the unincorporated east and north county residents who are employed commute outside the boundaries of their County Supervisorial

district, with 84% of District 2 residents working outside the district and 82% of District 5 residents working outside the district. Vehicle miles traveled could be reduced through greater mobility options for the unincorporated area (i.e., expansion of mobility hubs, increased transit options such as bus rapid transit, and improvements to transit frequency and service areas).

The County worked closely with SANDAG as part of the 2015 Regional Plan to identify roads in the unincorporated areas to include in the Regional Arterial System (RAS). Many of these roads serve as evacuation routes during emergencies, provide access to unincorporated communities from Caltrans roads, and create a link to the larger San Diego region.

County staff would like to continue coordinating with SANDAG to further identify Regional Plan investments in infrastructure, technology, and communication improvements for roads identified in both the County's Mobility Element and unincorporated roads included in the RAS and how these investments will further connect the unincorporated area to proposed mobility hubs, flexible fleets, or transit leaps. In addition to providing efficient movement of people and goods, these investments would increase the efficiency of evacuation routes, relay important information on evacuation conditions to first responders, and assist in getting residents safely away from hazardous conditions, all important components of resiliency planning.

#### **FUNDING AND FINANCING**

County staff appreciates the difficulty in forecasting funding and revenue sources for a regional transportation network. The Regional Plan identifies use of TransNet funds as part of the implementation, but it is not clear whether projects that have previously been planned, programmed, or awarded as part of the previous plan using TransNet would retain that funding allocation, or if there would be a reallocation of these funds as part of the Regional Plan. It is also unclear if there would be any changes to the current allocation or use of funds that local agencies receive directly for local road system improvements. The unincorporated area relies on TransNet funding to build, improve, and maintain transportation facilities that enhance roadway safety and support smart growth development, including road infrastructure to support increased transit options. Loss or reallocation of this funding could affect these projects and limit the County's ability to provide transportation services in support of our goal of reducing greenhouse gas emissions.

The Regional Plan indicates that user fees would help build a transportation system that provides travelers with alternatives to driving. County staff would like to further discuss how the proposed road user charges would be developed, implemented, and applied to ensure that this funding strategy will not disproportionately burden unincorporated communities, which often have longer commutes and less access to alternative transportation options due to lack of regional planning for transit services to these communities. Revenues generated should also be allocated to support additional transportation and mobility options in unincorporated communities, while vehicle use by those with access to alternate modes of transportation should be disincentivized since their communities are receiving significant investments in public transit.

County staff looks forward to learning more about how future funding and investment would be applied to ensure that both the benefits and the costs of the Regional Plan are equitably distributed across the region.

#### **RESOURCE DISTRIBUTION**

The Regional Plan provides SANDAG with an opportunity to guide future investments in a way that meets smart growth objectives and reduces GHG emissions, but also guides future allocation of resources to achieve equitable outcomes. Several of the unincorporated communities, such as Lakeside, Spring Valley, and Ramona, have larger populations than some of the incorporated

cities that are prioritized in the Regional Plan. In review of the proposed plan expenditures, a majority of the capital investments (55% of RTP funding) appear to go toward mobility hubs, complete corridors, and Next OS investments that are primarily outside of unincorporated communities. It is unclear what proportion of investment would go toward addressing mobility challenges within unincorporated communities and infrastructure investment that would provide linkages between the unincorporated areas and the proposed mobility hubs, transit leap, flexible fleets, and complete corridors. County staff is committed to working with SANDAG to further identify opportunities to equitably distribute the mobility benefits of the 5 Big Moves and further reduce GHG emissions regionwide.

The County appreciates the opportunity to comment on the Draft Regional Plan, and staff looks forward to future discussions regarding these comments. If you have questions regarding this letter, please contact Rami Talleh, Deputy Director with the Department of Planning and Development Services at 858-495-5475 or [Rami.Talleh@sdcounty.ca.gov](mailto:Rami.Talleh@sdcounty.ca.gov).

Sincerely,



SARAH E. AGHASSI

Deputy Chief Administrative Officer

cc: Chair Nathan Fletcher: Board of Supervisors, District 4  
Vice Chair Nora Vargas: Board of Supervisors, District 1  
Supervisor Joel Anderson: Board of Supervisors, District 2  
Supervisor Terra Lawson-Remer: Board of Supervisors, District 3  
Supervisor Jim Desmond: Board of Supervisors, District 5  
Kathleen Flannery, Acting Director, Planning and Development Services  
Jeff C. Moneda, Director, Department of Public Works  
Brian Albright, Director, Department of Parks and Recreation

Attachments:

Attachment A: Comments from County Departments and Divisions

Attachment B: Expansion Potential of Mobility Hubs (North County Metro, Lakeside, and Spring Valley)



# County of San Diego

**SARAH E. AGHASSI**  
DEPUTY CHIEF ADMINISTRATIVE OFFICER

LAND USE AND ENVIRONMENT GROUP  
1600 PACIFIC HIGHWAY, ROOM 212, SAN DIEGO, CA 92101  
(619) 531-6256  
[www.sdcounty.ca.gov/lueg](http://www.sdcounty.ca.gov/lueg)

## **ATTACHMENT A 2021 REGIONAL PLAN COMMENTS FROM COUNTY OF SAN DIEGO DEPARTMENTS AND DIVISIONS**

County of San Diego (County) staff in Planning & Development Services, the Department of Public Works, and the Department of Parks and Recreation reviewed the San Diego Association of Governments' (SANDAG) Draft 2021 Regional Plan (Regional Plan), for applicability to their respective work programs and County initiatives that are planned or currently underway. The County offers the following comments for your consideration.

### **TRANSPORTATION**

1. County staff would be interested to better understand and discuss further with SANDAG the potential for Regional Plan strategies to be used as part of a potential regional mitigation strategy related to Vehicle Miles Traveled (VMT).
2. When would funding be expected to be implemented related to Transit Leap/Flexible Fleet Connections to Mobility Hub areas, as this is a potential opportunity to reduce VMT for residents living in the unincorporated area?
3. The County has developed an Electric Vehicle (EV) Roadmap and is committed to assisting with the deployment of regionwide EV infrastructure to reduce GHG emissions in the transportation sector. Could SANDAG provide additional details on the future development, application, and implementation of the proposed Road User Fees and other proposed road usage revenues? Will consideration be given to exemptions for use of clean mobility strategies?
4. County staff would like to discuss with SANDAG staff the Regional Plan strategies, including funding for Major Transit (for purposes of CEQA, defined as a rail transit station, ferry terminal served by bus or rail, and a bus stop with two or more lines that provide transit service at 15 minute intervals or better during peak commute periods) in areas of the unincorporated area that are identified as "VMT efficient" in the SANDAG VMT Map.
5. There is significant investment in development and infrastructure in the Otay Mesa area, and Otay Mesa is identified as a "Mobility Hub" area in the RTP. County staff would like to better understand what funding has been identified for this "Mobility Hub" area.
6. County staff would like to discuss with SANDAG the potential for "Major Transit" services along the I-15 corridor, such as the potential for buses on shoulders.

## **ROADS/TRAFFIC/FIELD ENGINEERING**

7. Complete Corridors, such as the SR-67 and I-15 Corridors, are envisioned to act as the backbone of the regional transportation system. In addition to providing for safe and comfortable spaces to get around for all modes of transportation, road improvements such as intersection widening are important for the safe and reliable movement of all road users. County staff would like to discuss further identification and investment within complete corridors that provide linkages to the unincorporated area. These improvements could assist in providing routes for the County's eastern and northern rural regions that could be essential in the event of accidents or fire evacuation. For example, County staff would like to discuss with SANDAG the option of including safety improvements along the SR-67 Corridor on Wildcat Canyon Road, as this road is a relief route to SR-67. Additionally, road improvements on Old Hwy 395 and Pala Temecula Road in the north county may merit further conversation, as both of these roads serve as alternate routes to I-15 during peak traffic hours.
8. County staff would like to further discuss improvements of low flow crossings that are necessary to limit area flooding as well as the safe passage of motorists.
9. County staff would like to work with SANDAG to identify evacuation routes at a regional level, and the possibility of creating a separate section within the Regional Plan that would identify improvements of these routes and potential funding that could be part of the 2021 Regional Plan.
10. County staff would like to discuss with SANDAG how Smart Infrastructure and Connected Vehicles will address the legal and financial challenges with sharing traffic signal data with private entities and the liability of the potential misuse of signal timing data.
11. County staff would like to better understand the impact of Electric Vehicle Infrastructure on County of San Diego public right of way.

## **WATERSHED**

12. Stormwater Management & Regional Needs Assessment; suggested edits in Appendix R, page R-2:
  - a. "The County of San Diego has initiated an update of the 2010 Needs Assessment's 40-year water quality cost estimate using more recent water quality planning documents and strategies for achieving regulatory compliance and water quality objectives throughout the region. Since 2010, the Copermitees have worked to formulate Water Quality Improvement Plans (WQIPs) for the region's watersheds, including strategies, planned projects, and schedules to address their respective water quality objectives and compliance needs. The update to the Needs Assessment is intended to assist the County in planning and decision making and will draw upon the most recent WQIPs, with a focus on unincorporated areas to develop updated cost information."



## BIOLOGY

13. Figure AA.1 shows the conserved habitat lands in the San Diego region (light green) and displays the areas included in the four subregional habitat conservation plans (subfigure).
  - a. The Pre-Approved Mitigation Area (PAMA) of the South County Multiple Species Conservation Program (MSCP) and draft PAMA of the draft North County MSCP are labeled as “Proposed Conserved Habitat Lands” (dark green). This label may be misinterpreted by readers. While the MSCP Preserves will be assembled within the PAMA, not all PAMA designated lands will be conserved or are being actively pursued for conservation at this time.
  - b. The draft Focused Conservation Area (FCA) of the draft East County MSCP was not included in the “Proposed Conserved Habitat Lands” (dark green). This area is equivalent to the draft North County MSCP’s draft PAMA and should be included in this figure.
  - c. The Rancho Guejito property located north of San Pasqual Valley Road will not be included in future iterations of the draft North County MSCP Permit Area. The portions of this property identified within the draft North County MSCP should be changed from dark green to white to reflect this change.
  - d. In the subfigure, both the draft North County MSCP and Multiple Habitat Conservation Plan (MHCP) are identified by the number “4.” The MHCP area should be identified by the number “1” to correspond with the provided key.
  
14. Although the draft 2021 Regional Plan mentions the importance of protecting habitat corridors and wildlife linkages through land acquisition, it does not appear to include the construction of safe passageways to connect wildlife to preserved lands bisected by existing and future regional transit corridors. It is recommended that SANDAG work with the San Diego Monitoring and Management Program (SDMMP) and community partners to identify the areas along regional transit corridors that would benefit from wildlife crossings and that these improvements be included in future regional projects.

## PARKS AND RECREATION

15. For proposed projects that occur adjacent to Department of Parks and Recreation (DPR) County-managed lands, DPR staff would like to coordinate with SANDAG staff to ensure wildlife connectivity is maintained from adjacent lands to preserved County lands, including wildlife-only crossings.
  
16. For proposed projects that occur adjacent to or near existing or potential future trail connections, DPR staff would like to coordinate with SANDAG staff on trail connectivity throughout the County and incorporate safe multi-use crossings such as bridges or overpasses for recreational use.
  
17. DPR staff request SANDAG staff coordinate in developing SANDAG’s 5 Comprehensive Multimodal Corridor Plans as mentioned in Appendix B: Implementation near DPR facilities:
  - a. Central Mobility Hub and Connections, Coast, Canyons, and Trails – State Route 52, North County – SPRINTER/Palomar Airport Road/State Route 78/State Route 76, San Vicente – State Route 67, South Bay to Sorrento – Purple Line/Interstate 805/Blue Line/Interstate 5 South.

- b. Study additional seven corridors to inform the next Regional Continuing Actions.
- c. Pursue funding opportunities for projects, programs, and services identified in completed CMCPs.

18. County Staff would like to discuss with SANDAG the possibility of including trails and trail systems within the unincorporated area as part of the 2021 Regional Plan and to consider California Coastal Trail connections to DPR facilities.

## **AIRPORTS**

19. As the owner and operator for eight airports in the region, County Airports continues efforts to safely operate its facilities, ensure future land uses are compatible with aircraft operations, and protect the health and safety of people and property within the vicinity of an airport. The County's airports serve as transportation hubs, emergency service facilities and economic engines in their communities. McClellan-Palomar Airport is the only commercial airport in North County and has over 145,000 annual aircraft operations. It is also a Customs and Border Protection Port of Entry. In East County, Gillespie Field is the 44<sup>th</sup> busiest airport in the nation with 240,000 annual operations. Both of these airports support thousands of jobs and generate hundreds of millions of dollars in economic activity. The County looks forward to the integration of these airports into the regional transportation system.

20. The San Diego County Regional Airport Authority adopted Airport Land Use Compatibility Plans for the eight airports, which included land use compatibility policies related to airspace, noise, safety and overflight. Those policies have been adopted by the County of San Diego through its General Plan and Zoning Code. After evaluating the forecasted increases in housing and jobs around the Mobility Hubs, there are several land use assumptions related to safety and noise around Fallbrook Airpark, Jacumba Airport, Gillespie Field and McClellan-Palomar Airport that County staff would like to better understand. For example, there are forecasted incompatible housing increases within the Runway Protection Zones at Gillespie Field. These inconsistencies could result in the assumed intensities and densities increases being unachievable.



# County of San Diego

**SARAH E. AGHASSI**  
DEPUTY CHIEF ADMINISTRATIVE OFFICER

LAND USE AND ENVIRONMENT GROUP  
1600 PACIFIC HIGHWAY, ROOM 212, SAN DIEGO, CA 92101  
(619) 531-6256  
[www.sdcounty.ca.gov/lueg](http://www.sdcounty.ca.gov/lueg)

## **ATTACHMENT B 2021 REGIONAL PLAN PROPOSED MOBILITY HUB EXPANSION AREAS**

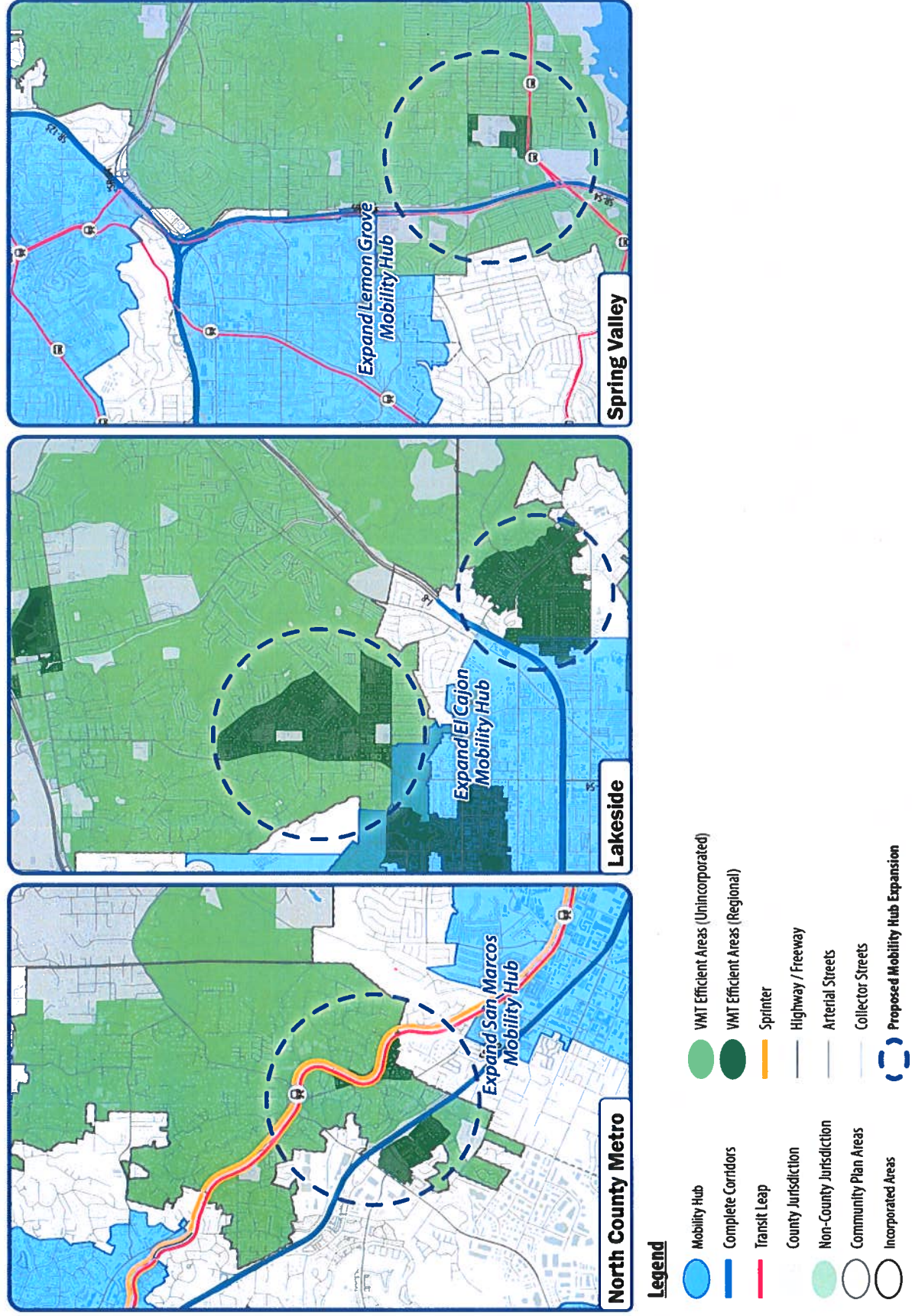
The Regional Plan will focus future investment, development, and growth in centralized areas referred to as “mobility hubs.” There are locations in the unincorporated area that the County has forecasted for future growth, which included already designated Regional Housing Needs Assessment (RHNA) sites, and are located within close proximity to a proposed mobility hub. The County would like to work with SANDAG to consider the expansion of proposed mobility hubs to include additional unincorporated north and east county communities. As indicated in Figure 1, these proposed expansions include areas in North County Metro, Lakeside, and Spring Valley. Additional details for these three mobility hub expansions are provided below.

The North County Metro community is located between the proposed Vista and San Marcos mobility hubs. Expansion of the San Marcos mobility hub could include the Buena Creek Sprinter Station and additional housing units, including multiple RHNA sites.

Lakeside has multiple areas that are identified as efficient areas compared to the regional vehicle miles traveled (VMT) average. These areas are located immediately adjacent to the proposed El Cajon mobility hub. Expansion of the El Cajon mobility hub could include these VMT efficient areas as well as potentially including additional growth areas in Lakeside along the I-8 corridor.

Spring Valley is located east of the proposed Lemon Grove mobility hub and south of the proposed La Mesa mobility hub. This community has existing transit access along Jamacha Boulevard and is in close proximity to the MTS Trolley stations in Lemon Grove. Expansion of this mobility hub could include the Spring Valley areas near SR-125 and along Jamacha Boulevard.

**Figure 1 Proposed Mobility Hub Expansions in North and East County**





August 5, 2021

Board of Directors  
SANDAG, Executive Director  
401 B St, Suite 800  
San Diego, CA 92101



**Re: Support incorporating *Reconnect Logan, 5 Freeway Lid Project* in the San Diego Association of Governments' (SANDAG) 2021 Regional Plan**

Honorable SANDAG Board,

On behalf of the residents and community leaders of Barrio Logan and Logan Heights, we submit these letters of support for the creation of a priority not currently identified in the 2021 Draft Regional Plan. It is imperative that you incorporate a project to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities. Specifically, **we request the addition of a Freeway Lid as a priority project in SANDAG's 2021 Draft Regional Plan (Draft Plan).**

Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know *ReConnect Logan Freeway Lid* will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.

As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.

Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs,



and Phasing, it is appropriate to identify and call out *ReConnect Logan Freeway Lid* as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:

- The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)
- Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)
- Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)

Besides being in line with the 2021 Draft Regional Plan, *ReConnect Logan Freeway Lid* is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to **the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.**

If you have any questions, you may contact me at 619-887-7292.

Sincerely,



DAVID ALVAREZ

on behalf of ReConnect Logan Community Leaders

cc: Hasan Ikhata

**Douglas A. & Christine L. Evans**  
3230 Corte Paloma  
Carlsbad, CA 92009-6093  
1-760-591-9107

June 5, 2021

San Diego Association of Governments (SANDAG)  
401 B Street, Suite 800  
San Diego, CA 92101

Subject: "Draft" 2021 Regional Plan" -- Chapter 3, How the Budget is Built, Road User Charges, Page 47 and Appendix V: Funding and Revenues, TransNet Program, page V-1 and Regional Road User Charges, page V-18

Dear Sir and Madam:

**We oppose "Road User Charges"** as a funding source that would be incremental / additional to the existing fuel fees and taxes for the transportation infrastructure as outlined in the 2021 Regional Plan Transportation. We request that you oppose implementation of such Road User Charges if they are in addition to the existing fuel fees and taxes.

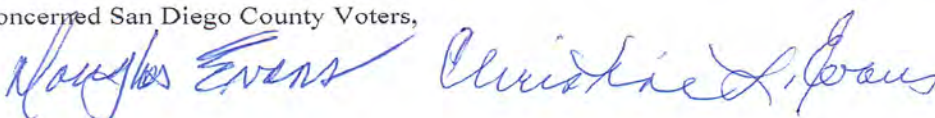
Road User Charges for all vehicles – Internal Combustion Engine (ICE), Electric Vehicles (EVs), Hydrogen, Hybrid, etc. -- is acceptable only if the State, County and City fuel fees (\$0.389/gallon) and taxes (California -- \$0.612/gallon)<sup>1)</sup> are eliminated. If those fees and taxes are eliminated, then implementing a Road User Charge of \$0.27/mile, which would generate the equivalent revenue as the current fuel fees and taxes would be reasonable (calculation assumptions -- average fleet fuel economy of 37.5 miles/gallon<sup>2)</sup> and miles driven per year of 12,524<sup>3)</sup>). If the fuel fees and taxes are not eliminated, then Road User Charges should be implemented for ICE vehicles. Such charges could be added to the non-ICE vehicle's license fee – EVs, Hydrogen, Hybrid, etc.

**Use the fuel fees and taxes (federal and state of \$1.19<sup>1)</sup>) as intended** by the voters instead of diverting gas fee and tax revenues into other projects. From the Los Angeles Daily News<sup>4)</sup>, "The gross misspending, waste and diversion of gas tax revenues into projects having nothing to do with roads or highways. Caltrans admits that as it tries to focus available funding on core system assets, it is simultaneously increasing our investment in bicycle and pedestrian transportation. Gov. Newsom signed an executive order in 2019 that redirected gas tax money to fund railway systems and other non-road projects. Although SB 1 raised taxes with the promise that the money would be used to repair crumbling roads and bridges, about 30 percent of the revenue raised by the tax hike is designated for other transportation priorities, including public transit, bike lanes and walk paths." From the Fresno Bee<sup>5)</sup>, another disturbing example of diverting funds from their intended purpose, Gov. Gavin Newsom issued [executive order N-19-19](#), which obligates the state transportation agency to leverage transportation spending on projects such as strategically directing discretionary transportation investments in support of housing production near available jobs and in accordance with the state's smart growth principles. **Stop diverting funds from their intended purpose.**

If projects for transportation in addition to roads and / or other non-transportation projects are needed, then put such projects on the ballot for a vote by the citizens of San Diego County / California to approve or reject a tax for such needs. Do not use the "bait and switch" tactic on the citizens of San Diego County. **Use fees and taxes for their intended purpose – PERIOD!**

Thank you for your attention to this matter. **We look forward to hearing your opposition to the Road User Charges as outlined in the SANDAG 2021 Regional Plan.**

Concerned San Diego County Voters,



References:

- 1) San Diego Union Tribune, March 12, 2021, *Gasoline taxes and fees in California*:  
<https://www.sandiegouniontribune.com/business/story/2021-03-12/how-much-are-you-paying-in-taxes-and-fees-for-gasoline-in-california>
- 2) Federal Register / Vol.85, No. 84 / April 30, 2020: <https://www.govinfo.gov/content/pkg/FR-2020-04-30/pdf/2020-06967.pdf>
- 3) The Zebra, Average Miles Driven per year / California:  
<https://www.thezebra.com/resources/driving/average-miles-driven-per-year/#average-miles-driven-per-year-by-state>
- 4) Los Angeles Daily News, April 18, 2021, *The great gas tax ripoff continues*, by Jon Coupal:  
<https://www.dailynews.com/2021/04/18/the-great-gas-tax-ripoff-continues/>
- 5) The Fresno Bee, March 16, 2020, *Gov. Newsom would rather take gas-tax money for bike lanes than fix California's Roads*, by Kerry Jackson, March 16, 2020: <https://www.fresnobee.com/opinion/op-ed/article241233226.html#storylink=cpy>





August 3, 2021

Keri Robinson  
Senior Planner  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

***Re: EHC Comments on SANDAG'S Appendix Y: Goods Movement Planning and Draft 2021 San Diego and Imperial Counties Freight Gateway Study Update***

Dear Ms. Robinson:

EHC's initial comments on SANDAG's Appendix Y: Goods Movement Planning and Draft 2021 San Diego and Imperial Counties Freight Gateway Study Update are summarized below and subsequently detailed in this letter for your consideration:

**High-Level Comments/Recommendations:**

- ZE drayage trucks (100 mile + range) are commercially available now and also comparable in costs today along with increasingly positive total cost of ownership (TCO) in years ahead.
- Zero emission drayage trucks should be the focus of regional efforts vs. near zero emission technology.
- Misclassification of workers needs to be explained and addressed in the SANDAG report.
- The Gateway Study should address potential impacts of climate change on 2050 freight projections.
- Policies should be included to support workers whose jobs may be at risk as a result of a shift to automation.
- Short sea shipping (e.g., marine highway) needs further analysis to know how this mode shift would impact air quality in Portside communities.
- Heavy duty charging facilities must be planned and installed in readiness for the transition to ZEV trucks that is mandated in California and the earlier goals established in the Community Emission Reduction Plan and the upcoming Maritime Clean Air Strategy.
- Regarding outbound cargo, it appears unnecessary to develop new imports of sand, gravel, and aggregate into the region.

## Detailed Comments/Recommendations:

A. ZE drayage trucks are commercially available now and also comparable in costs today along with increasingly positive total cost of ownership (TCO) in years ahead.

1. In section 4.1 (page Y-165), it states that “Port of SD: ZE vans and trucks ***may*** be suited to accommodate demand for goods movement in the area while reducing air quality and noise impacts, given the volume of local truck trips and improvements in ZE technologies....”. Data indicates that these local trips, as well as much longer drayage trips, are already feasible today with ZE drayage trucks.
2. Per the Port of San Diego study (November 2020)<sup>1</sup>, ZE drayage trucks with a range of over 100 miles are commercially available today. The Port study explains that:
  - a. Five different ZE drayage trucks are expected to be commercially available by the end of 2020, while another seven should become available by 2022/2023. Each has a range of over 100 miles, which is enough to complete the average drayage truck duty cycle of less than 100 miles on a single charge;
  - b. The range of existing electric Class 8 trucks cap out at around a 150-mile range on a single charge;
  - c. ZE drayage trucks requiring more than 150 miles will be available soon; and,
  - d. Truck ranges are expected to increase as manufacturers develop longer-range batteries with the Tesla semi planned to exceed 500 miles near the 2023 timeframe.
3. ZE drayage trucks are comparable in costs today along with increasingly positive total cost of ownership (TCO) in years ahead.
  - a. A Lawrence Berkeley National Laboratory (March 2021)<sup>2</sup> study concludes that a Class 8 electric truck operated 300 miles per day when compared to a diesel truck offers a roughly 3-year payback and net present savings of about \$200,000 over a 15-year lifetime."
  - b. The 2035 Report 2.0: Plummeting Costs and Dramatic Improvements In Batteries Can Accelerate Our Clean Transportation Future from UC Berkeley’s Goldman School of Public Policy (April 2021)<sup>3</sup> explains that the TCO for heavy duty electric vehicle starts out as positive compared to diesel and gets substantially better through 2035.

B. ZE drayage trucks (not near-zero) trucks are needed to reach air quality and climate goals.

1. EJ communities and Climate Action Plans require ZE (not near zero) trucks. However, the SANDAG report encourages and/or assumes near zero. On page Y-29, it states “.....In addition to the international gateway forecast, develop a freight forecast to 2050 for three specific urban areas of the Gateway Region that addresses emerging freight trends, such as the transition to zero/***near-zero-emission*** freight vehicles...”.

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<sup>1</sup> [https://pantheonstorage.blob.core.windows.net/ceqa/MCCW\\_Vol\\_1\\_Final\\_SEIR.pdf](https://pantheonstorage.blob.core.windows.net/ceqa/MCCW_Vol_1_Final_SEIR.pdf)

<sup>2</sup> [https://eta-publications.lbl.gov/sites/default/files/updated\\_5\\_final\\_ehdv\\_report\\_033121.pdf](https://eta-publications.lbl.gov/sites/default/files/updated_5_final_ehdv_report_033121.pdf)

<sup>3</sup> <https://2035report.com/transportation/>



2. The Luskin Report (2019)<sup>4</sup> specifically warns against meeting any short-term uptick in drayage truck turnover with natural gas trucks. The report explains that if investments focus on natural gas trucks as the primary replacement, more natural gas fueling stations will be needed. Given goals to transition to zero-emission trucks, these investments will inevitably be stranded or the ZE transition will be delayed unnecessarily.
- C. Misclassification of truck drivers needs to be explained in report.
1. Misclassification of truck drivers in California needs to be explained in the SANDAG report. On page Y-24, it states "...A large portion of truck operators in the freight industry are independent contractors who own their own vehicles and work for larger corporations. As policies start to implement regulations that discourage the continued use of heavy-duty diesel trucks and enforce the use of zero-emission vehicles, **independent truck owners will be left with outdated vehicles they can no longer use**, leading to potential unemployment for these operators...".
  2. The drayage, package delivery, and other short-haul segments of the trucking industry are home to ongoing and egregious worker exploitation.<sup>5</sup>
  3. Trucking companies, brokers, and other contracting entities often illegally misclassify drivers as independent contractors (when they are employees by law) to avoid paying wages, benefits, equipment costs, taxes, and regulatory compliance costs.<sup>6</sup>
  4. Misclassified drivers operate 70 to 90% of California's drayage trucks, making misclassification the drayage segment's dominant business model.<sup>7</sup>
- D. The Freight Gateway Study should address potential impacts of climate change on goods movement.
1. The Gateway Study did not address potential impacts of climate change on 2050 freight projections. Impacts are difficult to predict, but it would be reasonable to develop scenarios that do not assume simple linear growth in freight volumes, due to disruptions in supply chains, extreme weather events, sea level rise, and potential changes in key industries in the San Diego region such as agriculture, construction, and tourism. As overarching policy directions, the San Diego region must plan for producing critically important goods closer to home, and reducing our dependence on goods movement as an economic driver.
- E. Additional Comments on Goods Movement Planning and the Freight Gateway Study.

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<sup>4</sup> [https://innovation.luskin.ucla.edu/wp-content/uploads/2019/10/Zero\\_Emission\\_Drayage\\_Trucks.pdf](https://innovation.luskin.ucla.edu/wp-content/uploads/2019/10/Zero_Emission_Drayage_Trucks.pdf)

<sup>5</sup> USA Today, Rigged: Forced into debt. Worked past exhaustion. Left with nothing. 2017. Available at <https://www.usatoday.com/pages/interactives/news/rigged-forced-into-debt-worked-past-exhaustion-left-with-nothing/>

<sup>6</sup> Viscelli, The Big Rig: Trucking and the Decline of the American Dream, 2016.

<sup>7</sup> Bensman, Misclassification: Workers in the Borderland, 2014, available at [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2383396](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2383396).

1. Appendix Y correctly notes the importance of equity for workers in the freight industry, but mentions the potential impact of automation only in passing, on page Y-5. SANDAG needs to address the challenges of automation more fully. Who makes the decisions to automate unloading, loading, or movement of freight? What opportunities are there for workers and the public to participate in these decisions? What policies are in place, or needed, to support workers whose jobs may be at risk as a result of a shift to automation? Until these questions are answered fully, SANDAG's goods movement planning will be failing these workers.
2. Marine Highway M-5 is mentioned briefly on page Y-8 as a potential new source of trade. Short sea shipping may be a good option for reducing GHG and truck traffic. At the same time, Portside residents need to know how this mode shift would impact air quality in their communities. Will additional ships be coming to San Diego's cargo terminals if the project is approved? Will these ships be shorepowered? Goods movement planning requires that local impacts be identified and addressed.
3. Urban warehouses for e-bike deliveries are mentioned as an innovative delivery option on page Y-26. It is important to be clear that if trucks will also be accessing these facilities, they do **not** belong in residential areas. Residents of Barrio Logan and west National City have struggled for decades to eliminate incompatible land uses such as warehouses from their communities.
4. Regarding infrastructure needs for truck freight hauling, the report, in Section 2.1.2.1. Gaps in Existing Road Infrastructure, correctly notes the lack of dedicated truck parking, staging, and queuing facilities. Another essential piece of freight infrastructure planning: EV charging facilities for MD/HD trucks. Charging facilities must be planned and installed in readiness for the transition to ZEV trucks that is mandated in California.
5. Regarding outbound cargo, Figure 3.14 on page Y-129: Gravel is the largest outbound cargo, by tonnage, at 3,505 tons. This is a category of commodity that also includes aggregate. Sand is also a large outbound commodity, at 1,086 tons. It appears unnecessary to develop new imports of sand, gravel, and aggregate into the region, and unlikely to produce reductions of emissions from trucks.

Thank you for your time and consideration. Please contact Danny Serrano, Campaign Director at [dannys@environmentalhealth.org](mailto:dannys@environmentalhealth.org) for any additional information.

Sincerely,



Diane Takvorian  
Executive Director



Danny Serrano  
Campaign Director

*Joy Williams*

Joy Williams  
Retired Research Director

Friends of Rose Canyon  
Deborah Knight, Executive Director  
[rosecanyon@san.rr.com](mailto:rosecanyon@san.rr.com), 858-525-1489

#### Comments on the Draft 2021 Regional Plan - 8/4/2021

Our comments are focused on the geographic area that we are most familiar with: the area within and extending out from the I-805 / SR-52 / I-5 triangle. This includes the Rose Creek watershed (Rose Canyon, MCAS Miramar, San Clemente Canyon and Marian Bear Park, and Rose Creek extending south to Mission Bay) and the Carrol Canyon, Sorrento Valley, and Penasquitos Lagoon watershed. However, many of the concerns, issues and questions we raise in relation to this area apply to the entire RTP.

Our overall comment is that the 2021 Draft Regional Plan states that it proposes a bold new vision. However, it is based on a massive expansion of our highways. This includes widening many of our highways to add Managed Lanes and adding huge, elevated concrete “Managed Lane Connectors” ( MLCs) where highways intersect. These MLCs will require even further highway widening to add lanes where traffic would enter and exit the connectors. In some cases these MLCs connect highways at very different elevations or with multiple other on and off ramps and bridges in the same location. Judging from just the area we focus on, these added MLs and MLCs will have huge direct and indirect environmental impacts on sensitive habitat, MSCP lands, Marian Bear Park, Rose Canyon Open Space Park, MCAS Miramar, and the Rose Creek and Carroll Canyon Creek/Sorrento Valley/Penasquitos Lagoon watersheds. Furthermore, just in the area we focus on, these MLs and MLCs will cost many hundreds of millions of dollars.

We ask: How much induced demand will adding all this highway capacity cause? How sure is SANDAG of their calculations? Will this plan really reduce GHG emissions, and by how much? How sure is SANDAG of those calculations? What is the course correction if we start adding all this highway capacity and the benefits are not there? Do the RTP models rest on the assumption that the projected benefits require that all the highway MLs and all the MLCs be added to achieve the projected benefits? What if we get half way into building this out and find that adding all this highway capacity is not bringing the benefits anticipated?

Based on what we see proposed for just the area we focus on, we see major direct and Indirect Impacts on MSCP lands, open space, habitat, native plant and animal species, wildlife corridors, creeks, and watersheds. Adding Managed Lanes and Managed Lane Connectors means bulldozing land and building extensive new concrete surfaces and retaining walls and drainage ditches, expanding direct impacts and edge effects on habitat and wildlife, increasing storm water run-off, noise and light impacts, invasive species, habitat loss, loss of wildlife connectivity and wildlife corridors, increased erosion, trash, and air and water pollution. “Mitigating” these impacts through projects done in distant mitigation banks does nothing to reduce the impacts in the areas where these impacts occur.

While SANDAG staff have stated in meetings with the QOL coalition that they are not widening outside the highway ROWs, that does not mean there won't be major highway widening and environmental impacts. In some cases, CALTRANS has sufficient ROW to widen by multiple lanes. And widening even within the ROW extends the damaging impacts and pushes the edge effects closer to and into sensitive habitat.

Meanwhile, the Purple Line (Commuter Rail 582) from Sorrento Mesa to the Border (a true transit project) will not be completed until 2050. In concept, we strongly support this project, assuming it is largely underground through the environmentally sensitive areas we focus on. But despite the importance of this transit project, we know little beyond the vaguest description of its route. Where might it be underground? Where might it be at grade or above grade? Why is it not being completed until 2050 while the RTP prioritizes adding so many highway MLs and MLCs?

### **I-805 North Project**

On April 15, 2021, the Sierra Club sent the attached letter to SANDAG Director Hasan Ikhata, Director of Regional Planning Coleen Clementson, Senior Transportation Planner Jennifer Williamson, and several SANDAG BOD members. At a subsequent meeting with the Quality of Life Coalition's Transportation Committee, Coleen Clementson stated vehemently, "We agree with you." We therefore assume and would like confirmation, that the following is not in and will not be added to the RTP for the I-805 North from just south of SR-52 to Carroll Canyon Road:

- Any additional freeway widening beyond what has currently been built (one Carpool/ HOV lane in each direction was completed in 2016)
- Widening of the I-805 bridge over Rose Canyon
- Direct Access Ramps (DARs) at Nobel Drive
- A Park & Ride at the southwest corner of Nobel/I-805
- A bus station at the southwest corner of Nobel/I-805

### **Project ID CC114 is called I-805 (Nobel Drive) - it should be deleted from the RTP**

**Rationale:** I-805 North should locate access to and from the Managed Lanes at La Jolla Village Drive, not Nobel Drive. La Jolla Village Drive has extensive high density employment and high density housing located between the LJVD/I-805 intersection and Genesee Avenue. At Genesee there are two trolley stations surrounded by existing and planned high density employment and housing. La Jolla Village Drive is the route BRT lines should use to enter and exit the I-805 MLs. Nobel Drive is a poor location for a BRT route to enter or exit I-805 MLs. The location is far from significant employment or housing density. Furthermore, no parking lot or bus station should be located at Nobel/805. The I-805 commute is south to north in the morning, so parking lots near the I-805 should be located in communities well to the south where commuters come from in the morning. The land at the Nobel/ I-805 intersection should be protected from any further impacts. Most of it is MSCP, and there are vernal pools and numerous documented sensitive species. That area should have no further disturbance.



## **The area within and near the SR-52, I-805, I-5**

**The RTP should reduce the amount of highway expansion and the number of MLCs in this area. SR-52 should not be widened and the MLCs between these highways should be eliminated.**

**The following projects would cause major environmental damage to MSCP lands and to the area's critical and already highly constrained wildlife corridors.**

This area illustrates our concern about the RTP as a whole. The RTP proposes a massive expansion of highway capacity in the name of creating "Complete Corridors" that will, in theory, carry BRT lines and carpools. While it is true that some existing general purpose lanes will be converted to "Managed Lanes", the RTP proposes an expansion of all the highways in this area to add MLs plus multiple MLCs between these highways that will further degrade the habitat and wildlife corridors.

**CC085: 2035 - MLC I-805 (SR 52) West to North and South to East CCT - \$149 mil**

This MLC will cause major environmental damage to an area with important wildlife corridors that connect MCAS Miramar, San Clemente Canyon (and Marian Bear Park) and Rose Canyon. These wildlife corridors are identified in the MSCP and in the MCAS Miramar Natural Resource Management Plans. The wildlife corridor between MCAS Miramar and San Clemente Canyon is already highly constrained at the I-805/52 intersection. In addition, the elevation change between the I-805 and SR-52 is significant. A further environmental impact will occur due to adding two MLs to SR-52 east of I-805 and one ML to SR-52 west of I-805.

**CC086: MLC I-805 (SR52) North to West and East to South (\$126 mil):** More environmental impacts in this same area.

**CC003 - (by 2035) - I-5 (Pacific Highway to SR 52) 8F to 6F+4 ML (\$353 mil) (adding 1 lane in each direction to I-5)**

**CC004 by 2035 I-5 (SR 52 to I-805) 8F to 6F + 4ML (adding one lane in each direction) (\$190 mil)**

**CC028 by 2050 MLC I-5 (SR 52) South to East and West to North (\$202 mil)**

**CC065 by 2050 Complete Corridor: ML SR 52 (I-5 - I-805) 4F to 4F + 3 ML (\$214 mil)**

This massive widening of SR 52, with additional width needed to build the Managed Lane Connectors between I-5/52 and SR 52/ I-805 (MLCs in all directions) will have huge negative impacts on the adjacent MSCP lands in San Clemente Canyon and Marian Bear Park and on Rose Canyon and on the wildlife corridors between

**CC066 by 2050 I-5 (SR 52) MLC - North to East and West to South (\$202 mil)**



# SIERRA CLUB

SAN DIEGO CHAPTER

April 15, 2021 - via email

Re: **Sierra Club San Diego Chapter opposition to potential projects on the I-805 North**

Dear Chair Blakespear,

Since 1948 Sierra Club San Diego has earned a leadership role in the conservation of our County's natural resources. Presently, with more than 40,000 members and supporters, the San Diego Chapter is continuously addressing planning by all regional agencies. Particular attention is focused on the avoidance of impacts to the biological diversity which is so crucial to our quality of life. Sierra Club requests consultation and a place at the table whenever SANDAG is considering any of the following proposals.

**Sierra Club strongly opposes the following proposed projects for the I-805 North, from just south of SR-52 to Carroll Canyon Road:**

- Any additional freeway widening beyond what has currently been built (one Carpool/ HOV lane in each direction was completed in 2016)
- Widening of the I-805 bridge over Rose Canyon
- Direct Access Ramps (DARs) at Nobel Drive
- A Park & Ride at the southwest corner of Nobel/I-805
- A bus station at the southwest corner of Nobel/I-805

**We oppose the inclusion of any of these projects in the 2021 Regional Plan.**

- These projects (or any projects with a similar footprint) would:
  - Destroy and degrade native habitat in Rose Canyon that is part of the last remaining greenbelt and wildlife corridor connecting habitat west of I-805 with habitat on MCAS Miramar. The important wildlife corridor in Rose Canyon under the existing I-805 bridge is recognized in both the MSCP and the MCAS Miramar Natural Resources Management Plan.
1. Destroy and degrade core MSCP habitat.
  2. Destroy and degrade habitat with numerous sensitive plant and animal species, including:
    - Vernal pools
    - Rare Quercus Dumosa (Nuttall's scrub oak)
    - MHPA habitat with documented California Gnatcatchers as well as numerous other sensitive species

Thank you Chair Blakespear for your attention to our request for inclusion in the process. Retaining San Diego's reputation as a world renowned "biological hotspot" is a goal we must all strive for.

Sincerely,

Dave Grubb,  
Chair, Transportation Committee, Sierra Club San Diego Chapter  
George Courser,  
Chair, Conservation Committee, Sierra Club San Diego Chapter



PO Box 221051, San Diego, CA 92192-1051

858-597-0220 \* [rosecanyon@san.rr.com](mailto:rosecanyon@san.rr.com)

[www.rosecanyon.org](http://www.rosecanyon.org)

August 6, 2021

Submitted via email: [SDForward@sandag.org](mailto:SDForward@sandag.org)

Comments on the Draft 2021 Regional Plan

Active Transportation Projects:

**The City of San Diego's chosen alignment for the Coastal Rail chosen between Gilman/La Jolla Colony Drive and Sorrento Valley Coaster Station should be added to the RTP and the old alignment should be deleted (Rose Canyon, "UTC" (along Judicial Drive), Roselle Canyon and Roselle St to the Sorrento Valley Coaster station). This old alignment was thoroughly studied and rejected due to multiple major problems.**

The Draft RTP contains inconsistent and out-of-date labeling of a portion of the City of San Diego's Coastal Rail Trail. The City is the Lead Agency for the Coastal Rail Trail in the City, and it has selected the alignment and completed final design of the alignment along Gilman Drive to UCSD.

The City has deleted from its Bike Master Plan the old Rose Canyon, "UTC", and Roselle Canyon alignment. The City studied that route for years and rejected it for multiple reasons.

The RTP therefore needs to:

- cut three planned CRT segments and trim one CRT segment
- relabel the CRT route in the RTP to coincide with the approved Gilman Drive CRT segment, adding the UC San Diego CRT segment plus the I-5 Bicycle Corridor.
- Amend Appendix A and Appendix L in the SANDAG RTP to be consistent with this change.

The RTP should make the following changes summarized in the following tables:

CRT route as presented in the SANDAG RTP

SANDAG Project ID	Name/Description	SANDAG 2020 Cost	The RTP should make the following change	RTP Page reference
AT032	CRT - Carmel Valley to Sorrento to Roselle Canyon	\$20M	Change Carmel Valley to Roselle via Sorrento by removing Sorrento to Roselle. Carmel Valley to Sorrento remains.	Appendix A Table 1 p. A-6
AT036	CRT - Roselle Canyon	\$12M	Cut	Appendix A Table 1 p. A-6
AT037	CRT - UTC to Rose Canyon	\$11M	Cut	Appendix A Table 1 p. A-6
AT023	CRT - Rose Canyon	\$31M	Cut	Appendix A Table 1 p. A-8

The RTP needs to add the CRT route the City of San Diego has chosen for the segment from Sorrento Valley Coaster Station to the Gilman Drive/La Jolla Colony intersection

Segment	Start	End	Notes
CRT – I-5 Bicycle Corridor	Sorrento Valley	Voigt and Gilman	Already completed by Caltrans
CRT - UC San Diego	Voigt and Gilman Dr.	Gilman and La Jolla Village Dr.	UC San Diego is adding major bike infrastructure improvements through the campus on this route
CRT - Gilman	Gilman Dr. and La Jolla Village Dr.	Gilman Dr. and I-5 / Rose Creek Bike Path and La Jolla Colony Dr.	Protected bike lanes fully designed by City. Partial construction funding in SD City 2022 CIP budget.

## **Reallocation of funds and equity**

The savings for the three old, out-of-date segments to be cut is \$53 million (Rose Canyon, UTC (Judicial Drive) and Roselle Canyon, plus any savings from trimming the route AT032 by cutting Sorrento to Roselle, a segment made unnecessary by the I-5 bike path from the Sorrento Valley Coaster Station to UCSD. Two of the three segments in the City's chosen CRT route are either complete or funded, so it can be anticipated that almost all of the \$53 million in the RTP can be freed up for active transportation projects that address equity, for example, in Chollas Creek, South Bay, or the Midway Corridor.

## **Community and City of San Diego support and action for the CRT alignment up Gilman:**

The CRT route has City and Community support:

- The SANDAG RTP routes do not exist in the City of San Diego Bike Master Plan. They were explicitly deleted by the San Diego City Council in December 2013.
- The approved CRT Project route in San Diego has been selected, with the final Gilman Dr. link ready for construction and on the CIP list for 2020-2021.
- The approved CRT route was developed and selected by a City of San Diego Public Working Group in 2013-2014.
- The approved CRT route is supported by the Community Planning Groups: the UCPG in 2013 and 2021, and the La Jolla Planning Association in 2021.
- The approved CRT route has been supported by the City of San Diego in 2013, 2016 and budgeted in 2021.

## **The City's approved CRT route enhances important existing connections:**

- With the Rose Creek bikeway open, it is a connecting link to UC San Diego from the south.
- With the existing I-5 Bicycle Corridor, it is a connecting link to UC San Diego from Sorrento and the Coaster.
- The completed UC San Diego Gilman Bridge over I-5 provides comfortable and safe bicycle links to the east UC San Diego Campus, industry along Eastgate Mail, and the commercial center at UTC.



August 3, 2021

*By E-Mail*

Honorable Catherine Blakespear, Board Chair  
and Board of Directors  
San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92101  
[SDForward@sandag.org](mailto:SDForward@sandag.org)

*Re: Draft 2021 Regional Plan*

Dear Chairperson Blakespear and SANDAG Board of Directors:

This firm represents Lakeview 1, LLC, Lakeview 2, LLC and Moller Lakes Investment, LLC (collectively, Lakeview), owners of the approved Otay Ranch Resort Village Project (Resort Village).<sup>1</sup> On behalf of Lakeview, we have reviewed SANDAG's Draft 2021 Regional Plan (Draft Plan) and provide the comments that follow below.

As relevant background, the Resort Village is part of the Otay Ranch General Development Plan/Subregional Plan approved by the County of San Diego and City of Chula Vista in 1993. Otay Ranch, portions of which have been built out, is a complete community approved for 24,000 homes; commercial/retail uses; other non-residential uses; schools and public services; parks, recreation facilities, open space and a protected biological preserve; and complementary amenities designed to be developed over a 30- to 50-year period. Consistent with the land use parameters established in 1993 for Otay Ranch, the County of San Diego Board of Supervisors, in November 2020, approved the Resort Village for 1,938 residential units, a resort, and other complementary uses (such as parks and trails, a public safety site, an elementary school, and resident-serving commercial). As a general matter, development of the approved Otay Ranch planned community—of which the Resort Village is a part—has been accounted for in regional plans and projections since 1993.

As discussed below, it appears that SANDAG's Draft Plan has omitted from its design assumptions the Resort Village and its approved uses, resulting in a disconnect between the Draft Plan and the legal status of the Resort Village as a fully-entitled project.

We understand that the Draft Plan strives to transform the way San Diegans move through and about the region in an effort to address safety, traffic congestion, social inequities, air pollution and greenhouse gas (GHG) emissions. The Draft Plan includes an updated Sustainable Communities Strategy (SCS), which sets forth a "forecasted development pattern" that is designed to: (i) achieve per capita GHG reduction targets set for the region by the California Air Resources

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<sup>1</sup> The Resort Village also is referred to as Village 13.

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Board (CARB), (ii) accommodate the Regional Housing Needs Assessment (RHNA), *and* (iii) utilize the “most recent planning assumptions.” (Draft Plan, p. 19). SANDAG reports that its SCS will exceed CARB’s 2035 reduction target for the region by one percent; i.e., a 19 percent reduction is required and the SCS, if implemented, will realize a 20 percent reduction.

We provide the following comments on the Draft Plan, including its SCS:

1. Government Code section 65800, subdivision (b)(2)(B) requires SANDAG “to use the most recent planning assumptions *considering local general plans* and other factors” (italics added). In this regard, Figures F.7, F.8 and F.9 in Appendix F of the Draft Plan are in error and must be corrected to ensure SANDAG’s compliance with this statutory requirement for its SCS. Specifically, the referenced figures show approved and entitled development located within Otay Ranch—including the Resort Village—as “Vacant” on the SCS’ land use pattern maps for 2025, 2035 and 2050. This is obviously incorrect. The “Vacant” appellation is inconsistent with the County’s approval of its General Plan in 2011, the Otay Ranch General Development Plan/Subregional Plan in 1993, and the Resort Village in 2020. As such, it results in development forecasts that are incorrect and incapable of supporting the Draft Plan’s findings and objectives. Therefore, we respectfully request that SANDAG modify the referenced figures to reflect the land use densities long-approved by the County and long-recognized by its General Plan for this portion of unincorporated South County.
2. The Draft Plan’s forecasted development pattern will not accommodate the RHNA. Specifically, the Draft Plan—in Table F.3 of Appendix F—projects the construction of just 7,419 dwelling units in unincorporated County areas over the next roughly 30 years (through 2050). This number does not accurately represent the amount of approved, planned and reasonably anticipated growth in the unincorporated areas. For example, in the 6th RHNA Cycle, which covers the 2021 through 2029 planning period (and thus does not align with the 2035 horizon year of the SCS modeling), SANDAG assigned 6,700 dwelling units to the unincorporated areas.<sup>2</sup> Therefore, it appears the Draft Plan assumes that a mere 719 additional units will need to be built in unincorporated areas between 2030 and 2050, an assumption that is at odds with reasonable approximations of future RHNA cycles and existing market supply-and-demand evaluations for the San Diego region. The Draft Plan’s assumption of 7,419 units also is approximately 1/8<sup>th</sup> of the County’s General Plan build-out capacity of approximately 65,000 dwelling units. Thus, we respectfully request that SANDAG reevaluate the reasonableness of its forecasted development pattern by way of housing growth assumptions. It is critical to ensure that all modeling inputs are informed and reasoned, such that the SCS quantification analysis is defensible.

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<sup>2</sup> SANDAG, *6th Cycle Regional Housing Needs Assessment Plan* (July 10, 2020), Table 1.1, available at [https://www.sandag.org/uploads/projectid/projectid\\_189\\_27782.pdf](https://www.sandag.org/uploads/projectid/projectid_189_27782.pdf).

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3. It is unclear to what extent the SCS and its supporting quantification framework account for the home-to-work, interregional commute reality present in San Diego. We know that the San Diego region's failure to provide sufficient in-County housing opportunities has resulted in the exportation of some San Diego workers who now must commute into the region from more affordable housing opportunities in Riverside County or Mexico.<sup>3</sup> The spirit of Senate Bill (SB) 375, which created the statutory framework for SANDAG's SCS, will not be met unless and until we grapple with how land use choices made in the San Diego region affect San Diego workers. The Draft Plan must clarify SANDAG's strategies for reducing interregional commuting. Such strategies must ensure a sufficient quantity of in-County housing opportunities exists; otherwise, home-to-work, interregional commuting will continue to be a major problem.

In closing, we recognize that the transformation of San Diego's transportation patterns, long in the making, has been a "slow-and-steady wins the race" undertaking by SANDAG. We appreciate the opportunity to review and provide input on this Draft Plan, and are committed to advancing practical and effective strategies for the reduction of vehicle miles traveled and GHG emissions while developing much needed housing opportunities for the region. Thank you for your consideration of these comments.

Sincerely,



David P. Hubbard  
of  
Gatzke Dillon & Ballance LLP

DPH/rlf

cc: Nick Lee  
Eric Johnston  
Chuck Miller

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<sup>3</sup> See, e.g., Fehr & Peers, *Whitepaper on Inter-Regional Commute Trends Between Riverside and San Diego County* (February 12, 2020), available at <https://sdchamber.org/wp-content/uploads/2020/02/Regional-Commute-Trend-White-Paper-2-12-2020-FINAL.pdf>.

August 5, 2021

*By E-Mail*

Honorable Catherine Blakespear, Board Chair  
and Board of Directors  
San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92101  
[SDForward@sandag.org](mailto:SDForward@sandag.org)

*Re: Draft 2021 Regional Plan*

Dear Chairperson Blakespear and SANDAG Board of Directors:

This firm represents GDCI Proctor Valley, L.P., owner of the approved, but not yet constructed Adara community located in Otay Ranch's Village 14 and Planning Areas 16 and 19. On behalf of GDCI, we have reviewed SANDAG's Draft 2021 Regional Plan and provide the following comments thereon.

As relevant background, Village 14 and Planning Areas 16 and 19 are part of the Otay Ranch General Development Plan/Subregional Plan approved by the County of San Diego and City of Chula Vista in 1993. Otay Ranch, portions of which have been built out, is a complete community approved for 24,000 homes; commercial/retail uses; other non-residential uses; schools and public services; parks, recreation facilities, open space and a protected biological preserve; and complementary amenities designed to be developed over a 30- to 50-year period. Consistent with the land use parameters established in 1993 for Otay Ranch, the County of San Diego Board of Supervisors, in June 2019, approved the Specific Plan and Tentative Map for the Adara community for up to 1,119 residential units and other complementary uses (such as parks and trails, a public safety site, an elementary school, and resident-serving commercial). As a general matter, development of the approved Otay Ranch planned community—of which Village 14 and Planning Areas 16 and 19 is a part—has been accounted for in regional plans and projections since 1993.

As discussed below, however, it appears that SANDAG's Draft Plan has omitted from its design assumptions the Adara community and its approved uses, resulting in a disconnect between the Draft Plan and the legal status of Adara as a fully-entitled project located within Otay Ranch.

We understand that the Draft Plan strives to transform the way San Diegans move through and about the region in an effort to address safety, traffic congestion, social inequities, air pollution and greenhouse gas (GHG) emissions. The Draft Plan includes an updated Sustainable Communities Strategy (SCS), which sets forth a "forecasted development pattern" that is designed to: (i) achieve per capita GHG reduction targets set for the region by the California Air Resources Board (CARB), (ii) accommodate the Regional Housing Needs Assessment (RHNA), and (iii) utilize the "most recent planning assumptions." (Draft Plan, p. 19). SANDAG reports that its SCS

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will exceed CARB’s 2035 reduction target for the region by one percent; i.e., a 19 percent reduction is required and the SCS, if implemented, will realize a 20 percent reduction.

We provide the following comments on the Draft Plan, including its SCS:

1. Government Code section 65800, subdivision (b)(2)(B) requires SANDAG “to use the most recent planning assumptions *considering local general plans* and other factors” (italics added). In this regard, Figures F.7, F.8 and F.9 in Appendix F of the Draft Plan are in error and must be corrected to ensure SANDAG’s compliance with this statutory requirement for its SCS. Specifically, the referenced figures show approved and entitled development located within Otay Ranch—including Village 14 and Planning Areas 16 and 19—as “Vacant” on the SCS’ land use pattern maps for 2025, 2035 and 2050. This is obviously incorrect.<sup>1</sup> The “Vacant” appellation is inconsistent with the County’s approval of its General Plan in 2011, the Otay Ranch General Development Plan/Subregional Plan in 1993, and the Adara Specific Plan and Tentative Map in 2019. As such, it results in development forecasts that are incorrect and incapable of supporting the Draft Plan’s findings and objectives. Therefore, we respectfully request that SANDAG modify the referenced figures to reflect the land use densities long-approved by the County and long-recognized by its General Plan for this portion of unincorporated South County.
2. The Draft Plan’s forecasted development pattern will not accommodate the RHNA. Specifically, the Draft Plan—in Table F.3 of Appendix F—projects the construction of just 7,419 dwelling units in unincorporated County areas over the next roughly 30 years (through 2050). This number does not accurately represent the amount of approved, planned and reasonably anticipated growth in the unincorporated areas. For example, in the 6th RHNA Cycle, which covers the 2021 through 2029 planning period (and thus does not align with the 2035 horizon year of the SCS modeling), SANDAG assigned 6,700 dwelling units to the unincorporated areas.<sup>2</sup> Therefore, it appears the Draft Plan assumes that a mere 719 additional units will need to be built in unincorporated areas between 2030 and 2050, an assumption that is at odds with reasonable approximations of future RHNA cycles and existing market supply-and-demand evaluations for the San Diego region. The Draft Plan’s assumption of 7,419 units also is approximately 1/8<sup>th</sup> of the County’s General Plan build-out capacity of approximately 65,000 dwelling units. Thus, we respectfully request that SANDAG reevaluate the reasonableness of its forecasted development pattern

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<sup>1</sup> As noted in our August 3, 2021 comment letter submitted on behalf of Lakeview 1, LLC, Lakeview 2, LLC and Moller Lakes Investment, LLC, the very same mislabeling error has occurred in the Draft Plan’s referenced figures with respect to Otay Ranch’s Village 13.

<sup>2</sup> SANDAG, *6th Cycle Regional Housing Needs Assessment Plan* (July 10, 2020), Table 1.1, available at [https://www.sandag.org/uploads/projectid/projectid\\_189\\_27782.pdf](https://www.sandag.org/uploads/projectid/projectid_189_27782.pdf).



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by way of housing growth assumptions. It is critical to ensure that all modeling inputs are informed and reasoned, such that the SCS quantification analysis is defensible.

3. It is unclear to what extent the SCS and its supporting quantification framework account for the home-to-work, interregional commute reality present in San Diego. We know that the San Diego region's failure to provide sufficient in-County housing opportunities has resulted in the exportation of some San Diego workers who now must commute into the region from more affordable housing opportunities in Riverside County or Mexico.<sup>3</sup> The spirit of Senate Bill (SB) 375, which created the statutory framework for SANDAG's SCS, will not be met unless and until we grapple with how land use choices made in the San Diego region affect San Diego workers. The Draft Plan must clarify SANDAG's strategies for reducing interregional commuting. Such strategies must ensure a sufficient quantity of in-County housing opportunities exists; otherwise, home-to-work, interregional commuting will continue to be a major problem.

In closing, we recognize that the transformation of San Diego's transportation patterns, long in the making, has been a "slow-and-steady wins the race" undertaking by SANDAG. We also appreciate the opportunity to review and provide input on this Draft Plan, and are committed to advancing practical and effective strategies for the reduction of vehicle miles traveled and GHG emissions while developing much needed housing opportunities for the region. In the spirit of continued engagement, we formally request a meeting with the SANDAG staff members principally responsible for preparation of the Draft Plan in order to further discuss our comments herein. I can be reached at 760-431-9501 or [dhubbard@gdandb.com](mailto:dhubbard@gdandb.com) for purposes of scheduling the requested meeting. Thank you for your consideration of these comments.

Sincerely,



David P. Hubbard  
of  
Gatzke Dillon & Ballance LLP

DPH/rlf

cc: Elizabeth Jackson, President, Jackson Pendo Development Company

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<sup>3</sup> See, e.g., Fehr & Peers, *Whitepaper on Inter-Regional Commute Trends Between Riverside and San Diego County* (February 12, 2020), available at <https://sdchamber.org/wp-content/uploads/2020/02/Regional-Commute-Trend-White-Paper-2-12-2020-FINAL.pdf>.

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Rob Cameron, Jackson Pendo Development Company  
Dave Waters, GDCI Communities  
Dennis Moser, Moser Ventures



<https://gnpsd.org>



Annual Event at Perkins Elementary

August 5, 2021

Mr. Hasan Ikhata  
SANDAG, Executive Director  
401 B St, Suite 800  
San Diego, CA 92101

**Re: Support incorporating *Reconnect Logan, 5 Freeway Lid Project* in the San Diego Association of Governments' (SANDAG) 2021 Regional Plan**

Dear Mr. Ikhata,

My name is John Alvarado and my family has lived in Barrio Logan/Logan Heights for over 100 years I'm a retired school teacher and founder and Exec Dir of the Good Neighbor Project SD my home and office is located at 2215 Logan Ave. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities. **Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan (Draft Plan)**

Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know *Re-Connect Logan Freeway Lid* will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.

As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue

"Changing Our World One Neighbor at A Time"

to be a working-class neighborhood composed of nearly 90% Mexican Americans and while we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.

Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, it is appropriate to identify and call out *Re-Connect Logan Freeway Lid* as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:

- The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)
- Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)
- Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)

Besides being in line with the 2021 Draft Regional Plan, *Re-Connect Logan Freeway Lid* is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to **the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.**

If you have any questions, you may contact me at.

John Alvarado  
2215 Logan Ave.  
San Diego Ca. 92113  
Email: [john@gnpsd.org](mailto:john@gnpsd.org)

Thank you for your consideration,  
John Alvarado Exec. Dir  
Good Neighbor Project SD

## **Critique & Comments on 2021 Regional Transportation Plan - [Levine 7/28/21]**

I have conducted an in-depth review of the 2021 Regional Transportation Plan and wish to share my observations with the SANDAG Board of Directors and other interested SANDAG personnel. I have had an active interest in local governance, following a career in business management. I have elected to evaluate the RTP using business evaluation skills learned in over six decades in project, portfolio, and business management.

This document is in four parts, following this introduction. There is a general presentation of views and concerns. This is followed by a discussion of individual aspects of the RTP. Section three addresses options and impediments. The ending section is a profile of the author.

I need to preface my comments by expressing my admiration for the product that SANDAG has produced and for the investment that has been made in developing a potentially ideal transit-based solution to the environmental and density challenges with which we are faced in this remarkable county. The professionalism and quality exhibited in the published works are of the highest rank and served me well in my quest to understand the goals of the RTP and the methods to achieve them. It is indeed a visionary expression of a world-class system for a future population. I recognize the seriousness of the challenges and I fear for the future of the planet. I applaud the bold and creative efforts to meet these challenges head on, to work to meet state and federal mandates, and to qualify for state and federal funding and subsidies where available.

Nevertheless, I have to take issue with several assumptions and conclusions, as well as expressing my dismay at the massive investment of time, money and intellectual expertise for something that should have been questioned much earlier in the process.

In my consulting practice I have often been engaged to perform due diligence on business cases for major programs and for proposals for new business initiatives. As I became deeply interested in the 2021 RTP, I couldn't help seeing items that sounded alarms and triggered reality checks. As I have seen all too often, the search for the ideal has surpassed the practicalities of what is reasonable and achievable. I also am concerned that the sponsors may have based their assumptions on a best case or "wished for" values rather than a most likely set of scenarios. This plan begs for a responsible investigation and evaluation of the RTP by members of the SANDAG board who will carry the responsibility for this investment in the future. There is actually more at risk than an investment. The county appears to be committed to facilitate and mandate a radical change in the culture and behavior of a vast populace whose lifelong belief is that having a personal vehicle to go anywhere, at any time, is an inalienable right. The board is not voting for a transportation plan. It is voting to mandate a change to the very foundation of our lifestyle. They better get it right. We need to do something that will work.

### **OVERVIEW**

The 2021 Regional Plan, as presented in "San Diego Forward", depicts an environmental utopian paradise. It assumes a coordinated collection of paradigm shifts that support a vision of the ideal sizable urban/suburban metropolis where the government has considered and provided for the mobility of the



populace in the future. A future that requires a major reduction in greenhouse gasses and acceptance of increased housing density. It assumes that the public will readily give up their personal motor vehicles for the common good. SANDAG presents a perfected model that may work on paper. However, there is a huge hurdle to achieving that perfection.

Actually, there are two huge hurdles. One is the nature of people to resist paradigm shifts. Cultures cannot be mandated. They exist by will of the people. The 2021 Regional Plan makes assumptions of colossal culture change that cannot be reasonably presumed. This is a fact of life that governs what can be accomplished, no matter how “good” it is for the people and for the planet. For example we need only look to our current COVID-19 crisis. The only way out of the pandemic is via vaccination. The science is certain. The data is monumentally supportive. Yet, a major portion of the population refuses to do what is good for them and for the nation. Has this artifact of human nature been given adequate consideration in the plan?

The second hurdle, which has led to the demise of even the most seemingly foolproof plans, is the failure to consider the potential downside of the business case. In every plan there is a range of possible outcomes. We can look at the case through three lenses; the optimistic, the most likely, and the pessimistic. Where things fall apart is when exuberant support for the “optimistic” case causes the sponsor to downplay the “most likely” and to ignore the “pessimistic, and the associated risks.”

The pessimistic case fully considers risks. It creates alternate models representing the potential downside. The downside can happen. Even the most infallible plans have collapsed, leading to total failure of the venture, because of the reluctance to use assumptions that consider potential events and conditions that are not of the sponsor’s liking.

Here in San Diego, even in SANDAG, we have a history of inflated assumptions. We have seen it in the forecast of pension funding and in the projection of tax revenues. We have also seen it in the estimates of transit ridership. What assurances can you give the public that the 2021 Regional Plan is not based on inflated assumptions of income, ridership, or even the level of acceptance of change by the public?

Where are the models that represent a lesser level of expectations and what that would mean to accomplishment of the goals? I see a presentation of the ideal. Where is the picture of the realistic?

## **DISCUSSION**

I have watched and read a number of SANDAG presentations and publications. It started with the August 14, 2020 SANDAG presentation of the blueprint for the 2021 RTP. I watched the entire four-hour session and then skimmed through the 619 pages of attachments – educating myself in the details of the proposal. More recently, I have downloaded and examined the May 2021 draft of San Diego Forward: the 2021 regional plan (for public review), as well as Appendix B. And I have watched the full videos of the May 21, 2021 presentation to the SANDAG Board of Directors and the June 28, 2021 North County Inland Road Show. I have also held some discussions with board members or their designated staff members working on the SANDAG proposals.

Sifting through the mounds of data and assumptions, I find numerous areas where the expectations cannot be justified or validated. But before getting into the details, we cannot ignore the human factors in the plan. As much as we might want to focus on the data, it is human behavior that will be the biggest factor in whether this paradigm shift in transportation habits can be accomplished.

Director Ikhata boldly declares that it is the plan's intention to pressure the public to change its wasteful use of personal motorized vehicles as a response to environmental concerns of growing proportions, as well as to meet various government mandates. He talks about incentives. But when queried about how the change in behavioral culture will come about, he repeatedly brings up "pricing". He says "it will work if we price it right." Of course "pricing" is a code word for "fees." Using a euphemism cannot disguise what it is.

Invoking new fees, to use what has been considered to be something already covered by our taxes and DMV fees, is not an incentive. It is a penalty. The plan openly sets out to punish the public for doing what has been considered one of its most appreciated freedoms – the ability to get places, in the comfort and convenience of our own vehicles, on a timetable of our own choosing. SANDAG would have us give up this sacrosanct right and has set about to force the changes upon a recalcitrant public.

The pricing scheme is so devious that it not only imposes fees and taxes (a penalty, not an incentive) to force people to stop doing what is considered an inalienable right, but then directs the funds it collects away from what is wanted by the public (highway improvements). What kind of incentive sets out to punish rather than reward?

Let us not forget or ignore the penalties already inflicted on the driving public and the failures of previously imposed taxes to deliver what was expected or were diverted to other initiatives. For example I submit my motorcycle registration fee of \$233, which would cost me \$13 in NY. Or the income from the ½ percent TransNet sales tax that was grossly underestimated and is slated to be diverted from the highway projects it was supposed to support.

Now, looking at some of the initiatives in the RTP, there are data that belies the expected results. Director Ikhata was asked if he could provide an example of where **MANAGED LANES** was implemented. Oddly I-15 was used as an example. However, the design calls for Managed Lanes for I-5 and CA-78/56/52 without adding new lanes (except for repurposing shoulders), whereas the I-15 project created four additional lanes for HOV or toll-payer use. Unless all of the lanes are contiguous (which they are not) and narrow bridges are widened, the periodic merging of lanes would create new bottlenecks and backups. So would any breakdowns, public safety vehicles, or emergencies that would impact the travel lanes in the absence of shoulders. Is this really safe or practical? How would traffic control (police radar and traffic stops) operate? What happens in a medical emergency or when a vehicle has a mechanical problem, a flat tire, or runs out of gas or battery power? How is congestion reduction alleviated when a lane is isolated for busses? This model of managed lanes is more like a game of whack-a mole. I am apprehensive of drivers' attention being diverted from the road by a system of signs and signals directing them to a particular managed lane that changes with traffic conditions.

How effective would the Managed Lanes concept be if it doesn't involve increased reliable capacity? SANDAG projects an increase in use of mass transit (at peak commuting times) from about 3% to 11.2% (in 2035). Will this be enough to sufficiently impact the carbon reduction goal? SANDAG is also projecting a population growth of 15.2% by 2035. It would seem that the movement of commuters to transit will not be enough to offset the growing demand for roadways. How do we significantly reduce congestion (a key goal) without increasing capacity? Do we gain enough to justify the cost and inconvenience of construction and repurposing plus the imposition of user fees?

On the other hand, there are other conditions that might represent a reduction of emissions-producing vehicles. Among the important forecast values that we must consider for the RTP is the impact of electric vehicles. All manufacturers are making massive investments and commitments to have a majority of their output be EVs, within a decade. Governments are equally committed to replacing petroleum-fueled vehicles by 2035. Are we likely to gain more in the real goal of reduced greenhouse gases through the mandated and incentivized move to EVs?

When the shift to EVs is added to the impacts of more workers not having to drive to an office every day, potentially offsetting the population growth, the expense and "pricing" of the full managed lanes solution may not be warranted. Not if the justification is the reduction in the production of GHG. As an aside, we have to learn not to justify massive, expensive projects because there is government funding earmarked for such programs. Yes, I am thinking of California High-Speed Rail. These programs always end up growing extensively beyond the original (misrepresented) scope and cost, causing the agencies that thought that they were getting a free lunch to bleed real cash.

Let's get back to the "incentives" to get drivers to shun their cars. The "right" pricing essentially means making it painful to pay the VMT (vehicle miles traveled) fees. What I am hearing now is a charge of two cents per mile for the state plus two cents per mile for the county. So a highway trip from Rancho Bernardo to downtown and back would cost about two dollars. That is enough to make people angry, but not enough for them to use other means for travel. If they don't meet the HOV criteria, it's either pay additional fees or be limited to what are designed to be slower lanes. In the latter case, how does that help relieve congestion? It just pushes lower income drivers to use the most congested lanes. How does that support the stated "equality" goals?

The "right" pricing – that is; fees that will cause drivers to shun the controlled highways – may eventually lead to drivers eliminating such trips altogether. That may help the goal of easing congestion. But there will be offsetting penalties if the cancelled trips lead to people not shopping, eating out, or going to entertainment venues. This, in turn, will reduce income from sales taxes as well as impact the bottom line of these businesses (more tax losses). Has this been factored into the equation?

When combined with other initiatives, such as reducing or completely eliminating parking in many areas, both business and residential, the campaign against car owners becomes draconian. The thinking is that if people are using **MASS TRANSIT** and local connection options there will no longer be a need to own a personal vehicle. So whether you're going out to the mountains to go hiking, or over to Costco to load up on groceries and a 30-roll package of toilet paper, can you say that you really don't need a car?

Sure! Hey guys! Let's grab our beach chairs and umbrellas, the cooler, our cornhole game and a couple of surf boards and take the bus over to Cardiff State Beach (from Green Valley in Poway). And we'll stop off for dinner in Rancho Santa Fe on the way home, toting all our stuff. Currently, there is no reasonable mass transit to support that (according to MTS trip planner). The software did come up with a solution that would take four hours just to get to the beach, using four busses and the Sprinter (plus some walking) and told me to start 90 minutes earlier than I had specified. Is better coverage in the works? Would the group be able to make the trip in one day? Could they manage with all their gear?

So let's stop dreaming about a world without cars. Can we be practical and come up with ideas and real incentives to cut down on VMT?

Furthermore, as an "incentive" to dump your car or truck, the plan calls for charging for parking spot use and even to pull over to the curb. Yes, it's in the plan – see page 40 "Parking and curb pricing." Pricing is the term that is used for "fees."

With the estimate of only 11.2% of commuters using mass transit (and less for the general public) what we need is more parking. We shouldn't need to drive around looking for parking spots or hang out at the curb with the motor running. If you want to change behavior, do it with rewards, not with penalties. While there are some interesting ideas in this plan, I predict that the overall result will be to nickel and dime car owners in multiple ways without actually achieving the results that are expected.

The concept of **MOBILITY HUBS** is interesting. Providing flexible transit in selected concentration areas would be sensible and likely take care of some of the "last mile" issues that hinder the practicality of using mass transit. Here again, there are disconnects between wishful thinking and practical outcomes. The mobility hubs may be considered to be frequent destinations for the public. But what do people do on the other end (their origination point) when it's not in a mobility hub area. I reside about 1 ½ miles from the eastern edge of the Rancho Bernardo mobility hub (92128). About half of my family travel is to points within that hub. But how do I get to that hub without a car? (I do use my e-bike for some of this, but not if I am shopping or if I have to cross hazardous intersections, such as the I-15 ramps.)

The expectation that businesses will all of a sudden relocate to properties within a mobility hub is speculative, at the most. Where is the evidence? Furthermore, if the new model is for these businesses to not have parking then the people will choose to take their business elsewhere. In the end, SANDAG may achieve their goal to reduce VMT. The public will do their shopping on-line. They'll enjoy their own cooking at home. And the biggest accomplishment will be a local business decline and more tax losses. The roads will be wall to wall with gas-guzzling Amazon vans.

Bringing usable, frequent **mass transit** services to San Diego is something that we can all appreciate. But assuming that the car culture will significantly change because of the transit improvements is pie in the sky. No amount of disincentives will remove the need for highways and parking.

From a personal perspective (I live in 92128), I see little that serves my needs or interests. This area and adjacent Poway and places east are hardly served (except for a snippet of the RB mobility hub). The proposed Rapid bus is the same as now, except with improved frequency. But the transit stations are

not easily accessible except by car. With all the plans for commuter rail and light rail, the I-15 corridor is ignored. That is; except for the ghost of the California High-Speed Rail, which surprisingly shows up on Figure 2.3 – the Transit Leap map. I suspect that most of San Diego will have fallen into the Pacific before this foolhardy venture reaches any place where people live, let alone stretching south of I-10. Placing it on the Transit Leap map doesn't help to generate any confidence in the rest of the plan.

In regard to this Bakersfield/Fresno/Merced rail, I hear horrifying stories of issues with acquiring land rights. Have the experiences from that venture been factored into the land acquisition needs for transit and mobility hubs? If land acquisition is an issue in the sparsely populated SR-99 corridor, have we honestly considered the challenges in coastal San Diego? Is this a deal killer?

Back to my personal travel habits and needs. I recently purchased an e-bike and use it almost daily. I take it to the tennis courts on week days – just less than a mile and with no major intersections. I love the ride and am happy to not use my gas engine vehicles for such short trips. But the e-bike is not practical for most errands and my primary use is for exercise and recreation. There are several areas where I cannot ride because of poorly maintained bike lanes or unmarked bike lanes in high-traffic streets and intersections. The nearest formal bike trail (I-56) is about a ten mile ride over a treacherous, unmaintained bike lane on Carmel Mountain Road in Rancho Penasquitos. The money available for biking would be better spent on improving these impediments than in uprooting city streets to make us look like Holland. Also, I would not be able to use the e-bike with mass transit because the bike is too heavy to put on the bike carriers. (Does anyone ever use these? I never see a bus with a bike. I also never see a bus with more than two passengers.)

I have not addressed the practicality of the proposed high-speed coastal rail or other light rail expansions due to lack of details. Shouldn't we be looking at a set of alternatives, rather than a single plan? On the LOSSAN corridor segment, I'd like to see figures for a solution based on upgrading the Coaster system, rather than assuming that a new high-speed system is needed to meet our goals. The benefits of a high-speed train tend to be grossly overstated when one considers that the actual rail time is just a small portion of the overall door-to-door trip time. Doubling the speed of a locomotive may equate to a 5% to 10% improvement in trip time. Increasing distances between stations makes the use of high-speed rail less convenient and may add additional time to last-mile segments. Frequency (less waiting time) may contribute more to shortening trips than high speed. It is good to see this in the plan.

On a final note, I am compelled to comment on some disturbing issues relative to the relationships and behavior between the agency (SANDAG), the SANDAG Board of Directors, and the public. There is no way that we can accept the response by Director Ikhata to criticism voiced by board member Rodriguez (Oceanside), at the 5/21/21 SANDAG presentation. Obviously dismissing the board member's right to question the RTP, Ikhata interrupted to say "We are the experts." It is this attitude that highlights the importance of the Board exercising its responsibility to provide oversight and leadership for this important agency.

We must further question the intent of Director Ikhata to influence the recent Supervisor election, and hence the selection of board members by making a political contribution to a likely supportive candidate



in opposition to a candidate that voiced resistance to the developing RTP. How these two incidents can go unchallenged is beyond belief. Where is the oversight?

As I began to follow the RTP, the early news headlines consistently noted the sense that the Board was heavily leaning toward support for the emerging RTP. It appeared to represent a desire to take strong action to deal with the very real concerns regarding global warming and to address how re-envisioned transportation models can contribute to a viable solution.

Politically, it seemed sound to jump on the band wagon. However, as the details of the RTP were meted out to the public, there has been virtually unanimous rejection of the Plan. The public is saying that they do not favor the RTP and cannot see it as something that will produce the stated goals. One comment: "This is NUTS!" The board needs to listen.

As a concerned voter in San Diego County, it is my expectation that our representatives on the SANDAG Board of Governors will ask the type of questions that I highlighted here and to make certain that the RTP is based on honest assessments and assumptions. Due diligence requires that proposals consider a range of outcomes, based on an open-minded assessment of risks and variables. Common sense requires that we fully consider human factors and culture. Transparency should come with honest language that does not sugar-coat the burdens to be placed on the public to gain compliance.

I ask the SANDAG Board of Directors to provide intelligent oversight of SANDAG and the RTP, and to recognize the voice of the people in questioning the rationale and achievability of the proposal.

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## **OPTIONS AND IMPEDIMENTS TO CONSIDER**

Are there options available to address the goals of the 2021 RTP in more practical ways, with attention to getting the best bang for the buck, while satisfying the wider stakeholder base?

What options should be explored to bring reality closer and the probability of success greater?

What options are available to reward those who go the extra mile to support sensible initiatives, rather to penalize those who may not have the option to comply with these suggested draconian measures?

**High-speed Rail:** Going from 60 MPH to 120 MPH will not deliver a great time savings if distances between stops are greater and time from station to destination is increased. The easiest and most economical way to make train-based travel faster is actually to have stops closer to the "last-mile" and to up the frequency so that travelers don't have to spend the projected time gained waiting for the next train. Commuter rail, with short distances will not gain much from doubling the top speed. Electrification will help acceleration times and reduce GHG emissions. Can we modify what we already have and still achieve our goal -- faster and cheaper? Urban/suburban rail should run every four minutes in peak travel times and every eight minute at other times. At the least a ten minute interval would free travelers from needing to use timetables. Stations should be closely spaced and easily accessible by walkers and bikers as well as personal vehicles. Adequate parking will be needed. Express trains can be added to accommodate longer distance riders.

**Managed Lanes:** The biggest cause of highway congestion is the intermittent loss of a traffic lane. You can see that every day in places like I-15 northbound as it approaches the Bernardo Center Dr. and Rancho Bernardo Rd. interchanges. In this very short distance, the main highway loses one lane (due to narrow overpasses) and the traffic will back up at times of heavy use. Other causes of backups are vehicle breakdowns, police activity, and accidents. There MUST be space for vehicles to pull to the side of the road without losing a traffic lane.

The maximum capacity of any highway is determined by the capacity at its most constricted point. The plan calls for increasing capacity on limited access highways, such as SR-56, by utilizing shoulders. SR-56 would increase from four lanes to seven lanes. However, the inner shoulders are only four to eight feet and they do not continue at the six locations where the highway goes over a bridge. It seems that this would require adding lanes on the existing divider and building six new bridges at the overpasses to accommodate the three additional traffic lanes. Without this, the bottlenecks would nullify any gains from the added lanes.

**Rapid Bus Plazas:** These will have to be considerably upgraded if Rapid Bus is to be a principal component of a four-fold increase in mass transit patronage. As I look at the plaza closest to my residence, Rancho Bernardo, I see some major issues. Parking would have to be significantly increased, since the planned Flexible Fleets in Mobility Hubs will not reach all users. Plazas would likely need to be enlarged. Where will we find the land for this?

Also, at Rancho Bernardo, the transit plaza is not accessible from the east side of I-15. Walkers or bikers cannot readily get to the plaza. This can be remedied by building a pedestrian/biker structure from the east side of the I-15 bus ramp, over the northbound lanes of I-15 to adjacent Iberia Pl. This would provide easy access to the downtown business area of RB and several residential neighborhoods that do not have that access now. For me, the walk or ride would be 1.2 miles, rather than 2.6 mi via dangerous route and 3.0 miles via safer route.

**Biking:** I have recently joined the population that is using bicycles for short trips, as well as recreation. Mine is an e-bike and I can easily do round trips of up to 30 miles, even with the hills in my area. What I can't do is to make these trips in safety. The city and SANDAG are hyping their support for biking to alleviate some of the pollution and congestion caused by motor vehicles. But they can't even maintain the bike paths that we already have. Also, to use bikes for commuting (SANDAG is counting on at least a tripling of biking to work) we need well marked bike lanes and paths that are contiguous. Many of the areas are interrupted by stretches of missing or unmaintained bike lanes. We need more consistent riding paths and much improved driver education and awareness. The recent efforts to use green paint for bike lanes and to add a buffer between the bike lane and car lane need to be expanded as rapidly as possible. Adding a well-marked bike lane at left turns would be a welcome safety addition. I have seen this only at one place, the intersection of Carmel Mountain Rd. and Rancho Carmel Dr (next to Costco).

With 12 deaths to bikers in seven months, more has to be done promote safety. Countless injuries are awaiting bikers that are forced to ride on unmaintained bike lanes, opening up municipalities to large law suites.

**Reducing Carbon:** The RTP aims to reduce GHG emissions, primarily by penalizing travel with cars and trucks. However, as I interpret the plan, the methodology is aimed at generating new income from road usage fees. The plan bemoans the loss of gas tax income from drivers of EVs. Instead of providing incentives for driving EVs, the plan requires that EV owners pay a fee to cover the gas tax losses and then, adding insult to injury, earmarks that revenue for mass transit.

Would it not make more sense to offer payments to gas and diesel car and truck owners to turn in their cars and get them off the road? Couple this with rebates to exchange their petrol cars for EVs.

California registration rates are backwards. The fees should be based on weight and gas mileage, not property value. A Chevy Tahoe produces more wear and GHG than a Porsche 911. But the Porsche owner pays way more for registration. The owner of a BMW K1600 motorcycle pays more than for a Ford Fiesta. The latter weighs more than three times as much and uses twice the gas, but pays less for the registration. EV owners, with vehicles that are emission free and have less aggressive tires should get a break.

This may be extreme, but if you really want to cut GHG you can go to fuel rationing. There is a direct relationship between the fuel burned and the amount of emissions. But this would not work in the face of a model which is designed to generate usage fees, rather than cut emissions. It would also cut revenue from gas taxes. This may be an underlying factor in a model that is designed to generate income from fuel burners while the goal is to reduce the use of fuel. It is more likely to build the fee income than to achieve the stated goal.

## **AUTHOR PROFILE**

I am a mostly retired homeowner in Rancho Bernardo, and spend part of my time as an opinion columnist for the SDUT Community Press, writing under the “Just Sayin” by-line in papers serving the RB, 4S Ranch and Poway communities.

I am active in the community as a volunteer with political, cultural, homeowner and public service organizations, mostly at the board level. These organizations have included the RB Branch Library (hosting concerts), the Poway Symphony Orchestra, the RB Community Foundation, the SDUT Community Press, and the RB Democratic Club.

My career of over six decades focused on project, program and portfolio management, including strategic planning and business development evaluation. As part of this I was frequently engaged to review corporate-level business cases for potential new business ventures. I have published three books and over 300 papers on project and portfolio management and was a pioneer in the emergence of project portfolio management over the past two decades. I served as President and Chair of the Project Management Institute and am a PMI Fellow. As an odd coincidence, long before I became interested in local governance, I was engaged by a San Diego businessman (who I did not know at the time) to conduct seminars in Washington, D.C., demonstrating how traditional project management techniques could be effectively applied in government.

This commentary has been prepared by:  
Harvey A. Levine  
12391 Fairway Pointe Row  
San Diego, CA 92128 (Rancho Bernardo)  
(858) 485-0602  
halevine18@earthlink.net

Thank you for your time and consideration, and for your dedication to our community.

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## Jacumba Community Sponsor Group

To: Rami Talleh (via [rami.talleh@sdcounty.ca.gov](mailto:rami.talleh@sdcounty.ca.gov))

San Diego County Department of Planning and Development Services (PDS)

Subject: Comments on the San Diego Association of Governments (SANDAG's) Draft 2021 Regional Plan

August 6, 2021

Dear Mr. Talleh,

On July 16, 2021, community planning/sponsor groups were asked to provide their comments on the draft May 2021 San Diego Forward-The 2021 Regional Plan and its thirty-one lengthy and detailed appendices. Although this was an exceptionally limited review period, the Jacumba Sponsor Group has the following comments.

This draft plan identifies interdependent transformative strategies designed to address the greatest transportation and mobility challenges that the region faces: safety and traffic congestion; social inequities; and state and federal requirements to reduce greenhouse gas (GHG) emissions and air pollution—and they are noble goals. However, it makes many unsubstantiated assumptions based on inadequate data from which it then draws conclusions.

On page 10, the plan states that in 2019, greater than 90 percent of CA-MEX trade was moved by truck across the international border. A great fact to know, but where does your regional plan address and mitigate for the smoggy trucks registered in Mexico that are hauling those goods? Will the plan only regulate the emissions of vehicles registered in San Diego County (or California) while out-state and out-of-country (Mexican) vehicles get a “free pass?”

On page 12, the plan states: “from 2016 to 2050, nearly 60 percent of population growth will be among those who are 75 years and older.” Will this aging population (60 percent who are projected to be people of color), feel physically safe while using public transit (buses, trams, trolleys) during evening/night time? Will they all have smart phones and be able to navigate a smart phone application that gives them a choice of transportation modality based on a variety factors including CO<sub>2</sub> emissions?

On page 15, the plan states that if the 2021 plan was implemented, “By 2050, this could result in 13 percent of commuters using transit (up from 3 percent today) and that there would be a substantial decline in commuters driving alone to work (from 80 percent today to 62 percent in 2050). Those figures do not reflect any significant behavioral changes regarding transportation choices given that this plan would greatly expand mass transit frequency and routes. In 2021, many city busses are carrying just two to three passengers while trolleys carry more passengers depending on their routes. How realistic are the 2021 plan's predicted increases? Were urban



residents asked about factors that would actually make them leave their cars and use mass transit instead? Was the current trend of working remotely from home factored into these calculations? What if the public perceives that it is not in their best interests to share a bus or a trolley with a group of strangers who may or may not be healthy? What happens when the next pandemic impacts our region and mass transit shuts down for public safety reasons? Clearly more studies on the current trends in mass transit usage must be analyzed before the predictions contained in this plan can be validated. Also, additional studies on post-COVID mass transit usage figures are critical. Analysts should avoid using the data from any month when all mass transit ridership fares have been waived, as they will skew the data. (This will happen in September 2021.)

On page 25, the 2021 plan calls for providing a variety of transit riders with reduced fares (seniors, low-income, students, youth and the disabled). This is fiscally untenable. What is the actual cost per passenger mile on a bus, trolley, or light rail? **Appendix A predicts that in 2020 dollars, transit fare subsidies in 2035 will be \$982 million dollars and in 2050, subsidies will be \$4 BILLION dollars which means that the answer to the previous question about the cost per passenger mile must be too high to print!!!** This plan cannot seriously contemplate spending \$4 billion dollars to possibly achieve a 13 percent increase in mass transit ridership.

The 2021 plan which seeks to “reimagine” regional transportation strategies appears to be a huge and costly wish list of programs and government regulations directed primarily at changing residents’ driving behavior at a tremendous loss of personal freedoms. It envisions spending millions of dollars to create an expanded bike network with corridors by 2050. Again, where is the data that shows that kind of expenditure will get more people out of their cars and onto bicycles? A recent case in point: the removal of 400 parking spaces along the business district on 30<sup>th</sup> Street in the North Park area so that bike lanes, that are rarely used to commuting to and from work, could be installed. Not only are the merchants upset about the loss of customer parking and business, but delivery trucks are now blocking bike lanes to make their deliveries and handicapped parking has become confusing for those who need it. The 2021 plan will greatly expand on that unpopular and costly transportation strategy.

Under this plan, transportation in and around mobility hubs or areas of concentrated development (cities) would be highly regulated with curb management regulations/fees based on the time of day parking rates, and ride-hailing opportunities. Ride-hailing at mobility hubs is described as offering people on-demand vehicles for short and long-distance trips, possibly subscription-based services which would “allow people to reserve a vehicle that best serves the needs of their trip.” So, it is okay to rent/drive a vehicle but just not to personally own a vehicle?

On page 32, the plan states: “In the San Diego region, almost half of all trips are three miles or less, and most everyday trips are made within neighborhoods using local streets.” Where is the data to back up this statement? This page also states: “On average, one person is killed or seriously injured in traffic violence everyday in the region.” Everyone understands the safety risks that they take when they drive a car and they believe those risks to be acceptable. Again, no

driving statistics are referenced, and of course, the plan does not provide data on the numbers of people who are mugged walking down the region's streets or at trolley stations, etc.

Everyone agrees that climate change is real. On page 34, several climate strategies are listed. The blue pie chart at the top of the page lists "collecting rainwater" as one viable climate mitigation strategy. Why doesn't this 2021 plan identify more impactful strategies such as building new reservoirs/expanding existing ones or building additional desalinization plants? It should be noted, that even if the 2021 plan is implemented, it will not stop the sea levels from rising.

This plan would require employers and developers to provide transportation benefits and on-site amenities to encourage people to use sustainable transportation choices. Does the County want even more businesses to flee California for a friendlier business climate? Employers can figure out how to use flexible work schedules and tele-work options to attract and sustain their workforce without unnecessary government intervention/regulation.

Of course, of the 2021 plan's proposed transportation management "strategies" come at a huge cost (\$163 billion dollars). The plan identifies \$90 billion dollars that will come from local funding sources: sales taxes, impact fees, fuel taxes, roads tolls, increased passenger fares, general funds, housing revenue, ride-hailing fees, value pricing, and road user charges also called vehicle miles travelled (VMT). Road usage fees or VMT, which have yet to be implemented through legislation, are needed to offset the reduction in gasoline taxes as more electric vehicles (EV) use our roadways. Under this plan, VMT fees would come on top of the existing federal, state, and local gasoline taxes, and they would unfairly penalize the drivers of gas-powered vehicles, who frequently are the low-income residents who live in the rural areas of the County. (VMT would not be collected on out-of-state vehicles.) Under the 2021 plan, fees of all kinds would be raised, including variable road tolls based on the time of day (congestion), fees for solo drivers using carpool lanes, and fees for ride-sharing services like Uber. The fees and regulations imposed by this plan will disproportionately impact low-income residents, while the plan claims to promote social equity. They are the ones who will not be able to afford to park/drive their own private vehicles while transportation choices of more affluent residents will not be affected.

Figure 3.3 on page 50 shows the 2021 Regional Plan Expenditures with an estimated total of \$163 billion in 2020 dollars. There needs to be a similar pie chart within the 2021 plan that shows how much money will be spent on each transportation category: Transit Leap (mass transit), mobility hubs, complete corridors, bicycle network, highway improvements etc. Although there may be appendices that list all the funding for a specific category, it is unlikely that most people will wade through all of them to find that important information.

On page 53 of the 2021 Regional plan is a list of a priority implementation actions. Number 1 on the list is "Apply the Social Equity Planning Framework". Number 10 on the list is: "Advance a data science program to better understand travel behavior in the region." These priorities should be reversed. **You can't apply a framework until you have solid, valid, and recent (post COVID) data!**

This very expensive “Lamborghini” transportation plan with its “woke” statements about social equity and its claims to “strengthen a sense of place,” is a direct assault on the personal transportation choices of San Diego County residents. County leaders must choose a less expensive “Toyota” plan that will not transform “America’s Finest City” into a third-rate economy where only the wealthy residents can still afford to drive a car.

Cherry Diefenbach  
Chair, Jacumba Community Sponsor Group  
619-743-5224

CC: Supervisor Joel Anderson

August 5, 2021

Mr. Hasan Ikharata  
SANDAG, Executive Director  
401 B St, Suite 800  
San Diego, CA 92101

**Re: Support incorporating *Reconnect Logan, 5 Freeway Lid Project* in the San Diego Association of Governments' (SANDAG) 2021 Regional Plan**

Dear Mr. Ikharata,

My name is James Brown and I have been a Logan Heights business owner for over 12 years. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities. **Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan (Draft Plan)**

Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know *ReConnect Logan Freeway Lid* will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.

As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.

Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out *ReConnect Logan Freeway Lid* as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:

- The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)
- Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)
- Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)

Besides being in line with the 2021 Draft Regional Plan, *ReConnect Logan Freeway Lid* is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to **the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.**

If you have any questions, you may contact me at [jb@publicdigital.com](mailto:jb@publicdigital.com).

Sincerely,  
  
James Brown, Owner Bread & Salt and Public Architecture

1955 Julian Ave, San Diego, CA, 92113



August 6, 2021

Mr. Hasan Ikhata  
SANDAG, Executive Director  
401 B St, Suite 800  
San Diego, CA 92101

**Re: Support incorporating *Reconnect Logan, 5 Freeway Lid Project* in the San Diego Association of Governments' (SANDAG) 2021 Regional Plan**

Dear Mr. Ikhata,

My name is Martha Zapata and I have been a Logan Heights resident for 34 years. I am writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities.

**Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan (Draft Plan)**

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As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.

Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out *ReConnect Logan Freeway Lid* as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:

- The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)
- Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)
- Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)

Besides being in line with the 2021 Draft Regional Plan, *ReConnect Logan Freeway Lid* is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to **the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.**

If you have any questions, you may contact me at [m.zapata35@gmail.com](mailto:m.zapata35@gmail.com)

Sincerely,

Martha Zapata  
1817 Julian Avenue  
San Diego CA 92113

810 Mission Avenue  
Oceanside, CA 92054  
(760) 966-6500  
(760) 967-2001 (fax)  
GoNCTD.com

June 21, 2021

Ms. Catherine Blakespear  
Chair  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

Mr. Hasan Ikhata  
Executive Director  
SANDAG  
401 B Street, Suite 800  
San Diego, CA 92101

Re: North County Transit District Feedback and Questions on the Draft 2021  
Regional Plan

Dear Chair Blakespear and Mr. Ikhata:

On behalf of the North County Transit District's (NCTD) Board of Directors (Board), I commend San Diego Association of Governments (SANDAG) staff for advancing the Draft 2021 Regional Plan (Plan). The Plan proposes to push the region forward by enhancing our transportation network through the integration of roads, transit, land use, and technology via the 5 Big Moves.

Given the importance of updating the Plan, I requested NCTD staff review the Plan and prepare recommendations and clarification on behalf of the NCTD Board to submit to SANDAG during the public review period. As you are aware, the region has significant funding needs to complete current TransNet projects that have been promised, but are unfunded, along with the need to support our future through continued investments in our transportation system that meet or exceed statewide environmental, mobility, social equity, and economic goals.

NCTD understands the importance of the Plan as it relates to the development and prioritization of projects for inclusion in a potential future ballot initiative. NCTD acknowledges that the needs of transit and other modes of transportation are vast and that no single initiative will address all the needs. It is within this context that NCTD staff has compiled feedback and requests for clarification to better understand details of the Plan as it relates to NCTD's needs and the

regional transportation system so that the NCTD Board can adopt and submit its recommended priorities to SANDAG.

NCTD staff is requesting that SANDAG provide a response to the feedback and questions posed by July 8, 2021 to support potential discussions at the July and September meetings of the NCTD Board of Directors, to which SANDAG staff will be invited to participate.

On behalf of the NCTD Board, I thank you and SANDAG staff for your willingness to provide responses to the feedback and questions. Feel free to contact me or NCTD's Executive Director, Matthew Tucker, if you have any questions.

Sincerely,

A handwritten signature in blue ink that reads "A. J. Kranz". The signature is stylized and cursive.

Tony Kranz  
NCTD Board Chair

Attachment A: NCTD Feedback and Questions Regarding the Draft 2021  
Regional Plan

Attachment B: Project Data Request

Attachment C: Transit Service Levels Data Request

Attachment D: Detail of Proposed Rail Lines

## Attachment A

### NCTD Feedback and Questions Regarding the Draft 2021 Regional Plan

NCTD recognizes the significant amount of data analysis, modeling, and planning that has contributed to the 5 Big Moves and the 2021 Draft Regional Plan (Plan). Based upon the information published on May 28, 2021, NCTD has summarized a series of points below for recommendation, discussion, and clarification.

#### Questions and Clarifications

##### *Regional Capital Project Prioritization and Implementation*

1. NCTD seeks clarity on the status of specific projects that were included in the constrained *TransNet* funding plan but are at risk due to lack of funding. NCTD is seeking information on how much of the estimated \$160 billion proposed plan estimate is allocated to complete these unfunded *TransNet* projects on a project-level basis. NCTD is seeking more detailed information that expands upon the corridor-level information included in Appendix A: Transportation Projects, Programs, and Phasing of the Plan.
2. NCTD seeks clarity on the project phasing proposed within the Plan. Specifically, NCTD is seeking to understand the timing of implementation of unfunded *TransNet* projects related to new projects presented within the Plan. To support this, NCTD is requesting that SANDAG input the information requested in Table 1 (Attachment B).
3. NCTD seeks clarity on the assumptions related to the completion of major capital projects, including the assumed percentage level of federal and state match funding required to implement the projects envisioned in the Plan. To support this, NCTD is requesting that SANDAG input the information requested in Table 1 (Attachment B).
4. NCTD seeks specific data on the proposed 200 miles of rail service contemplated in the 2021 Draft Regional Plan. To support this, NCTD is requesting that SANDAG input the information requested in Table 3 (Attachment D)

##### *Operational and Financial Assumptions*

1. NCTD seeks specific data on the proposed dedicated source of funding to be used to provide reduced or free fares within the region. NCTD believes that it is important that SANDAG identify a source that is not sales tax based to mitigate impacts to service levels during economic downturns. The source of funding should also match increases in operating costs.



2. NCTD seeks specific data on the proposed level of funding that is proposed to be dedicated to transit operations, preventative maintenance, and state of good repair maintenance and replacements, respectively.
3. NCTD seeks specific data on the assumed transit service frequencies throughout the duration of the plan, and specifically as it relates to local transit bus operations. To support this, NCTD is requesting that SANDAG input the information requested in Table 2 (Attachment C).
4. NCTD seeks specific data on plans and funding that will be allocated to support road, technology, and other infrastructure improvements to advance faster, frequent, and more reliable transit service.

#### *Customer Research Questions*

1. NCTD seeks clarity on the transit customer research conducted as part of the Central Mobility Hub planning process, either as part of the Draft 2021 Regional Plan development process or the Central Mobility Hub Comprehensive Multimodal Corridor Plan (CMCP) process. NCTD is specifically seeking information on transit user experience impacts related to the relocation of transit service from Old Town Station to the proposed Central Mobility Hub.
2. NCTD seeks clarity on the transit customer research conducted as part of the Sorrento Mesa spur planning process, either as part of the Draft 2021 Regional Plan development process, SD-LOSSAN Rail Corridor Realignment Study process, or South Bay to Sorrento CMCP. NCTD is specifically seeking information on transit user access and user experience impacts related to the relocation of transit service from the existing Sorrento Valley COASTER Station to a proposed Sorrento Mesa location.

## ATTACHMENT B – Project Data Request

**Table 1: Project Information Request**

<b>Project</b>	<b>Estimated Total Project Cost</b>	<b>Current Planned Year of Construction</b>	<b>Draft RTP Assumed Year of Construction</b>	<b>Assumed Federal/State Matching Funding (%)</b>
San Dieguito Lagoon Double Track and Platform				
Batiquitos Lagoon Double Track and Bridge Replacement				
Eastbrook to Shell Double Track				
Carlsbad Village Trench				
La Costa to Swami Double Track				
San Onofre Bridge Replacements				
Rose Canyon Bridge Replacements				

**ATTACHMENT C – Transit Service Levels Data Request**

**Table 2: Anticipated Transit Frequencies (in Minutes) Information Request**

<b>Mode of Service</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>	<b>2040</b>	<b>2045</b>	<b>2050</b>
Local BREEZE Bus						
Local MTS Bus						
Rapid Bus						
SPRINTER						
Trolley						
COASTER						



City of Oceanside Bicycle and Pedestrian Committee  
BikeWalk Oceanside

Phone: 619-200-6133 • E-Mail: tlichterman@cox.net

July 15, 2021

SANDAG  
401 B Street  
Suite 800  
San Diego, CA 92101

SUBJECT: 2021 Regional Plan Comments (sent via email and U.S. Postal Service)

Dear SANDAG Regional Plan Staff,

The Oceanside Bicycle and Pedestrian Committee is a citizen’s advisory committee whose role is to advise the City on programs and projects which improve bicycling and walking in the community. The Committee’s membership includes over 75 Oceanside residents who are concerned about bicycling and walking infrastructure and opportunities. Our goals are to promote bicycling and walking in the community for health, recreation, and transportation, to promote bicycle and pedestrian safety, and to improve bicycling and pedestrian facilities.

Our Committee has reviewed the draft 2021 Regional Plan and wishes to submit several comments for SANDAG consideration. First, as a general statement, the Committee appreciates the Plan’s significant shift in how people move about in the region, as proposed through the “Five Big Moves” and interrelated projects and programs. We concur with SANDAG’s conclusion that the imperative of responding to the climate crisis requires such a significant shift from previous Regional Transportation Plans. We also strongly agree with the statement on page 1 of *Appendix L: Active Transportation*, that:

*Active Transportation is a key element interwoven through the 5 Big Moves; it connects people to all kinds of destinations and defines the infrastructure needs to make the system work for everyone.*

With this statement in mind, we have specific input regarding several of the key Active Transportation projects which affect Oceanside, as listed in *Appendix A*, Page A-35, as follows:

**AT031 – Coastal Rail Trail Oceanside – Broadway to Eaton**

– This project appears to be off-street from Vista Way/Broadway to Broadway/Eaton (using the railroad right-of-way), then on-street on Eaton to Hwy 101. The existing portions of the Coastal Rail Trail north and south of Cassidy Street in this area are sub-standard (see photo) – the usable width of the trail in this section is only about 7 feet wide and does not provide sufficient space for





# City of Oceanside Bicycle and Pedestrian Committee

## BikeWalk Oceanside

Phone: 619-200-6133 • E-Mail: tlichterman@cox.net

cyclists to pass walkers safely without nearly coming to a stop. In addition, in preliminary City discussions with the Buena Vista Audubon Society, the possibility exists that the Society might allow development of the trail through their property south of the end of Broadway Street, connecting to the improved trail on Coast Highway. This would provide a safer and traffic-free connection rather than putting trail users directly on Eaton and Coast Highway. For these reasons, the City of Oceanside, with Committee support, submitted a Caltrans Sustainable Transportation Planning Grant request in February 2021, seeking funding for a “Coastal Rail Trail Morse-Vista Way Improvement Study”. Please see our attached January 27, 2021 letter on same. We await word on the outcome of this grant request. Accordingly, we recommend that SANDAG include the potential for widening the trail in this area and connecting it through the Audubon Society property as part of Project AT031 and revise the budget accordingly.

**AT049 – Inland Rail Trail Oceanside** – This project is intended to cover the entire Inland Rail Trail segment within Oceanside, from Melrose to west of I-5. The Committee strongly supports this project – completion of the Inland Rail Trail and the Coastal Rail Trail within Oceanside are the two top-priority projects in Oceanside’s adopted Bicycle Master Plan.

The Committee’s concern about this project is SANDAG’s listed “Year Built” of 2035. Completion of the Inland Rail Trail has been an adopted goal of the north county communities it travels through since 1995, through a Memorandum of Understanding (copy attached). In that MOU, the corridor agencies adopted the following vision 25 years ago:

*NCTD and the sponsor agencies desire to create a multi-modal transportation facility which will help these communities achieve a higher quality of life by promoting alternative transportation opportunities, reducing automobile trips, improving air quality, reducing congestion, providing recreational opportunities, and increasing access to desired North County destinations.*

This trail has also been identified as a priority project in the SANDAG *Ride to 2050 Plan* and is key in promoting bike commuting in the region. The only nearby alternative to completing this trail in Oceanside is to ride on Oceanside Blvd., which is very challenging if not outright unsafe for cyclists given its narrow bike lane widths, complete disappearance of the bike lane at major intersections, high traffic speeds, and heavy truck volume.

Simply put, the citizens of Oceanside should not have to **wait 40 years** for their portion of the IRT to be completed, when the communities across North County made it clear in 1995 that completion of this trail was a priority. This delay is not fair to Oceanside on a general basis and is further exacerbated by equity considerations – Oceanside is home to a significant minority population (52% composition) whereas other North County coastal cities have majority white populations ranging from 74% to 90%<sup>1</sup>.

---

<sup>1</sup> Per City of Oceanside’s FY2020-21 Caltrans Sustainable Transportation Planning Grant for an Inland Rail Trail – Oceanside Alignment Analysis and Conceptual Design Study

# City of Oceanside Bicycle and Pedestrian Committee

## BikeWalk Oceanside

Phone: 619-200-6133 • E-Mail: tlichterman@cox.net

The proposed SANDAG Regional Plan includes a significant “Focus on Equity”, including the statement,

*In developing and implementing the 2021 Regional Plan, SANDAG has a responsibility to listen to the communities we serve, prioritize equitable solutions in the transportation system, and analyze the burdens and benefits of this system for historically underserved communities<sup>2</sup>.*

While Escondido and San Marcos had all or portions of their IRT constructed by 2008, and Vista’s segments are completed, in design, or under construction now, the Oceanside segment is not even in preliminary planning at this time. Given the frequent mention throughout the Regional Plan of the importance of bike trail improvements to the overall success of the Plan, and the Focus on Equity, we implore SANDAG to move up the completion of this segment of the IRT commensurate with its importance to the Adopted Regional Bike Network. We believe that this project could be completed in roughly five years if it was prioritized, as follows:

- 18 months for alignment definition and design
- 18 months for any necessary permitting, approvals, and right-of-way acquisition
- 24 months for construction

**AT074 – Coastal Rail Trail Oceanside Segment 1 ALT** – According to the materials provided by SANDAG staff, this segment of the Coastal Rail Trail at the northern connection with the San Luis Rey River Trail would become just an on-street bike lane on Pacific Street, from just west of the railroad tracks underpass to west of the Oceanside Transit Center. This alternative does not appear to take advantage of the currently-built off-street segment adjacent to the tracks from under I-5 to Neptune Way (see photo). Why not incorporate that portion as part of this segment before returning to on-street status?



Existing Trail from Neptune Way looking north.

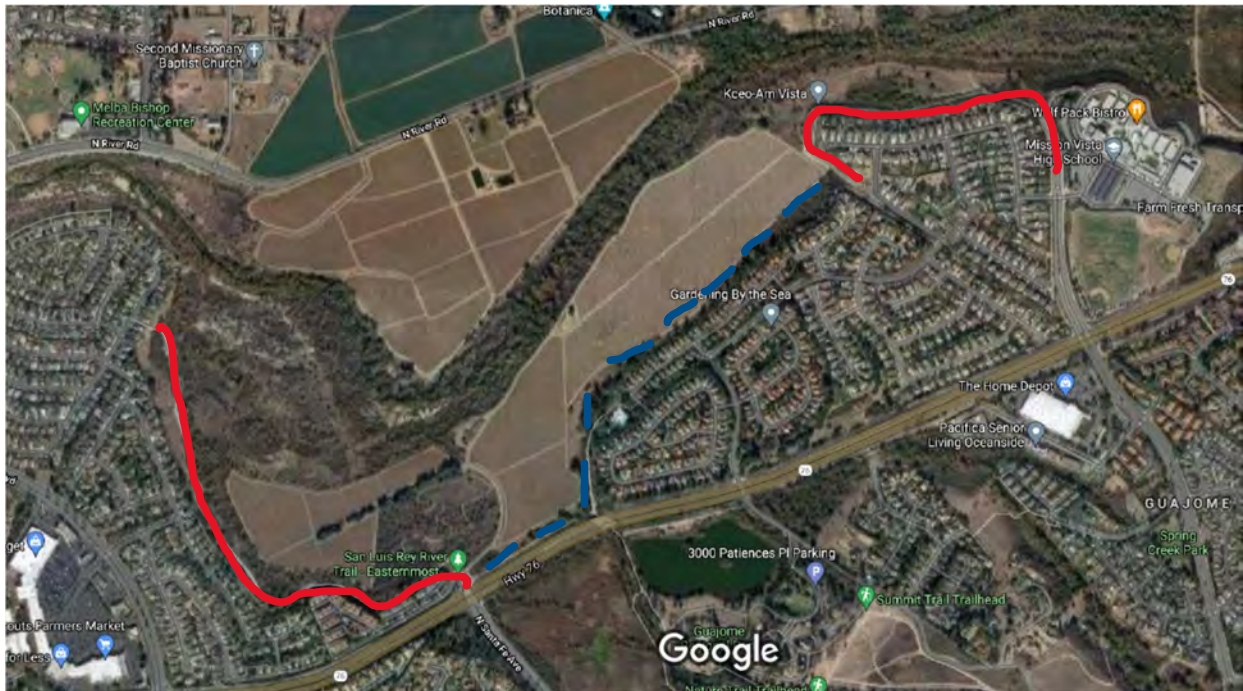
**AT113 – San Luis Rey River Trail Extension** – This project proposes to extend the east end of the San Luis Rey River Trail from where it returns to surface streets at Andrew Jackson Street near Polk Street, all the way out to Old Hwy 395, mostly adjacent to the river. It should be noted that the proposed alignment does not make use of the already-constructed segment from Tyler Street to Via Manos at Hwy 76. In addition, there may also be City easements along the farmland adjacent to Highway 76, leading from Via Manos to the next neighborhood to the

<sup>2</sup> Draft 2021 Regional Plan, Page 11.

# City of Oceanside Bicycle and Pedestrian Committee BikeWalk Oceanside

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east. There, another already-constructed trail segment circumnavigates the residential neighborhood, coming out right across the street from Mission Vista High School on Melrose. All of these segments, if linked together, offer the opportunity to create a significant trail extension in the near future at very little cost. We urge SANDAG to consult with long-term Bicycle and Pedestrian Committee members who have extensive historical background on trails in this area.



Existing trail segments and opportunities to extend the San Luis Rey River Trail:

Red – Existing constructed trails

Blue – Potential City Easements

**Additional Proposed Project #1** - SANDAG should consider an improved connection between the Vista Way shopping area east of I-5 and the Oceanside communities west of I-5. Currently, due to the topography of the alternative East/West routes, the freeway is a significant barrier to this community having access to the large shopping area on Vista Way east of I-5. Riding from the shopping center, west to the coast, requires riding up a very steep hill at the back of the shopping center and another one on Cassidy Street. They are both difficult climbs, especially with groceries. Such a project would likely entail a bridge overpass of I-5, in the vicinity of Kelly Street. Travelling East, once the Active Transportation user is past I-5, the optimum route would probably follow the least-elevation-change path, which would entail a

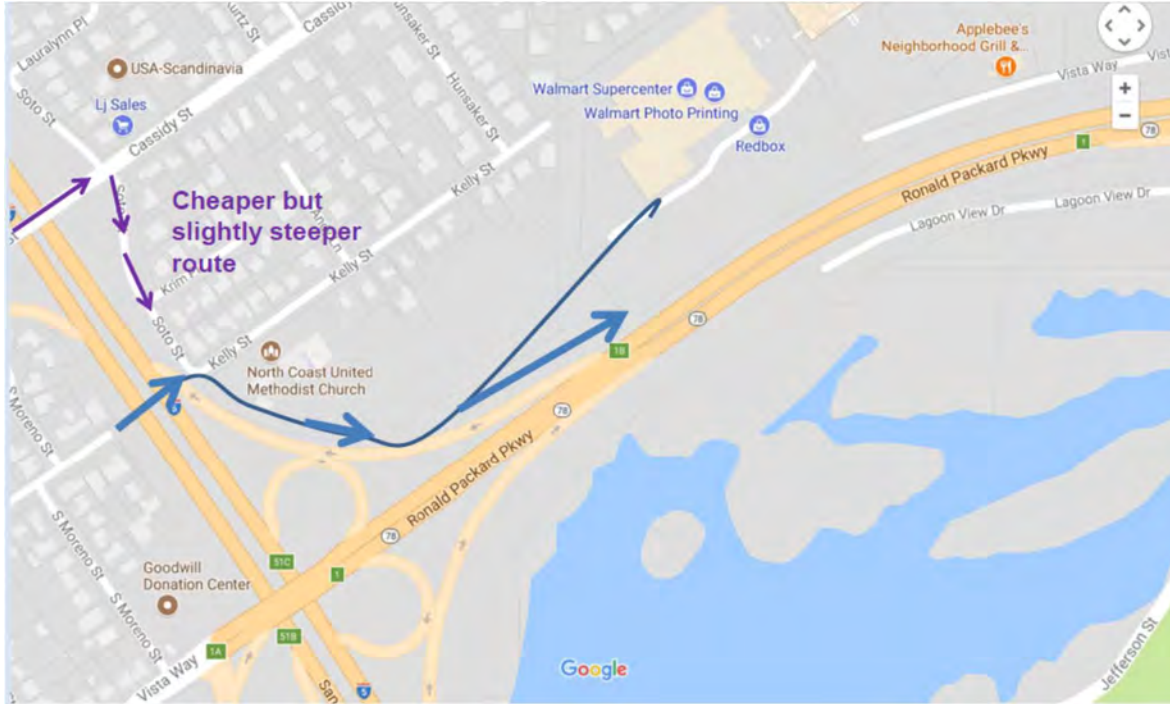


# City of Oceanside Bicycle and Pedestrian Committee

## BikeWalk Oceanside

Phone: 619-200-6133 • E-Mail: tlichterman@cox.net

turn to the south. We found that there is a similar bridge in Cupertino, over I-280, on Mary Avenue, that cost only \$8 million, approximately 13 years ago.



Oceanside neighborhoods near the I-5 and Hwy 78 interchange. Kelly Street routing, highlighted in blue, is a conceptual routing. Major shopping center is near the east end of Kelly, though no physical connection exists.

**Additional Proposed Project #2** - SANDAG should consider the Oceanside Coast Highway Corridor Study Road Diet and Incentive Zone, as approved by Oceanside in August 2019 between Harbor Drive and Morse, to be an Active Transportation Project. The project would convert this portion of the road, which is now mostly avoided by the Active Transportation Community, to be one that is safe and desirable.

This “complete street” transformation would provide more room on the road for all roadway users, fewer signalized intersections, and reduced speeds. It would maintain good traffic flow, by having roundabouts at most arterials and a turning lane for streets and driveways between arterials. It would have a desirable mixed-use, smart-growth ambiance, with designated bike lanes, wider sidewalks, community-oriented commercial developments, upscale housing, and shade trees. This project is on the historical Route 101. The street is two blocks East of the Oceanside Transit Center, where new developments are planned. The City Library, a Community Center, and City Hall are on this street, just blocks from the Transit Center. The Bicycle and Pedestrian Committee has been urging Oceanside to expand its Climate Action

City of Oceanside Bicycle and Pedestrian Committee  
BikeWalk Oceanside

Phone: 619-200-6133 • E-Mail: tlichterman@cox.net

Plan (CAP) by giving its City employees a car-parking system that encourages use of alternative modes to driving alone. This complete street project would help City employees get to work without driving.

Thank you for the opportunity to comment on the 2021 Regional Plan.

Sincerely,

A handwritten signature in blue ink that reads "Tom Lichterman". The signature is written in a cursive, flowing style.

Tom Lichterman  
Chairman, Oceanside Bicycle and Pedestrian Committee

cc: Oceanside Mayor, City Council and City Manager  
Howard LaGrange, Active Transportation and Micro-mobility Coordinator  
Oceanside Bicycle and Pedestrian Committee Members

ATTACHMENTS (2)



# City of Oceanside Bicycle and Pedestrian Committee BikeWalk Oceanside

Phone: 619-200-6133 • E-Mail: tlichterman@cox.net

January 27, 2021

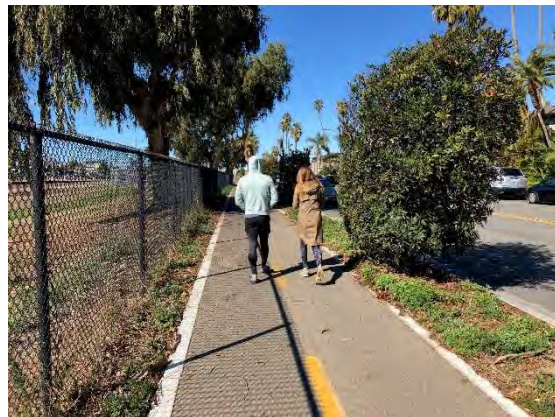
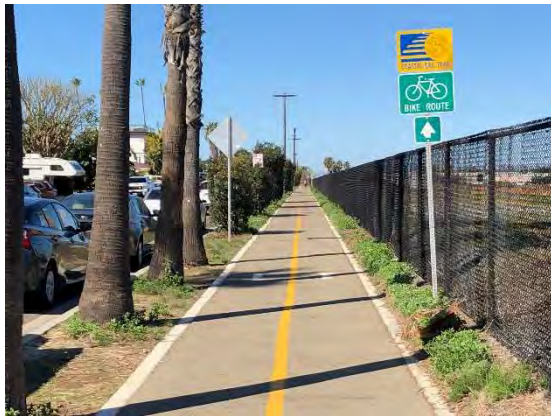
Ms. Barbara Valentine  
Caltrans District 11  
4050 Taylor Street  
Mail Station 240  
San Diego, CA 92110

RE: Requested Funding for a Coastal Rail Trail Morse-Vista Way Improvement Study

Dear Ms. Valentine:

The Oceanside Bicycle and Pedestrian Committee's purpose is to promote bicycling and walking in the community for health, recreation, and transportation, to promote bicycle and pedestrian safety, and to improve bicycling and pedestrian facilities.

The Committee is pleased to provide a letter of support for the City of Oceanside's application for funding in response to the Senate Bill 1 Caltrans Sustainable Transportation Planning Grant program. With this requested funding, Oceanside will prepare a Project Study Report to evaluate options for increasing the capacity of the current narrow Coastal Rail Trail segment between Morse and Vista Way that was constructed with SANDAG funds in 2002. This trail was the first segment of the Coastal Rail Trail constructed in the county. The existing width of 7 ft of asphalt with 6" concrete curbs/borders on each side is far below current standards, insufficient to accommodate a mix of cycling and walking trail users. The photos below illustrate how narrow the trail is in this area, with two people walking side-by-side effectively taking up the entire trail. The narrow width will also present issues as other portions are constructed to modern standards.



The City additionally needs to evaluate the best options for connecting the trail from Vista Way to the Oceanside/Carlsbad Coastal Trail on Coast Hwy. Assuming the City will be successful in obtaining funding to bridge Loma Alta Creek, increasing the capacity and connectivity of the southern portion of the trail will be critical. The Coastal Rail Trail has been identified as a priority project in the SANDAG *Ride to 2050* Regional Bicycle Network and is key in promoting bike commuting in the region.

A successful Coastal Rail Trail Morse-Vista Way Improvement Study Report will:

- Evaluate options to widen the existing trail to meet current SANDAG design standards, from Morse Street to Vista Way.
- Determine the additional right-of-way that would be required.
- Identify and study options to extend the trail from its current terminous at Broadway Street and Vista Way, to a connection with the Oceanside/Carlsbad Coastal Trail on Coast Hwy. The Buena Vista Audubon Society has indicated an interest in supporting extension of the existing trail south along Broadway street and through the open area to the south, to meet up with the current trail on Coast Highway.
- Determine if any environmental issues exist.
- Provide an order-of-magnitude estimated cost of the project.

The Oceanside Bicycle and Pedestrian Committee urges Caltrans to approve this important grant application request so that the region can continue to make progress toward a completed county-wide Coastal Rail Trail.

Thank you for your consideration.

Sincerely,

A handwritten signature in blue ink that reads "Tom Lichterman". The signature is written in a cursive, flowing style.

Tom Lichterman  
Chairman, City of Oceanside Bicycle and Pedestrian Committee

cc: City of Oceanside Council Members and City Manager  
Howard LaGrange, Oceanside Active Transportation and Micromobility Coordinator  
Oceanside Bicycle and Pedestrian Committee Membership



## NORTH SAN DIEGO COUNTY TRANSIT DEVELOPMENT BOARD

CONSENT CALENDAR  
AGENDA ITEM A-8

February 16, 1995

TO: North San Diego County Transit Development Board Members  
FROM: Executive Director  
SUBJECT: MEMORANDUM OF UNDERSTANDING

STAFF'S RECOMMENDED ACTION:

That the Board authorize the Executive Director to enter into a Memorandum of Understanding with the Cities of San Marcos, Escondido, Oceanside, Vista, and the County of San Diego to establish a framework for a partnership to provide a bikeway adjacent to the Escondido Subdivision Railroad Spur line.

BACKGROUND DATA:

A Memorandum of Understanding has been formulated by the City of San Marcos to establish a partnership between the North San Diego County Transit Development Board (NSDCTDB) and the Cities of San Marcos, Escondido, Oceanside, Vista, and the County of San Diego (sponsor agencies) to provide a bikeway adjacent to the Escondido Subdivision Railroad Spur line in conjunction with the development of NSDCTDB's Oceanside - Escondido passenger rail project. The proposed bikeway will provide a continuous Class I bicycle facility between the Oceanside Transit Center and the Escondido Transit Center traversing the Cities of Oceanside, Vista, San Marcos, and Escondido, and a portion of unincorporated San Diego County.

SANDAG's FY94 Regional Transportation Improvement Plan designated the City of San Marcos as the lead agency and Project Administrator for the development of the bikeway portion of the Oceanside - Escondido passenger rail project. The sponsor agencies have obtained federal and state funding for design and construction of the bikeway which they will share with NSDCTDB to complete the Environmental Assessment and design for the joint project. Since the bikeway and the passenger rail projects are being combined, the City of San Marcos will reimburse NSDCTDB a corresponding portion of the consultant contract fee associated with the Environmental Assessment and design.



The bikeway and passenger rail project will continue to be considered a joint project until the construction stage. NSDCTDB and all sponsor agencies will review and approve all plans before construction is permitted. Furthermore, NSDCTDB and the sponsor agencies will adopt a formal agreement which specifies access rights, responsibilities, and duties with regards to the construction, maintenance, and liabilities associated with the bikeway at a point in time before the bikeway construction plans are signed by NSDCTDB.

Attachment

# MEMORANDUM OF UNDERSTANDING

between the  
North San Diego County Transit Development Board  
and the  
City of San Marcos  
City of Escondido  
City of Oceanside  
City of Vista  
San Diego County

## ESCONDIDO TO OCEANSIDE RAIL/TRAIL BIKEWAY PROJECT

### -RECITALS-

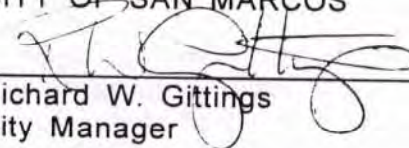
- A. The purpose of this Memorandum of Understanding (MOU) is to establish the framework for a partnership between the North County Transit District (NCTD) and the Cities of San Marcos, Escondido, Oceanside, Vista, and the County of San Diego (Sponsor Agencies), to provide a bikeway adjacent to the Escondido Subdivision Railroad Spur line.
- B. NCTD and the sponsor agencies desire to create a multi-modal transportation facility which will help these communities achieve a higher quality of life by promoting alternative transportation opportunities, reducing automobile trips, improving air quality, reducing congestion, providing recreational opportunities, and increasing access to desired North County destinations.
- C. The planned bikeway will provide a continuous Class I Bicycle facility between the Oceanside Transit Center and the Escondido Transit Center, and will span the Cities of Oceanside, Vista, San Marcos, and Escondido, including a portion of unincorporated San Diego County.
- D. The sponsor agencies have designated San Marcos as the Project Administrator in coordinating project development in partnership with NCTD, and have formalized this relationship by making this designation part of the Regional Transportation Improvement Plan, adopted by the SANDAG Board of Directors on June 25, 1993.
- E. The sponsor agencies have obtained funding grants from Federal and State sources for the design and construction of the bikeway portion of the project. The agencies will utilize these funds in assisting NCTD to complete the Environmental Assessment and design of the project.
- F. NCTD owns rights-of-way within which it maintains and operates the rail line, and within which it will be developing and operating passenger railroad service.
- G. This memorandum of understanding does not establish a contract or obligation between any of the participating agencies nor shall this memorandum be construed to be an agreement for the joint exercise of powers or creating a joint powers agency under the provisions of Government Code Section 6500 et seq. Each participating agency shall retain full regulatory authority with respect to the subject matter of this memorandum of understanding and full discretionary authority with respect to the provisions of the facilities within their respective jurisdictions.



-BASIC AGREEMENT TERMS-

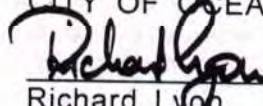
1. The bikeway will occupy railroad right-of-way except where infeasible due to conflicts with necessary railroad facilities, highway facilities, physical limitations, or conflicts with environmentally sensitive areas.
2. The agencies within which the bikeway exists will be granted rights by NCTD to place and maintain the bikeway facility.
3. NCTD will retain all rights to utilize the bikeway as their primary access for railroad maintenance activities.
4. NCTD will manage a consultant contract which will satisfy the preliminary design and environmental assessment requirements for a project which combines the development of both the passenger railroad service and the bikeway into an integrated transportation facility.
5. NCTD will follow the requirements of the CalTrans Local Programs Manual in managing the consultant contract.
6. San Marcos, as Project Administrator acting for the sponsor agencies, will assist NCTD in managing the consultant contract, supporting NCTD and the consultant in producing project design and environmental assessment necessary to gain authorization from oversight agencies to proceed with preparation of construction plans for the projects.
7. With the grant funding available, the sponsor agencies will share in the expenses associated with the preliminary design and environmental assessment consultant contract, making available to NCTD funds which will reimburse NCTD for an appropriate portion of the consultant contract fee.
8. After the projects have achieved environmental oversight clearance, San Marcos, as Project Administrator acting for the sponsor agencies, will prepare plans, specifications, and estimates for the construction of the bikeway portion of the project. NCTD, and all sponsor agencies, will review and approve these plans before construction is permitted.
9. NCTD, as well as the sponsor agencies, will adopt a formal agreement which specifies access rights, responsibilities, and duties with regard to the construction, maintenance, and liabilities associated with the bikeway at a point in time before the bikeway construction plans are signed by NCTD.

CITY OF SAN MARCOS

  
Richard W. Gittings  
City Manager

Date: 12/1/94

CITY OF OCEANSIDE

  
Richard Lyon  
Mayor

Date: 10-21-94

CITY OF VISTA

*Morris Vance*

Morris Vance  
City Manager

Date: 11/30/94

CITY OF ESCONDIDO

*Doug Clark*

Doug Clark  
City Manager

Date: 9-14-94

COUNTY OF SAN DIEGO

*Thomas J. Pastuszka*

Thomas J. Pastuszka  
Clerk of the Board of Supervisors

Date: 10/14/94

NORTH SAN DIEGO COUNTY TRANSIT DEVELOPMENT BOARD

Richard Fifer  
Executive Director

Date: \_\_\_\_\_

*William D. Smith*  
11-14-94

Approved and/or authorized by the Board  
of Supervisors of the County of San Diego  
Date: 11/1/94 Minute Order No. 28  
THOMAS J. PASTUSZKA  
Clerk of the Board of Supervisors  
By *A. Gomez*  
Deputy Clerk

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RESOLUTION NO. 94-327

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF ESCONDIDO, CALIFORNIA, AUTHORIZING THE CITY MANAGER AND CITY CLERK TO ADOPT AND EXECUTE, ON BEHALF OF THE CITY, A MEMORANDUM OF UNDERSTANDING BETWEEN THE CITY OF ESCONDIDO, CITY OF SAN MARCOS, CITY OF OCEANSIDE, CITY OF VISTA, COUNTY OF SAN DIEGO AND NORTH SAN DIEGO COUNTY TRANSIT DEVELOPMENT BOARD

WHEREAS, the cities of San Marcos, Escondido, Oceanside and Vista, and the County of San Diego desire to establish a Class I Bikeway along the SR 78 Rail Corridor; and

WHEREAS, the City of San Marcos has been designated as the project administrator of the Escondido to Oceanside Bikeway project by the SANDAG Regional Transportation Improvement Plan; and

WHEREAS, the City of San Marcos is preparing to complete an Environmental Assessment and to design the bikeway facilities throughout the SR-78 corridor; and

WHEREAS the North San Diego County Transit Development Board is preparing to complete an Environmental Assessment and to design the passenger railway facilities throughout the SR-78 corridor; and

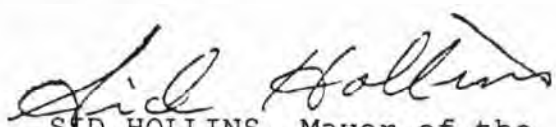
NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Escondido, California, as follows:

1. That the above recitations are true.
2. That the City Manager and City Clerk are authorized on behalf of the City, to execute a Memorandum of Understanding in substantially the form as submitted on Exhibit "1" with other cities and the North San Diego County Transit Development Board for the development of the Escondido to Oceanside Railway and Bikeway.

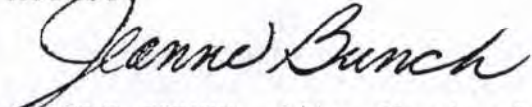
PASSED, ADOPTED AND APPROVED by the City Council of the City of Escondido at a regular meeting thereof this 7th day of September, 1994, by the following vote to wit:

- AYES : Councilmembers: CAMERON, FOSTER, HARMON, HOLLINS, PFEILER
- NOES : Councilmembers: NONE
- ABSENT : Councilmembers: NONE

APPROVED:

  
SID HOLLINS, Mayor of the  
City of Escondido, California

ATTEST:

  
JEANNE BUNCH, City Clerk of the  
City of Escondido, California

## MEMORANDUM

**To:** SANDAG Management and Staff (SDForward@SANDAG.org)  
**From:** Philip R. Kern, PE  
**Subject:** Comments on Draft 2021 Regional Plan

Thank you for the opportunity to comment on the 2021 Regional Plan. I would like to forward a few global comments on the challenges facing us as a region and the general approach to the regional program.

The 2021 Regional Plan is a significant departure from previous approaches in several regards, principally that it would be exorbitantly expensive to the region at a cost \$163B should it be implemented. By way of illustration, every one of the 3.3M residents of San Diego County in 2016 could be provided with a \$49,000 electric vehicle for less cost than implementing the proposed Regional Plan, without even allowing for tax incentives. Also by way of comparison, the entire Transnet program will generate \$15B through the 40 year life of the program from 2008-2048, less than 10% of the cost of the proposed 2021 Regional Plan.

The funding model for the 2021 Regional Plan is also a departure from previous efforts. Where in the past a transportation charges returned a defined benefit (i.e. improved roadway maintenance or the privilege of driving in a less congested Managed Lane), no such pretense is offered with this cost model. Per mile VMT "user fees" (which could be considered by many as taxes or penalties on autos) charged to use a private vehicle on a public roadway are mostly diverted to transit improvements, operations, maintenance, subsidies, and other programs rather than returned to the user in the form of a benefit. Many will view area roadways as bought and paid for with their and their parent's tax dollars, not as a government-owned resource carrying a toll to be charged back to motorists. Given that the gas tax will not only remain, but most likely escalate, and be piled on to other fees and taxes, including VMT costs passed through by companies transporting daily goods, the situation does not promote equity or provide affordability to San Diego's working families.

The track record of SANDAG and its partners (principally Caltrans, MTS and NCTD) in delivering major transportation programs for the San Diego region within budget and on schedule has not been stellar, particularly when transparency on the real costs of the programs is factored into the equation. MTS' Mission Valley East Trolley Extension (or "Green Line") was pushing 50% over the original budget (\$361M vs. \$506M) and even that did not approach inclusion of all the costs required for the expansion of the system. Although delivery methods, and consequently cost and risk management, appear to have improved with the Mid-Coast Trolley Extension, no easily accessible "dashboard"



or other record of construction Contract Change Orders could be found on SANDAG's website for the project.

Several other major programs that were supposed to be included in the original Transnet authorization (extensions of State Route 76 and State Route 52, for example) were delayed over a decade with the commensurate increases in cost of the programs, traffic congestion, delays and emissions. The same pattern of deferring promised capital projects (particularly roadways) ad infinitum appears to be repeated in the 2021 Regional Plan. Assuming adoption of the Regional Plan by 2025 it appears highly unlikely given previous efforts that environmental, design and construction for any of the major transportation programs will be completed and ready for revenue service by 2035. Very few, if any, major local highway or transit projects in the region have gone from inception to ribbon cutting in a decade. The Mid Coast Trolley extension will end up taking over twenty years from inception to revenue operations. Accountability in this area is a serious issue.

The single most costly element of the 2021 Regional Plan is the proposed "high speed rail" (HSR) network. Aligning local high speed rail (HSR) facilities underground is not a panacea for avoiding environmental, right of way, utility, acquisition, and relocation costs related to development of a high speed transit network, nor will relying on tunneling technologies that are yet to be developed (and which may ultimately be proprietary) substantially reduce the risk or cost, or automatically render an economically infeasible transportation system more feasible once it goes underground.

Tunneled alignments carry a whole new set of risks and costs, all of which come in to play when you elect to use the earth as a structure supporting your transportation system or the infrastructure above it. Fire and life safety, geologic conditions, surficial settlement, faulting/seismicity, HVAC needs, groundwater, subsurface environmental conditions, and other factors all have the ability to exponentially increase the cost and risk of below grade facilities, as well as kill the project outright. Proposing an underground (and under water) alignment parallel to the eastern shore of San Diego Bay under unstable Bay Mud, with the specter of future sea level rise and across a fault zone would range from ill-advised to sheer lunacy.

Elon Musk's The Boring Company (TBC) estimates current tunnel costs can range from \$100M to \$1B per mile. Their ultimate goal is to reduce costs to 10% of the low-end figure, or \$10M per mile, to be truly feasible on a large scale and today they are not even close to approaching that figure. TBC recently complete a 1.7 mile "bare" tunnel (no vehicles, track or infrastructure) in the sandy soils under the Las Vegas Convention Center at a cost of \$52.5M, or over \$30M per mile.

The cost of a fully functioning surface high speed rail system including track, systems, vehicles, stations and support facilities can be expected to be at least \$200M per mile in

2020 dollars, not allowing for more expensive tunneled alignments. The best data points are recently constructed and nearly completed projects, including Mission Valley East and Mid-Coast Trolley extensions. Published per mile costs for several recent programs in the western U.S. are shown in the table below, confirming the roughly \$200M per mile plus escalation is the going rate for a high speed, grade separated, electrified surface rail system in an urban setting.

<b>Project Name</b>	<b>Total Length</b>	<b>Total Cost</b>	<b>Per Mile</b>	<b>Comments</b>
Sonoma-Marin Area Rail Transit (SMART)	45 mi.	\$585M	\$13M	Existing alignment and ROW, DMU vehicles
Mission Valley East Trolley Extension	5.8 mi.	\$506M	\$87M	Constructed cost (2005), new alignment,
CA High Speed Rail (Projected System)	520 mi.	\$100B	\$192M	Surface, grade separated, latest estimate
CA High Speed Rail (Current Construction)	119 mi.	\$18.3B	\$154M	Surface, grade separated, mostly flat rural terrain
Mid-Coast Trolley Extension	11 mi.	\$2.17B	\$197M	Surface, grade separated, constructed
Las Vegas High Speed Rail (Brightline)	170 mi.	\$8B	\$47M	Surface, flat rural terrain
Las Vegas Convention Center Tunnel	1.7 mi.	\$52.5M	\$31M	No infrastructure or vehicles
2021 Regional Plan-Commuter Rail 581A/B	15.7 mi.	\$9.77B	\$622M	Proposed tunneled alignment (2050)
2021 Regional Plan-Commuter Rail 582	19.3 mi.	\$12.66B	\$657M	Proposed tunneled alignment (2035)
2021 Regional Plan-Commuter Rail 583	5.4 mi.	\$7.58B	\$1.41B	Proposed tunneled alignment (2050)

A major factor in the selection of underground alignments will be the availability of expertise and resources with the San Diego region to prosecute a large-scale tunneling program. With the exception of a very short section of “real” tunnel (as opposed to a “cut and cover” installation) on MTS’ Green Line, regional design and construction experience/expertise on passenger-carrying tunnels is essentially non-existent. Importing consultants and contractors is always an option, but never a good one as it does little for local hiring and talent development, or the ability to favorably negotiate contracts on behalf of the region when there is only one game in town (or worse yet, coming in from out of town). Decades of experience have been developed in the region developing the LRT system, this needs to be leveraged in a local High Speed Rail program.

Another question mark in the development of the Regional Plan is that the proposed high speed rail alignments generally parallel existing transportation corridors (whether

you are talking freeways or LRT) but propose entirely new alignments. This is the worst of both worlds. It is far less expensive to increase capacity by (re)constructing new facilities within existing transportation corridors than by pioneering new alignments. New alignments require connecting infrastructure to be reconstructed and have the potential to introduce new environmental impacts (and mitigation) to areas not previously exposed to transportation activities, which also factors into the environmental justice arena. The entire San Diego Trolley system could be reconstructed as a high(er) speed rail system for a fraction of the cost of a new underground HSR system with the bonus that the same vehicles could be used regionally to phase out the diesel powered DMUs used on the Sprinter. Trolleys can run at 55 mph, how fast do you want to go? On modern transit systems travel time is dictated more by the number of stops rather than the top speed of the vehicles.

Also, to be fair and transparent to the region, the costs for the local HSR and other systems need to account for **all** costs attributable to the development of the system, rather than the classic “just get program past the point of no return, then they will have to pay for it” approach. In addition to trackways, systems, vehicles, modifications to the existing system and other capital costs, the program needs to account for such esoteric items as new maintenance shop space, technicians, and training as well as specialized equipment required to operate and maintain the new rail vehicles. Adding yet another type of transit vehicle requiring its own maintenance infrastructure to the regional fleet would be violating the first rule of fleet management: maximize commonality.

The “per-mile costs” outlined above should also serve as a yardstick to determine the financial feasibility of the system at a glance, i.e. if you cannot deliver a transportation network by 2050 for less than \$500M per mile (\$200M per mile escalated 30 years at 3%), you need to seriously consider other alternatives. At costs exceeding \$500M per mile the 2021 Regional Plan proposal does not pass the “sniff test” on the high speed rail issue. The planners need to go back to the drawing board on this element to provide better alternatives.

In closing, the magnitude of the expenditures proposed under the 2021 Regional Plan demands independent, professional capital cost accountability, representation and reporting to the public. ITOCs composed of well-intentioned laypersons with little or no authority and “third party independent reviews” conducted by consultants with a vested interest in continuing the program provide little comfort or accountability to the taxpayers and transportation users of the region who are footing the bill.



February 10, 2021

SANDAG Board of Directors  
401 B Street  
San Diego, CA 92101

**RE: Priorities for the 2021 Regional Transportation Plan**

Dear Chair Blakespear and SANDAG Board Members:

The authors of this letter represent thousands of families, residents, and workers throughout the region advocating for an equitable, safe, and healthy transportation system for all communities in our San Diego region.

We are writing in support of seven outcomes we would like to see accomplished in the 2021 Regional Transportation Plan (RTP). As we have noted in prior communications, it is imperative to transform transportation across San Diego County from the ground up, in a manner that goes above and beyond state targets in climate, social justice, and economic justice and gives all in our region the clean and healthy environment they deserve while ensuring high-quality jobs and a world-class transportation network.

Below we have attached seven outcomes the RTP should achieve to support a safe and healthy future for all communities in our San Diego region. We urge the Board to hold these priority outcomes as the measures of success against which any draft RTP should be evaluated.

We look forward to working in partnership with SANDAG staff and the Board of Directors to ensure that the new vision for our regional transportation system supports a just, prosperous, and sustainable future for all.

Sincerely,

*Andy Hanshaw, Executive Director, San Diego County Bicycle Coalition*

*Justin Hammond, Co-Founder and Chief Energy Advisor, Hammond Climate Solutions*

*Tara Hammond, Manager, San Diego Climate Hub*

*Bridgette Browning, President, UNITE HERE Local 30*

*Pamela Heatherington, Director, Environmental Center San Diego*

*Matt O'Malley, Executive Director and Managing Attorney, San Diego Coastkeeper*

*Ron Forster, Escondido Neighbors United*

*Jeremy Abrams, Business Manager, IBEW 569*

*Diane Nygaard, President of the Board, Preserve Calavera*

*David Grubb, Transportation Chair, Sierra Club San Diego*

*Mike McCoy, President, Southwest Wetlands Interpretive Association*

*Diana Ross, Executive Director, Mid-City CAN*

*Bee Mittermiller, Transportation Committee Chair, SanDiego350*

*Andrew Meyer, Conservation Director, San Diego Audubon*

*Deborah Knight, Executive Director, Friends of Rose Canyon*

*Kyle Heiskala, Interim Executive Director, BikeSD*

*Laura Walsh, Policy Coordinator, Surfrider San Diego County*

*Randy Torres-Van Vleck, Director of Policy and Planning, City Heights Community Development Corporation*

*Noah Harris, Policy Advocate, Climate Action Campaign*



## Key Outcomes for SANDAG's RTP

To secure a healthy, safe, and equitable future, SANDAG must embrace an outcomes-driven RTP and identify priority outcomes aligned with those values. Below are seven key outcomes the Quality of Life Coalition urges SANDAG to prioritize in the 2021 Regional Transportation Plan:

### 1. Improve public health in disadvantaged communities and prioritize transportation and environmental justice by:

- **Reducing transportation related pollution levels in disadvantaged communities.**
  - AB 805 requires SANDAG to identify which communities to prioritize in their efforts to reduce pollution levels in this RTP.
  - SANDAG must use CalEnviroScreen 3.0 to identify these communities; we recommend defining disadvantaged communities as those in the top 30% of census tracts countywide, but also acknowledge that there are historically underinvested communities in San Diego County that are not adequately represented on this tool.
  - Any new transportation vision that successfully reduces pollution levels in disadvantaged communities must include significant reduction in Vehicle Miles Traveled (VMT) and rapid electrification of the bus fleet.
- **Providing infrastructure that:**
  - Encourages increased physical activity from active transportation
  - Reduces the risk of traffic related fatalities and injuries for all modes
- **Analyzing health outcomes** that are affected by the regional transportation system in each alternative, such as asthma, cardiovascular and pulmonary disease, lung cancer, type 2 diabetes, physical activity and obesity rates, by demographic group.

### 2. Align with and exceed cities' CAP transportation mode shift targets.

- SANDAG's plan needs to support those local plans in order for our cities to be able to hit their targets and support transportation alternatives to driving, such as mass transit.
- Further, AB 805 – the new state law to reform SANDAG – requires that SANDAG align the RTP with local climate action plans.

**3. Achieve a 30% or more per capita GHG reduction from transportation by 2035.**

- SB 375 requires a minimum of 19% reduction by 2035; however, SANDAG Executive Director Hasan Ikhata has identified a 30% target as feasible, and SANDAG should pursue the maximum feasible reduction to adequately address the threat of climate change.
- VMT reduction and mode shift through land use, housing, and transportation planning decisions must play a significant role in GHG reduction.
- As evidenced by Governor Brown's Executive Order B-55-18 to Achieve Carbon Neutrality by 2045, and SB 32 and EO S-3-05, which set statewide emissions reductions targets at 40% below 1990 levels by 2030 and 80% below 1990 levels by 2050, the State of California continues to move towards decarbonization. SANDAG should align with these statewide goals in the next RTP.
- When vegetation is destroyed for transportation facilities the resulting loss of carbon sequestration and storage capability should be counted as a loss in future GHG reduction tabulations.

**4. Create a rate structure that increases ridership and expands access to mobility.**

- The regional transportation system must include Youth Opportunity Passes, which are no-cost transit passes for students and youth 24 years old and under.
- It must also include strategically-priced fares that maximize transit usage in all income brackets to increase use of public transit, improve public health, lower greenhouse gas emissions, and enhance social equity.
- Finally, it must be easier for seniors, people with disabilities, and Medicare users to obtain the discounted passes they are entitled to by making them available online and at more in-person sites.

**5. Ensure that public transit is safe, comfortable, convenient and competitive with automobile travel.**

- Public transit must be competitive with driving in terms of time, cost, predictability, and convenience.
- Prioritize urban core and transit-dependent communities, who are frequently low-income communities of color.

- Provide 24-hour service and immediate improvements to bus service, including amenities such as restrooms at transit stations.
- Ensure safe and comfortable bike and pedestrian first and last mile access to transit through funded, comprehensive, low-stress bikeway networks connected to mobility hubs, as well as adequate accommodation for bicycles on transit.
- Prioritize new rail transit that connects underserved communities with job centers such as the blue line express and a purple line alignment through City Heights while evaluating the impacts on communities that are being displaced and gentrified.
- Prioritize relocation of public transit corridors that are vulnerable to erosion and sea level rise, rather than armoring in place.
- Ensure rural communities have access to quality, convenient, sustainable travel options that offer alternatives to fossil-fuel vehicles.

**6. Ensure transportation projects are creating high-quality careers in construction in our region through a Project Labor Agreement.**

- Major cities including Seattle and Los Angeles have employed project labor agreements to promote their commitment to labor stability, joint labor-management apprenticeship and a diverse, local workforce.
- Encourage construction employment and training opportunities in ways calculated to mitigate the harms caused by geographically concentrated poverty and unemployment in economically disadvantaged areas and among disadvantaged workers.
- Adopt a Community Workforce Policy that is implemented through a Project Labor Agreement with the Building Trades to create career pathways for a skilled and trained workforce for residents of our local communities.

**7. Preserve Biodiversity, Natural Habitat, and Open Space**

- Ensure transportation projects protect the integrity and contribute to successful implementation of existing and planned multiple species conservation plans (MSCPs) including avoiding sensitive habitat areas within the City of San Diego's Multi-Habitats Planning Area and County of San Diego's Pre-Approved Mitigation Area and consistency with MSCPs rules.

- Ensure transportation projects preserve natural habitat and other ecologically sensitive lands not covered by regional MSCPs including: urban canyons, waterways, waterbodies, ecological linkages, and ecologically important greenfields.
- Direct transportation projects away from remote or rural natural lands and into existing developed communities and urban areas.
- Ensure habitat mitigation land related to transportation projects is protected and managed for that ecological benefit.

## Quality of Life Coalition Comments on the Draft Regional Plan

Friends of Rose Canyon

Deborah Knight, Executive Director [rosecanyon@san.rr.com](mailto:rosecanyon@san.rr.com), 858-525-1489

Comments on the Draft 2021 Regional Plan - 8/4/2021

Our comments are focused on the geographic area that we are most familiar with: the area within and extending out from the I-805 / SR-52 / I-5 triangle. This includes the Rose Creek watershed (Rose Canyon, MCAS Miramar, San Clemente Canyon and Marian Bear Park, and Rose Creek extending south to Mission Bay) and the Carrol Canyon, Sorrento Valley, and Penasquitos Lagoon watershed. However, many of the concerns, issues and questions we raise in relation to this area apply to the entire RTP.

Our overall comment is that the 2021 Draft Regional Plan states that it proposes a bold new vision. However, it is based on a massive expansion of our highways. This includes widening many of our highways to add Managed Lanes and adding huge, elevated concrete “Managed Lane Connectors” ( MLCs) where highways intersect. These MLCs will require even further highway widening to add lanes where traffic would enter and exit the connectors. In some cases these MLCs connect highways at very different elevations or with multiple other on and off ramps and bridges in the same location. Judging from just the area we focus on, these added MLs and MLCs will have huge direct and indirect environmental impacts on sensitive habitat, MSCP lands, Marian Bear Park, Rose Canyon Open Space Park, MCAS Miramar, and the Rose Creek and Carroll Canyon Creek/Sorrento Valley/Penasquitos Lagoon watersheds. Furthermore, just in the area we focus on, these MLs and MLCs will cost many hundreds of millions of dollars.

We ask: How much induced demand will adding all this highway capacity cause? How sure is SANDAG of their calculations? Will this plan really reduce GHG emissions, and by how much? How sure is SANDAG of those calculations? What is the course correction if we start adding all this highway capacity and the benefits are not there? Do the RTP models rest on the assumption that the projected benefits require that all the highway MLs and all the MLCs be added to achieve the projected benefits? What if we get half way into building this out and find that adding all this highway capacity is not bringing the benefits anticipated?

Based on what we see proposed for just the area we focus on, we see major direct and Indirect Impacts on MSCP lands, open space, habitat, native plant and animal species, wildlife corridors, creeks, and watersheds. Adding Managed Lanes and Managed Lane Connectors means bulldozing land and building extensive new concrete surfaces and retaining walls and drainage ditches, expanding direct impacts and edge effects on habitat and wildlife, increasing storm water run-off, noise and light impacts, invasive species, habitat loss, loss of wildlife connectivity and wildlife corridors, increased erosion, trash, and air and water pollution. “Mitigating” these



impacts through projects done in distant mitigation banks does nothing to reduce the impacts in the areas where these impacts occur.

1

While SANDAG staff have stated in meetings with the QOL coalition that they are not widening outside the highway ROWs, that does not mean there won't be major highway widening and environmental impacts. In some cases, CALTRANS has sufficient ROW to widen by multiple lanes. And widening even within the ROW extends the damaging impacts and pushes the edge effects closer to and into sensitive habitat.

Meanwhile, the Purple Line (Commuter Rail 582) from Sorrento Mesa to the Border (a true transit project) will not be completed until 2050. In concept, we strongly support this project, assuming it is largely underground through the environmentally sensitive areas we focus on. But despite the importance of this transit project, we know little beyond the vaguest description of its route. Where might it be underground? Where might it be at grade or above grade? Why is it not being completed until 2050 while the RTP prioritizes adding so many highway MLs and MLCs?

### **I-805 North Project**

On April 15, 2021, the Sierra Club sent the attached letter to SANDAG Director Hasan Ikhata, Director of Regional Planning Coleen Clementson, Senior Transportation Planner Jennifer Williamson, and several SANDAG BOD members. At a subsequent meeting with the Quality of Life Coalition's Transportation Committee, Coleen Clementson stated vehemently, "We agree with you." We therefore assume and would like confirmation, that the following is not in and will not be added to the RTP for the I-805 North from just south of SR-52 to Carroll Canyon Road:

-Any additional freeway widening beyond what has currently been built (one Carpool/ HOV lane in each direction was completed in 2016)

-Widening of the I-805 bridge over Rose Canyon -Direct Access Ramps (DARs) at Nobel Drive

-A Park & Ride at the southwest corner of Nobel/I-805 -A bus station at the southwest corner of Nobel/I-805

### **Project ID CC114 is called I-805 (Nobel Drive) - it should be deleted from the RTP**

**Rationale:** I-805 North should locate access to and from the Managed Lanes at La Jolla Village Drive, not Nobel Drive. La Jolla Village Drive has extensive high density employment and high density housing located between the LJVD/I-805 intersection and Genesee Avenue. At Genesee there are two trolley stations surrounded by existing and planned high density employment and

housing. La Jolla Village Drive is the route BRT lines should use to enter and exit the I-805 MLs. Nobel Drive is a poor location for a BRT route to enter or exit I-805 MLs. The location is far from significant employment or housing density. Furthermore, no parking lot or bus station should be located at Nobel/805. The I-805 commute is south to north in the morning, so parking lots near the I-805 should be located in communities well to the south where commuters come from in the morning. The land at the Nobel/ I-805 intersection should be protected from any further impacts. Most of it is MSCP, and there are vernal pools and numerous documented sensitive species. That area should have no further disturbance.

2

### **The area within and near the SR-52, I-805, I-5**

**The RTP should reduce the amount of highway expansion and the number of MLCs in this area. SR-52 should not be widened and the MLCs between these highways should be eliminated.**

**The following projects would cause major environmental damage to MSCP lands and to the area's critical and already highly constrained wildlife corridors.**

This area illustrates our concern about the RTP as a whole. The RTP proposes a massive expansion of highway capacity in the name of creating "Complete Corridors" that will, in theory, carry BRT lines and carpools. While it is true that some existing general purpose lanes will be converted to "Managed Lanes", the RTP proposes an expansion of all the highways in this area to add MLs plus multiple MLCs between these highways that will further degrade the habitat and wildlife corridors.

**CC085:** 2035 - MLC I-805 (SR 52) West to North and South to East CCT - \$149 mil

This MLC will cause major environmental damage to an area with important wildlife corridors that connect MCAS Miramar, San Clemente Canyon (and Marian Bear Park) and Rose Canyon. These wildlife corridors are identified in the MSCP and in the MCAS Miramar Natural Resource Management Plans. The wildlife corridor between MCAS Miramar and San Clemente Canyon is already highly constrained at the I-805/52 intersection. In addition, the elevation change between the I-805 and SR-52 is significant. A further environmental impact will occur due to adding two MLs to SR-52 east of I-805 and one ML to SR-52 west of I-805.

**CC086:** MLC I-805 (SR52) North to West and East to South (**\$126 mil**): More environmental impacts in this same area.

**CC003** - (by 2035) - I-5 (Pacific Highway to SR 52) **8F to 6F+4 ML (\$353 mil) (adding 1 lane in each direction to I-5)**

**CC004 by 2035 I-5 (SR 52 to I-805) 8F to 6F + 4ML (adding one lane in each direction) (\$190 mil)**

**CC028 by 2050 MLC I-5 (SR 52) South to East and West to North (\$202 mil)**

**CC065 by 2050 Complete Corridor: ML SR 52 (I-5 - I-805) 4F to 4F + 3 ML (\$214 mil)**

This massive widening of SR 52, with additional width needed to build the Managed Lane Connectors between I-5/52 and SR 52/ I-805 (MLCs in all directions) will have huge negative impacts on the adjacent MSCP lands in San Clemente Canyon and Marian Bear Park and on Rose Canyon and on the wildlife corridors between

**CC066 by 2050 I-5 (SR 52) MLC - North to East and West to South (\$202 mil)**

3

April 15, 2021 - via email

Re: **Sierra Club San Diego Chapter opposition to potential projects on the I-805 North**

Dear Chair Blakespear,

Since 1948 Sierra Club San Diego has earned a leadership role in the conservation of our County's natural resources. Presently, with more than 40,000 members and supporters, the San Diego Chapter is continuously addressing planning by all regional agencies. Particular attention is focused on the avoidance of impacts to the biological diversity which is so crucial to our quality of life. Sierra Club requests consultation and a place at the table whenever SANDAG is considering any of the following proposals.

**Sierra Club strongly opposes the following proposed projects for the I-805 North, from just south of SR-52 to Carroll Canyon Road:**

- Any additional freeway widening beyond what has currently been built (one Carpool/ HOV lane in each direction was completed in 2016)
- Widening of the I-805 bridge over Rose Canyon
- Direct Access Ramps (DARs) at Nobel Drive
- A Park & Ride at the southwest corner of Nobel/I-805
- A bus station at the southwest corner of Nobel/I-805

**We oppose the inclusion of any of these projects in the 2021 Regional Plan.**

- These projects (or any projects with a similar footprint) would:
- Destroy and degrade native habitat in Rose Canyon that is part of the last remaining greenbelt and wildlife corridor connecting habitat west of I-805 with habitat on MCAS Miramar. The important wildlife corridor in Rose Canyon under the existing I-805 bridge is recognized in both the MSCP and the MCAS Miramar Natural Resources Management Plan.

1. Destroy and degrade core MSCP habitat.

2. Destroy and degrade habitat with numerous sensitive plant and animal species, including:

- Vernal pools
- Rare Quercus Dumosa (Nuttall's scrub oak)
- MHPA habitat with documented California Gnatcatchers as well as numerous other sensitive species

Thank you Chair Blakespear for your attention to our request for inclusion in the process. Retaining San Diego's reputation as a world renowned "biological hotspot" is a goal we must all strive for.

Sincerely,

Dave Grubb,  
Chair, Transportation Committee, Sierra Club San Diego Chapter  
George Courser,  
Chair, Conservation Committee, Sierra Club San Diego Chapter

Put General Comments not tied to a specific section here:

The Southwest Wetlands Interpretive Association (SWIA) is extremely invested in seeing that SANDAGs newest version/update of its Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) is the most effective and feasible approach for this region. The plan must present land use and transportation strategies to achieve the Air Resources Board's SB 375 San Diego Region greenhouse gas (GHG) emission reduction targets, improve the transportation system, facilitate efficient land use and housing, and address long-standing inequities related to those issues. Our coastal wetlands are particularly vulnerable to climate change and associated sea level rise, both of which are primarily affected by continued high GHG emissions.

Overall, we believe the draft RTP/SCS – the 5 Big Moves – represents a fundamental and necessary break from past approaches. The basic strategy to focus on improvements to the infrastructure that give real incentive for reducing sprawl and vehicle use (mobility hubs, transit leap, complete corridors – assisted by flexible fleets), integrated via the Next Operating System, appears to be both forward-looking and pragmatic.

We are submitting these comments and recommendations that we believe are necessary to ensure the RTP/SCS is an appropriate and feasible strategy to achieve its required objectives. [SWIA ]

## Chapter 1: A Bold New Vision for the 2021 Regional Plan

We like it!

***“The 2021 Regional Plan reduces per capita GHG emissions from cars and light duty trucks to 20% below 2005 levels by 2035, exceeding the region’s state mandated target of 19%. The 2021 Regional Plan also meets federal air quality conformity requirements”*** - This means our 29 year plan is barely ambitious enough to meet our insufficient state mandate. SANDAG should independently acknowledge the need to act on climate instead of stating from the outset that they are mandated to do so, and therefore meet the bare minimum with no margin for error. Less than 2% change annually is in the realm of noise in measurement. We need more bold commitment to change.(Karl A. channeling CM J. Shu)

Page 9. The brief description of this region’s natural resources, biodiversity, cultural history and other unique assets should be expanded and include a short description of the relationship of the regional transportation planning and multiple species conservation planning and permitting. This could be simply done by adding a short summary from Appendix AA .

In the early 2000’s, SANDAG and the state/federal wildlife agencies entered into unique agreements linking regional conservation commitments with expedited transportation project permitting (and mitigation). How does this plan continue and support those agreements and commitments?

Page 13. Provide more description regarding how the anticipated increases in peak period transit use from 3% (2020) to 13% (2050) will result in a reduction in solo commuter vehicle use from 80% (2020) to 62% (2050); what are the expected contributions from other mode shifts required to achieve this goal? Add a summary table (or cross reference an existing table) that shows all mode shifts (carpool/rideshare, active transit, etc.) for 2025, 2035 and 2050. In addition, the plan’s performance metrics must include tracking of the (housing) density and transportation infrastructure improvements in smart growth areas as well as what actual/calculated GHG reductions are occurring compared to what was projected. Also briefly introduce and describe the plan’s adaptive management approach for triggering and implementing measures to correct failings in meeting the plan’s goals.

Page 13. The plan states that it is expected to exceed the current vehicle-based per capita GHG emissions requirement for 2035, but as annotated in the list of state GHG emission reduction legislation/executive orders on Page 14, aggressive overall GHG emission reduction targets have been established for 2030, 2040 and 2050. Provide explanation of how the plan will continue to contribute to reducing vehicle per capita (and overall) GHG emissions to complement the overall GHG emission reduction goals after the 2035 target date. [As noted in our comment on Appendix D (Page D-4), the plan’s post-2035 contribution to reducing GHG emissions remains flat after 2035, implying that the current measures will not contribute substantially to those higher GHG emission reduction targets.] [SWIA]



## Chapter 2: Sustainable Communities Strategy – A Framework for the Future

Page 23. The plan states that, to the extent feasible, it will stay within rights-of-way to minimize impacts and would produce other environmental benefits (water quality, air quality, reduced flooding, etc.). How does the infrastructure system that is proposed in the 5 Big Moves compare to the transportation infrastructure system that was anticipated in 2004 when the original RTP and MSCP agreements were established? More specifically, because SANDAG agreed to mitigate (and has mitigated?) for expected upland and wetland habitat impacts in advance of projects impacts – based on a previous set of projects/infrastructure, will the new infrastructure have new impacts that are beyond or not mitigated by the previous agreements? For example, adding many connectors among the freeways and expanding some state routes could directly and indirectly impact habitat and wildlife corridors in excess of what was anticipated in the initial agreements. If so, how will the plan ensure no net losses of habitat acres, functions and values (including to movement corridors)?

Page 25. The plan has the potential to produce and encourage environmental benefits (climate change mitigation, air and water quality improvements) as summarized in this section. Include more discussion about the plan's commitments to meet or improve upon the longstanding habitat and conservation agreements (e.g., NCCP/HCP permits), avoid new/unpermitted impacts to habitat/species, and mitigate for any significant unavoidable impacts.

Page 27. To assist the public's understanding of the essence of the plan, add several figures to show the relationships (by time period) among transportation infrastructure, mobility hubs, and smart growth/increased housing density areas). More specifically, provide a set of diagrams to illustrate – at the system/regionwide perspective - which projects are to be completed by 2025, 2035, and 2050 and which mobility hub/ Smart Growth areas they serve. Because Smart Growth areas are expected to increase their housing densities, the plan must provide justifications and demonstrable commitments (e.g., policies, funding, incentives) that support the presumptions that the cities and county will make those density increases in step with the basic transportation improvements (transit leap, active transportation, mobility hubs, complete corridors).

Previously, SANDAG produced a short list/explanation of its incentives for smart growth ([https://www.sandag.org/uploads/publicationid/publicationid\\_1187\\_5188.pdf](https://www.sandag.org/uploads/publicationid/publicationid_1187_5188.pdf)), but it is unclear how effective those incentives have been. How does the plan improve on those incentives?

Page 31. Goods movement comprises a relatively small part of the region's GHG emissions (Appendix X), but its associated on-road use by heavy trucks and allied freight rail access/rail car storage – especially through/near disadvantaged communities and the Port District terminals – creates significant impacts to local transportation, air quality and quality of life. The RTP/SCSs transportation infrastructure system improvements must be fully integrated with the Port's implementation of its proposed maritime operations strategy and additional actions to relocate (to the extent feasible) truck parking and freight rail car storage away from the coastal area.

Pages 32-33. The essence of the plan's sustainable communities strategy is expressed in the introduction to the region's growth and development: "The 2021 Regional Plan envisions a regional pattern of growth and development that reflects smart growth, transit-oriented development, preserving natural resources, and building communities that are resilient to the consequences of climate change and other environmental changes. Ensuring social equity and the availability of housing that is affordable for everyone are also top priorities." Those goals will only be achieved when the cities and county, which constitute SANDAG, fully acknowledge the necessity to amend their general plans to accommodate and implement the identified changes.

The forecasted concentration of jobs and housing (and population) in the urban areas that are necessary to implement the plan would create a more efficient, livable region that supports the proposed transportation system. It would also alleviate pressure for development in the unincorporated county, reduce impacts on the natural landscape, and lessen the risks from wildfire to people and structures.

If the plan is approved, then how are the cities and county proposing to commit to implement those changes? What ramifications are there to the plan – and for a jurisdiction's ability to benefit from the transportation system improvements – if a jurisdiction does not make those needed general plan changes?

Pages 34-35. The global threat from continued GHG emissions and unique threats, conditions, and opportunities to reduce GHGs within our region are recognized in this plan. The GHG inventory and calculation of anticipated reductions by sector illustrate how the plan would be able to meet and exceed the region's SB 375 GHG emission reduction target for 2035. As noted in preceding comments, achieving that goal requires significant cooperation from each of SANDAG's member jurisdictions through changes to their general plans (especially land use/zoning) as well as how their Climate Action Plans support and augment the RTP/SCS.

While this plan demonstrates that it could meet/exceed the mandated GHG emission reduction target for 2035, the projected emissions out to 2050 in Appendix X suggest that the region will be far from "carbon neutrality by 2045." That is not a region-by-region requirement, but it is critical that this plan incorporate goals and policies - and at least propose possible actions/projects – that would put the region on a more aggressive GHG emission reductions pathway post-2035.

Decisions pertaining to which and when to initiate projects should balance the basic GHG emission reduction priority and their effectiveness in promoting the more broad actions (i.e., specific local jurisdiction actions) to optimize system buildout. However, as noted on Page 14 of the plan, SANDAG has a specific requirement to identify disadvantaged communities, include strategies to reduce pollution exposure in those communities, and use of a skilled and trained workforce (via the RTP/SCS). So, the "balancing" decision must have a larger frame of reference than just GHG emission reductions. [SWIA]

### Chapter 3: Paying for the Regional Plan, Forming Partnerships and Taking Action, and Monitoring How the Plan Performs

Page 44. The plan should clarify that the region' projected population growth will result in continued – albeit slowing - total VMT, but implementing the plan will result in a significant net reduction in VMT/capita that is consistent with the requirements of SB 375.

Page 45. As described, there are real constraints on the allowable uses (types of project investments) and timing (when available) of the known and reasonably anticipated funding sources. Our prior comments (e.g., Pages 19, 27, 32-33) raised concerns about how the RTP/SCS will ensure concurrent and effective linking of the growth in the mobility hubs (smart growth areas) with the transportation infrastructure. This is particularly of concern because growth in the mobility hub areas may occur – based on local jurisdictions' requirements and needs - even if the transportation infrastructure and operational improvements are not able to be funded concurrently. How will the RTP/SCS ensure (and measure/monitor) that the housing/jobs/transportation linkage will occur as needed?

Pages 45-47. The projected costs to implement the revised transportation infrastructure and operations, combined with SCS strategies, will require SANDAG to evaluate and adopt new revenue funding sources. The plan does not provide sufficient descriptions of how SANDAG will evaluate the effectiveness of implementing the identified potential new revenue sources. For example, charges for Managed Lane use and a general Road User Fee potentially overlap costs for drivers; paying the premium for managed lane access may induce more VMT as well as be cost-prohibitive to lower income populations; there is no discussion about how local jurisdictions could/should adopt parking cost strategies to both promote transit (reduce vehicle use) and increase revenues that can be then incorporated into their local funding share.

Page 50. Successfully implementing the regional plan will require cooperation with and incentives for participation by the member jurisdictions and cooperating agencies that comprise SANDAG. The plan needs to provide more description of how SANDAG's current incentives programs ([https://www.sandag.org/uploads/publicationid/publicationid\\_1187\\_5188.pdf](https://www.sandag.org/uploads/publicationid/publicationid_1187_5188.pdf)) will be augmented and prioritized to ensure that the necessary infrastructure and operational investments correspond to the projected growth (e.g., location of new housing and jobs).

Page 53. The plan proposes a reasonable list of priority implementation actions. One item that is not discussed in the plan but is referenced in Item 9 is to expand nature-based climate solutions. As recommended in our prior comment on Page 9 of the plan, it should provide more description about the regional environment, which would then establish the context for “nature-based solutions.” Though the assessment/analysis of what those solutions are and how they advance the goals of the RTP/SCS will be part of the subsequent CEQA EIR, this document needs to better describe (at a general level) what this action involves.

Pages 54-55. Monitoring must address both implementation and performance. The proposed performance indicators align with the regional plan's goals and would collate/integrate relevant existing measurement/data and reporting sources. But the

corresponding implementation monitoring needs to be better described and some additional monitoring considered. As noted in our comment on Pages 13, 27 and 32-33, the plan does not effectively illustrate how the key components are expected to integrate. Specifically, the plan needs to monitor and report (and provide simple illustrative mapping) how the actual growth in housing/jobs within the mobility hubs/smart growth areas and the associated transportation infrastructure/operational improvements are in alignment and how they are advancing compared to their anticipated advancement per this plan. This type of implementation tracking and reporting is essential and it does not appear to be covered by the proposed performance indicators in Table 3.1. [SWIA]

## Appendix A: Transportation Projects, Programs, and Phasing

(Sierra Club) The ever-increasing urgency to prevent a climate catastrophe demands fast action to reduce greenhouse gas emissions. One of the most significant ways to do that is to quickly reduce driving. In light of this, projects that fail to reduce vehicle miles traveled (VMT) must be deferred until the vehicle fleet has mostly been replaced by zero-emission vehicles. Otherwise well-intentioned projects like HOV to HOV connectors will actually increase VMT by reducing travel times, encouraging more people to drive and pay whatever fees are required to use the HOV lanes. Vehicles powered only by internal combustion engines must be banned from any form of managed lanes.

There is no need to expand freeways when it is clear that driving must be reduced. Managed lanes must replace existing general purpose lanes. Adding lanes for any reason is unacceptable while driving is the largest source of GHG emissions.

### Table A.5: Interstate 5 North Coast Corridor

#### Item TL06

(Sierra Club)

Realignment of the LOSSAN segment through the University Community to a tunnel between Rose Canyon and Sorrento Valley would improve rail efficiency and travel times by avoiding Miramar Hill and would improve connections to other public transportation with a station at University Town Center. Realignment of the LOSSAN segment through Del Mar to a tunnel under Del Mar Heights between Sorrento Valley and the Del Mar Fairgrounds would also improve rail efficiency and travel times, improve public access to the coast, and accommodate managed retreat from eroding bluffs by avoiding the unsustainable current alignment on the delicate bluffs of Del Mar.

Sierra Club generally supports realignment of the two segments of the LOSSAN rail corridor to the extent that the new alignments and tunnels are located and constructed in a manner that fully minimizes impacts and maximizes preservation and restoration of natural habitat, open space, and wildlife corridors in Los Penasquitos and San Dieguito lagoons, Carroll Canyon, Crest Canyon, Rose Canyon, and Torrey Pines State Natural Reserve Extension.

The following are a number of Sierra Club recommendations on how Caltrans and SANDAG should accomplish these goals through selection of locations for the realigned LOSSAN segments and measures to fully minimize and mitigate project impacts.

### **Protect & restore Los Penasquitos & San Dieguito lagoons**

- Realigned track across or near Los Penasquitos Lagoon should be located as close as possible to old Sorrento Valley Road and I-5 and, if located in the Lagoon, should be on an elevated bridge across the entire Lagoon to protect and maintain lagoon hydrology. An existing hill portion of Carmel Valley Road between Caminito Pointe Del Mar and Portofino Drive should be lowered as necessary to accomplish these goals.
- The Project should not impede tidal flow in Los Penasquitos or San Dieguito lagoons.
- The Project should include maintenance of open Los Penasquitos and San Dieguito lagoon channels to the ocean.

### **Remove old track infrastructure & restore lagoons & native habitats**

- Old track infrastructure should be fully removed and restored to wetlands, coastal bluff scrub, coastal sage scrub, and other location-appropriate native habitats and vegetation. Removal of old track infrastructure includes removal of all Del Mar bluff stabilization structures to allow for natural bluff erosion, removal of all berms and bridges across Los Penasquitos Lagoon, and removal of all tracks, berms, trenches, and retaining walls in Carroll and Rose Canyons[1] and in Sorrento Valley.
- Fill soils in the berm across Los Penasquitos Lagoon may have originated from the Del Mar bluffs and should be returned and incorporated into restoration of the old track cut on the Del Mar bluffs if soils are appropriate.

### **Protect and restore wildlife corridors**

- Realigned track should be below grade in a tunnel or covered trench capped with native vegetation to protect wildlife movement in and between the Crest Canyon Preserve and San Dieguito Lagoon.
- Realigned track above Carmel Valley Creek and Carmel Valley Road should not restrict deer and other wildlife movement in and between Torrey Pines State Natural Reserve, Los Penasquitos Lagoon, and Carmel Valley (under I-5).
- Realigned track should emerge in Sorrento valley from the tunnel under the University Community elevated on a bridge over Carroll Canyon Creek.



- Old track infrastructure should be removed and berms and slopes should be recontoured and planted with native vegetation to restore a wildlife connection between MCAS Miramar and Carroll Canyon and Sorrento Valley.

### **Establish a Del Mar bluffs park**

The old LOSSAN right-of-way on the Del Mar bluffs should include a linear park with a public walkway and connections to the beach. However, park and beach access infrastructure should not interfere with natural bluff erosion and managed retreat.

### **Protect existing preserves and open space**

Tunnel vents should not be located in Crest Canyon Preserve, Torrey Pines State Natural Reserve Extension, or any University Community open space.

### **Control invasive non-native plants**

The Project should bar deliberate planting of invasive non-native plants and provide for long-term control of any colonizing invasive non-native plants.

### **Retain and improve pedestrian and bicycle infrastructure**

The Project should retain and improve pedestrian and bicycle infrastructure and connections including between Sorrento Valley Road and Carmel Valley Road, the San Dieguito River Park Coast to Crest Trail, and between the Coast to Crest Trail and Crest Canyon.

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[1] Old track infrastructure could be retained in either Carroll Canyon or Rose Canyon if needed to maintain a rail connection to Miramar Marine Corps Air Station Miramar.

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- (Katie) Many of the Active Transportation projects listed are from the Early Action Plan that they adopted in 2013 and were supposed to be completed within 10 years. There was \$200 million allocated for these bikeways, most of which are yet to be fully built. I'd like to understand if this is new funding and the timing of when these projects that are already in the works are supposed to open. It seems a bit like double dipping and now the build date is 2025 at the earliest but some say 2035, which is unacceptable (Jacob -- you may be able to help with the open dates since you just did a review!)
- (Katie) I only see mention of the San Ysidro and Central Mobility Hub specifically. Is Table A.14 in reference to those or amenities for mobility hubs for all of the other new lines? We need a commitment to ensure transit accessibility for those on foot and bikes.

**BICYCLE COALITION:**

<b>A</b>	General	General	Several projects that were in the Early Action Plan appear in Appendix A. How do the projects in the EAP differ from the projects here?
	General	General	In general, the dollar amount spent on managed lanes rather than mode-shift is concerning. More funding and increased timelines for active transportation & transit leap projects should be prioritized.
	A-14	TL58	How does the San Diego - Coronado Military Ferry connect to the Central Mobility Hub?
	A-42	Table A.13	In general, the Arterials section neglects to mention active transportation and public transportation facilities along arterial corridors. If SANDAG wants to get San Diegans out of their cars, then arterial streets need to prioritize pedestrians, bicycles, and public transportation over cars.
	A-42	CB04B	This intersection's bike lanes are in need of protection and better visibility for drivers. NCTD Bus 309 stops at this intersection as well, is SANDAG planning on providing any infrastructure improvements for bus and pedestrian connectivity?
	A-42	CB22	SANDAG should prioritize building safe active transportation infrastructure to and from the Carlsbad Poinsettia Station along this corridor. Sidewalks and bike lanes heading north disappear at the station, and this project makes it appear that SANDAG isn't planning on including those elements. SANDAG should not widen Avenida Encinas from Palomar Airport Road to Embarcadero Lane. Instead, SANDAG should keep the current configuration and build wide sidewalks and protected bicycle facilities.
	A-42	CB31	The bike lane along this segment of El Camino Real is often subject to vehicle intrusion. SANDAG should add protection to the bicycle facility here to keep cyclists safe.
	A-42	CHV69	SANDAG must include in this project upgrades the existing bicycle connection to the North Island Credit Union Amphitheatre. The currently existing Class II lanes on Heritage Road are often subject to vehicle intrusion.
	A-42	CNTY14 A	SANDAG must build Class IV protected bike lanes in addition to pedestrian safety improvements along this corridor to improve connectivity to the Sprinter and NCTD Busses 305 & 332.
	A-43	CNTY21	Additional pedestrian safety measures are needed for the Overpass at SR-67, including bulb-outs and more visible crosswalks.
	A-43	CNTY34	SANDAG must be specific about what bike facilities are planned for the Dye Road Extension in Ramona.
	A-43	CNTY98	The current condition of Otay Lakes Road has Class III bike facilities. What facilities are planned for this project?
	A-43	ESC04	SANDAG has forgotten to include what happens to the currently-existing Class II buffered bike lanes with this project. Bicycle lanes should be included in the bridge design over Escondido Creek.

A-43	ESC08	SANDAG should include safe bicycle facilities in this project.
A-43	ESC24	What intersection improvements are planned? How will SANDAG maintain or upgrade the existing bicycle facilities? In addition, Mission Road is misidentified. The street becomes Mission Avenue after it crosses I-15.
A-43	NC01	SANDAG should include safe bicycle facilities in both Phase II and Phase III of this project.
A-43	O22	The street Avenida de la Plata is misspelled here. SANDAG should add protected bicycle facilities along this corridor.
A-44	SD34	SANDAG has forgotten to include what happens to the currently-existing Class III sharrows with this project. Bicycle lanes and sidewalks should be included in the design to connect to future planned bus service at Via de la Valle.
A-44	SD70	What bridge is SANDAG planning on replacing? These bridges are extremely busy and bicycle facilities should be protected Class IV, not Class II.
A-44	SM19	The six-lane arterial street from Craven to Grand Avenue must include safe, protected bicycle infrastructure to provide a complete network. The intersection of Craven Road and Discovery Street should be redesigned to close the slip lane and provide safe crossing for cyclists and pedestrians.
A-44	SM24	SANDAG should add protected bicycle lanes along this project, and include a safer pedestrian crossing under SR-78.
A-44	SM31	The proposed widening of Discovery Street from Via Vera Cruz to Craven Road must include safe, protected bicycle facilities and pedestrian infrastructure.
A-44	SM32	This project must include safe, protected bicycle facilities and pedestrian infrastructure to provide network connectivity.
A-44	SM42	This project must include safe, protected bicycle facilities and pedestrian infrastructure to provide network connectivity to CSU San Marcos.
A-45	SM48	This project's bike path should not meander, but provide clear connectivity along the route to promote bicycle commuting.
A-45	SM69	The intersection of Twin Oaks Valley Road and Barham Drive in San Marcos is currently hostile to pedestrian and bicycle traffic, with slip-lanes and disappearing bicycle lanes. What plans are in place to increase use of active transportation at this intersection?
A-45	CB212	What classification of bicycle facilities are being planned for College Boulevard Reach A?
A-45	CNTY35	What classification of bicycle facilities are being planned for the Ramona Street Extension? SANDAG should also consider re-striping and adding more signage to Ramona Street's currently-existing lanes.
A-45	SD190	What bicycle facilities will SANDAG include in the Palm Avenue Bridge project?
A-54	Table	Support for increased funding for GO by BIKE, and an e-bike incentive

	A.17	program.
A-54	Table A.18	What is the cost breakdown of the local bike program?
A-55	Table A.19	SANDAG should consider incentivising alternative cargo delivery vehicles for local delivery services under this table. For example, incentivise the usage of cargo e-bikes for parcel delivery in dense, urban neighborhoods.
A-68	Figure A.11	Segments of the Bayshore Bikeway that are already completed seem to be missing from this map.

## Appendix B: Implementation Actions

### BICYCLE COALITION:

<b>B</b>	B-4	3 (b)	Support updating the evaluation and monitoring procedures of projects using TransNet local streets and roads funds, including prioritization of safety for vulnerable road users in the development of complete streets. The procedures should include a mechanism for the public to comment.
	B-4	3 (c)	Support the development of a Regional Active Transportation Plan, including updating the San Diego Regional Bike Plan to reflect need for safe bicycle infrastructure county-wide.
	B-4	3 (d)	Support the development of a Regional Vision Zero Action Plan, including a Regional Safety Policy. This regional safety policy should establish clear procedures that allow for the collection of accurate crash data, and the usage of that data to make changes to dangerous designs.
	B-7	7 (a)	Support the implementation of the 2021 Regional Transportation Improvement Program (ETIP) & building bike early action program projects
	B-7	7 (d)	Support building projects with an emphasis on safety for all road users to implement Vision Zero
	B-7	8 (b)	Support for updating evaluation criteria and provisions of SANDAG grant programs to improve social equity, advance roadway design with an emphasis on safety for vulnerable road users, implement climate action plans, and others listed.
	B-8	8 (e)	Support for incentivizing the implementation of complete streets projects that complement regional investments within Mobility Hubs, along Complete Corridors, and supporting Flexible Fleets. We absolutely support a formalized Quick Build implementation program that develops complete streets solutions.
	B-9	9 (g)	Support for transportation demand management grant and incentive programs, including e-bike, carpool, and vanpool incentives
	B-10	10 (a)(b)(c)(d)(e)	Support for policies outlined under this heading

Appendix C: Air Quality Planning and Transportation Conformity

Appendix D: Sustainable Communities Strategy Documentation and Related Information

**BICYCLE COALITION:**

<b>D</b>	D-8	Table D.3	This table lists micromobility costs as \$0 for access/egress to transit. Does this mean SANDAG is planning on subsidizing micromobility rides as a last mile solution?
	D-8	Table D.3	What model is SANDAG using to determine that 36% of privately owned bikes will be e-bikes by 2035?

General Comment. This appendix is essentially a matrix of SB 375, AB 805 and other legislative/legal requirements and a compilation of past documents that were used to prepare specific components of the RTP. Providing a conformance matrix of those requirements and what is in the RTP does not explain how the RTP comprises a sustainable communities strategy. At a minimum, this appendix should provide a short (a page or two) summary of how the plan integrates critical elements or summarize sections from Chapter 2 in the main body of the RTP/SCS where an explanation of that integration (the basic strategy) is provided.

Page D-4. While the state does not set a 2050 target for GHG emissions reduction and the MPOs are not required to produce an official GHG reduction target for 2050, the projected regional reduction of 20.3% from the 2005 baseline is alarming. That is only 0.3% below the 2035 regional reduction, which implies that all of the anticipated new GHG reductions within the region “max out” their effectiveness by 2035. One can assume that between now and 2035 there will be additional regulations and technologies that will force/enable the region to improve upon that projected 2050 reduction. In that vein, this document should include more extensive discussion about how and what future iterations of the RTP/SCS will commit to doing to continue to identify relevant GHG reduction options for the region. Presenting this number and then not providing further discussion about how SANDAG will be addressing what appears to be a “stalled” GHG reduction effort post-2035 is neither sufficient nor acceptable.

The relevance of this concern is clearly illustrated by the data provided in Appendix F (Figure 1) regarding the projected population growth, which is estimated to be 437,000 between 2016 and 2050 –about a 13% increase. Even if the region added only roughly 100,000 people from 2035-2050, absent a more aggressive RTP/SCS that is initiated well before 2035, the region would be totally incapable of attaining the state’s “target reduction” of 80% below baseline by 2050 or the more recently cited statewide goal of net zero by 2040. The RTP/SCS should, at the least, provide a discussion about how future versions of the document will be addressing post-2035 GHG emission reductions.

Page D-20. The legend for this figure should be revised to “Existing and Proposed/Potential San Diego Region Habitat Conservation Lands.” [SWIA]



## Appendix E: Performance Monitoring

### BICYCLE COALITION:

E	E-2	Housing	Support the addition of using Housing as a Performance Indicator.
	E-2	Quality of Life	Support the addition of using unemployment, social equity, telework, and homelessness as a Performance Indicator.
	E-3	Transportation Planning	Support the addition of using Bike Lane Miles and Annual Transit Ridership as a Performance Indicator.

This appendix provides only a minimal level of information and it is unclear when the appropriate level of detail necessary to implement the performance monitoring will be developed and made available. The types of issues subject to monitoring (e.g., Health and Environment; Energy and Water; Housing; Quality of Life; and Transportation Planning) address issues relevant to SB 375 and other mandates, and the Indicators and Sources of Information seem reasonable. But the appendix does not provide any discussion or examples of how the indicators will be used. For example, which components of “Air Quality” are to be used, what are the relevant standards, etc. When a general indicator is to be used (e.g., Percentage of households with housing costs greater than 35% of income), what is the RTP/SCS intending to do with that number?

For all Indicators, one presumes that there is a threshold or trigger point (for when the plan is failing to meet an objective) at which the plan would be required to begin to initiate actions in response to reaching the trigger/threshold. Or conversely, if the threshold indicates that the plan has successfully achieved a goal, what if any additional effort is required?

The RTP/SCS performance monitoring plan will likely have to be periodically updated to reflect new requirements (e.g., air quality standards may change), new technologies may allow for improvements to the current indicators, and conditions may warrant changes in the types of issues relevant to the plan and/or the identified indicators may need to be revised or replaced. Regardless of that reality, the public, stakeholders and jurisdictions/agencies that will be reporting, evaluating and relying on the performance monitoring to determine how the RTP/SCS is functioning must be provided a more complete description of the performance monitoring plan. [SWIA]

## Appendix F: Regional Growth Forecast and Sustainable Communities Strategy Land Use Pattern

Pages F-10-12 (Tables F.1-3). While there appears to be a similarity in the relative growth in population, jobs and housing among the jurisdictions, the Unincorporated County's projected population growth (0.9%), jobs growth (23.2%) and housing growth (4.3%) seem to be noticeably different. In particular, there is a very high projected growth in jobs compared to population and housing. How does that seeming disparity in jobs growth with population and housing growth (which has implications for transportation to housing) impact transportation planning? Are there other jurisdictions for which the "disparity" in projected population, jobs and housing pose challenges to the RTP/SCS's 5 Big Moves approach?

Page F-15 (Figure F-5) – Five areas that appear to support significant jobs but are outside of mobility hubs are Camp Pendleton, MCAS Miramar, Pt. Loma and North Island (military employment) and East Otay Mesa. How are SANDAG and the military services planning to address this? [SWIA]

## Appendix G: Public Involvement Plan

### BICYCLE COALITION:

<b>G</b>	G-50	3.0	Support the inclusion of SANDAG's Commitment to Equity Statement
	G-50	3.1	Support for Social Equity and Environmental Justice Considerations
	G-51 & G-52	3.2 - 3.5	Support for working in partnership with Tribes, Mexico, Military, and other stakeholder agencies
	G-53	4.0, Table 1, Public Workshops	Rather than increasing the amount of public workshops by an arbitrary number (10%), SANDAG staff should use data to calculate public engagement by geographic region throughout the county, and use that data to determine low engagement rates where more public workshops are needed.
	G-53	4.0, Table 1, Pre-document consultation	Add: "Gather an additional" to "5,000 individual remarks" so context is more clear
	G-53	4.0, Table 1, Opportunities for engagement	Rather than "increasing variety of platforms for public engagement by 15%", the goal should be to re-evaluate the effectiveness of current platforms being used during a certain time period and then determine if another platform could be more effective. In addition, special topic/targeted workshops should be made available in as many languages as possible and include dedicated outreach to stakeholder groups who have not participated in or have been historically excluded from the public engagement process prior to the 2021 Draft Regional Plan.
	G-57	Appendix A.1	In order to reach a younger audience, "San Diego County Media Outlets" should be expanded to include student publications at the region's school systems and colleges/universities. In addition, many young people engage

			with social media accounts for local news information, so SANDAG should research where they could make an impact through social media channels besides their own.
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Appendix H: Social Equity: Engagement and Analysis

**BICYCLE COALITION:**

<b>H</b>	H-15	Existing Conditions in Disadvantaged Communities in the Region	SANDAG notes that 5.7% of households in the region have "zero vehicles available" but hasn't defined what a vehicle is outside of being "dependent on transit services." How does SANDAG define "transit services?" If a person didn't own a car, but used a personal bike, skateboard, or rented a micro-mobility solution to travel, would that person be considered as "not having access to a vehicle"?
	H-33	Defining Performance Measures for Social Equity Analysis	Support using percentage of population within 0.25 miles of a Bike Facility as a social equity performance measure.
	H-55	Access to Basic Needs	Why were biking and walking metrics only included for parks and retail sections, but not for access to employment or education centers?
	H-58	Table H.11	The bicycle statistics laid out in this table are inaccurate and out-of-touch with reality. While theoretically true that a bicycle could use the existing network to access parks, our current street network is dangerous for cyclists due to the lack of safe infrastructure and most parks are not considered accessible by regional bicycle advocates. How was "Access" by bike defined and used in these calculations? Did safety, comfort, bike parking, and ridership play a part in defining "access" by bicycle?
	H-60	Table H.12	This table has the same issue with Table H.11. The bicycle statistics laid out in this table are inaccurate and out-of-touch with reality. While theoretically true that a bicycle could use the existing network to access retail spaces, our current street network is dangerous for cyclists due to the lack of safe infrastructure and most retail/commercial areas are not considered bicycle-friendly by regional bicycle advocates.

Appendix I: Tribal Consultation Process for San Diego Forward: The 2021 Regional Plan – Communication, Cooperation, and Coordination

Appendix J: Megaregion and Borders Planning and Collaboration

Appendix K: Regional Housing Needs Assessment Plan

**BICYCLE COALITION:**

<b>K</b>		5: Objective s and Factors	
	K-29		Support the promotion of shared-use mobility, including bike sharing

Appendix L: Active Transportation

**BICYCLE COALITION:**

<b>L</b>	General	General	How does SANDAG plan to promote use of active transportation by allowing bicycles on transit?
	General	General	How does SANDAG plan on expanding the bicycle locker program?
	General	General	SANDAG should consider adding bicycle cars on trains to accommodate bicycles on trains.
	L-6	Complete Streets in Mobility Hubs	What does "enhanced bike and micromobility parking" mean?
	L-7	Vision Zero	What are the details of SANDAG's plan to collect and analyze crash data for bicycle traffic?
	L-7	Riding into the Future	What is the timeline for SANDAG developing a new, comprehensive Regional Active Transportation Plan as a near-term action from the 2021 Regional Plan?
	L-10	Significance of Reduced Speed Limits	What is SANDAG's plan to reduce speed limits in San Diego County?
	L-15	Principles by Layer: General	Add: Limit bicycle interaction with mixed traffic wherever possible
	L-15	Principles by Layer:	All Transit Leap nodes should be served by bicycle routes.

		General	
L-22	Table L.1		SANDAG should ensure that Bicycle Facility Selection Plan tool is used consistently throughout the region, and that any arterial/TransNet funds follow this tool.

## Appendix M: Progress on Near-Term and Continuing Actions

### BICYCLE COALITION:

<b>M</b>	M-8	Near-term Action #4	Support for the promotion of vehicle miles traveled reduction through Regional Complete Streets Policy
	M-9	Near-term Action #5	This action item should be amended in two ways: 1) SANDAG should include pursuing data-sharing agreements with mobility companies operating in the San Diego region, and 2) SANDAG should begin procuring more bicycle and pedestrian counters, and identify places where they are needed
	M-16	Near-term Action #11	Support for the development of a regional military base access plan and implementation program. Most of San Diego's military installations are uniquely positioned within urban contexts and SANDAG should incentivize active transportation and public transportation usage to/from these sites.
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	M-30	Continuing Action #18	Support for opportunities to expand shared mobility services near Smart Growth Opportunity Areas. SANDAG should consider how expanded mobility services interact with the surrounding communities and provide safe infrastructure for those services.
	M-31	Continuing Action #20	Support for identifying transportation solutions to improve connectivity to the San Diego International Airport. These solutions should include building safe long-term bike parking and provide connectivity to existing



			bikeways in the community
M-33	Continuing Action #22		Support for continuing to apply social equity and environmental justice considerations in the implementation of SANDAG projects and programs.
M-33	Continuing Action #23		Support for collaboration with key partners and stakeholders, including representatives from low-income and minority communities, and actively involve the public in the planning process. SANDAG should create guidelines for conducting outreach and collaboration, and gather data to improve performance. SANDAG should also continue to provide ongoing outreach across many languages to ensure communities that were traditionally underrepresented have a voice in the process.

[Appendix N: SANDAG Federal Congestion Management Process](#)

[Appendix O: Federal System Performance Report](#)

[Appendix P: Travel and Tourism](#)

**BICYCLE COALITION:**

<b>P</b>	P-1	Year-Round Tourism	San Diego has a thriving tourism industry that unfortunately relies on tourists renting cars to visit popular tourist destinations. This appendix does not present any strategies to mitigate VMT from car rental services, nor does it lay out any strategies to provide alternative transportation access to any of San Diego's major tourist attractions that rely on vehicle access. Tourist destinations are not only places to visit, but many of them are major employment centers that could benefit from efficient transportation connections.
	P-1	Year-Round Tourism	SANDAG should also consider other services that tourists use in San Diego County and how they interact with the Regional Plan. This includes hotels, the airport, the cruise ship terminal, and alternative tourist mobility solutions such as the Old Town Trolley, GoCar City Tours, hotel and airport shuttles, etc.
	P-1	Year-Round Tourism	San Diego is a world-class bike tourism destination. The 2021 Regional Plan should reflect the need for facilities to accommodate bicycle tourism.
	P-3	Special Events	SANDAG should consider adding pop-up safe bicycle parking to special events to incentivize San Diegans to ride their bicycles to special events.
	P-4	Next Steps	SANDAG should study traffic patterns of major tourist destinations and devise strategies to reduce VMT and incentivize public/active transit usage.

[Appendix Q: Transportation Security and Safety](#)

[Appendix R: Stormwater and Resilience](#)

[Appendix S: Travel Demand Modeling Tools](#)

**BICYCLE COALITION:**

<b>S</b>			The five classification types described in this section don't seem to match anywhere else in the SANDAG RTP, and should be rethought to better fit the language throughout the document. For example, this appendix references bike boulevards as Class IV facility, but Appendix L-25 describes a bicycle boulevard as "most similar to the Class 3 facility." If SANDAG is going to change classification types for modelling purposes exclusively, this appendix should specify that. In addition, the Active Transportation Network Input should take into account the surrounding infrastructure (speed limits, driveways, and other bikeway intrusions) to determine the comfortability of riders using the facility.
	S-21	Active Transportation Network Input	

[Appendix T: Network Development and Performance](#)

**BICYCLE COALITION:**

<b>T</b>	T-25	Table T.9	The bicycle statistics laid out in this table are inaccurate and out-of-touch with reality. While theoretically true that a bicycle could use the existing network to access parks or retail within 15 minutes, our current street network is dangerous for cyclists due to the lack of safe infrastructure and most parks and retail spaces are not considered accessible by regional bicycle advocates. How was "Access" by bike defined and used in these calculations? Did safety, comfort, bike parking, and ridership play a part in defining "access" by bicycle?
	T-27	Table T.10	The bicycle statistics laid out in this table are inaccurate and out-of-touch with reality. While theoretically true that a bicycle could use the existing network to access parks or retail within 15 minutes, our current street network is dangerous for cyclists due to the lack of safe infrastructure and most parks and retail spaces are not considered accessible by regional bicycle advocates. How was "Access" by bike defined and used in these calculations? Did safety, comfort, bike parking, and ridership play a part in defining "access" by bicycle?

[Appendix U: Cost Estimation Methodology](#)

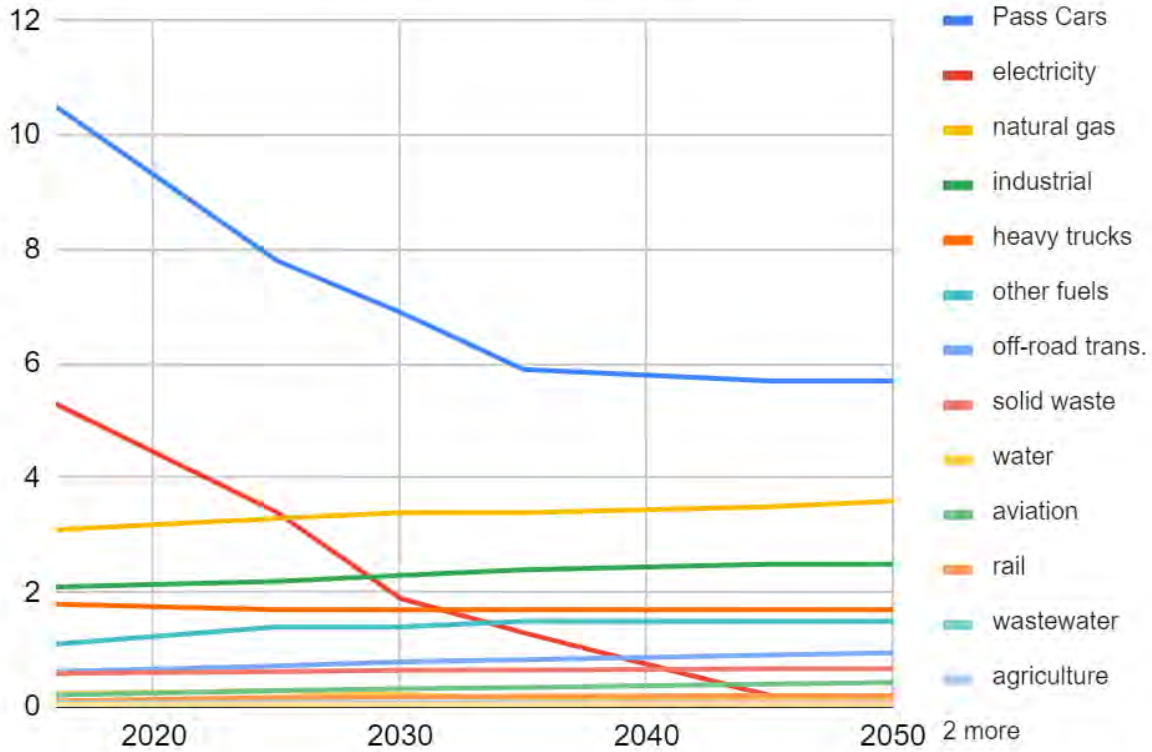
[Appendix V: Funding and Revenues](#)

[Appendix W: California Coastal Trail Technical Memoranda and 2021 Technical Addendum](#)

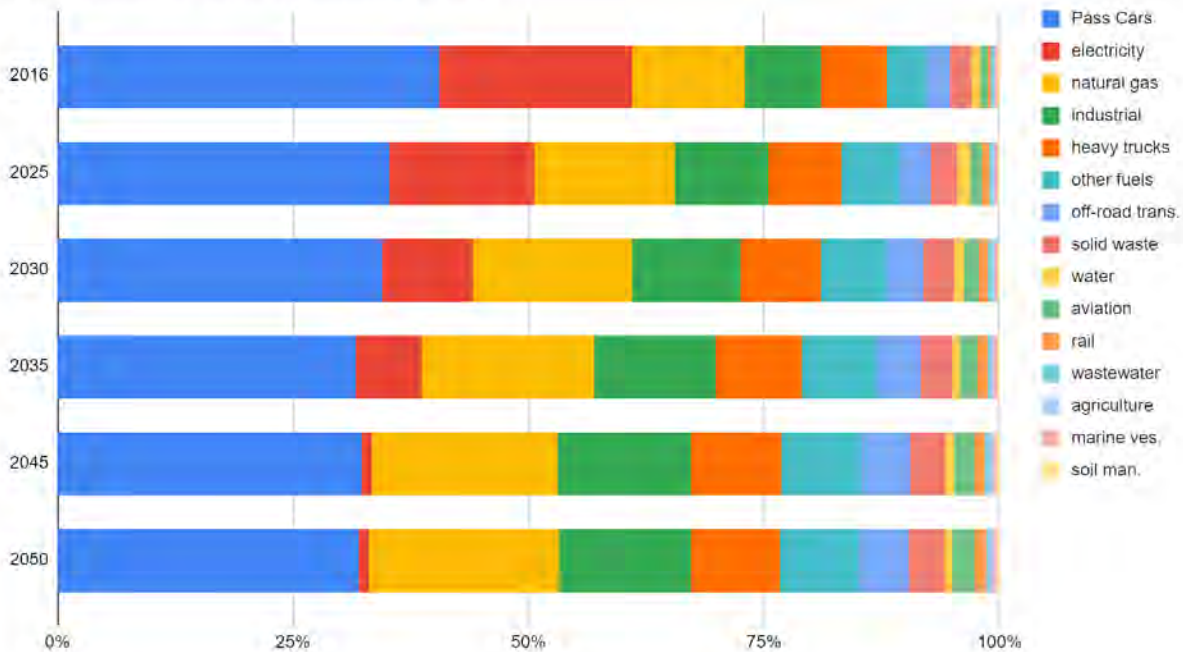
## Appendix X: 2016 Greenhouse Gas Emissions Inventory and Projections for the San Diego Region

Projected emissions from GHG of Natural Gas use doesn't assume a reduction in use by 2050 but instead assumes unabated use. Appreciate that it's pessimistic and not optimistic, but these numbers will be very inaccurate, given changes in building code for 2022. (Table X.16) (Karl A.)

### MMT CO<sub>2</sub>e SANDAG projection



Percentage of GHG emissions CO2e



Wanted to visualize the numbers from table X.3 better. Note that methane gas is the second highest contributor after 2025, and it becomes 20% of the emissions by 2050, with no expectations of abatement. (Karl A)

Appendix Y: Goods Movement Planning and draft 2021 San Diego and Imperial Counties Freight Gateway Study Update

Appendix Z: California State Wildlife Action Plan

Appendix AA: Regional Habitat Conservation Vision

Where is the habitat funding? We need a strong commitment to a regional funding source for habitat.

Page AA-1. The introductory paragraph – or a new second paragraph - should include a brief description of the relationship of SANDAGs existing TransNet program, the regional Multiple Species/Multiple Habitat Conservation programs and regional funding for habitat conservation and preserve management. Any significant differences in the proposed RTP/SCS from previous versions should be discussed later in this appendix.

Page AA-3. Figure AA.1. Recommend the map title be revised to “Existing and Proposed/Potential San Diego Region Habitat Conservation Lands” and change the legend to conform.

Page AA-6. The Regional Habitat Conservation Vision presumably applies across all of the lands within the SANDAG member agencies. Because the local jurisdiction and agencies have their own General Plans/Open Space Element, Climate Action Plans, and other

planning processes that would have direct effects on a regional vision, please provide more discussion regarding how this vision is expected to be integrated into the local jurisdictions' and agencies' plans. Such as, will SANDAG add staff to coordinate this effort, what new policies and projects would this require, will additional funding be identified and provided, etc.

Page AA-6. The Regional Funding section should add more information. We recommend adding more to the introduction of this issue. Begin the section with a new introduction: "A functioning and adequately funded set of regional habitat preserves is essential to this region's overall capability to address climate change. The benefits from habitat preserves range from meeting regulatory requirements associated with future development and ongoing operations and maintenance by the local jurisdictions; improving/enhancing the long-term potential for rare/threatened species and their habitats to adapt to climate change; providing for movement by species and vegetation communities as a response to climate change; and serving as a carbon sink. While these conserved and managed lands are part of the "baseline" condition relative to GHG emissions, they are valuable because natural areas remove CO2 and eliminate development potential." Also, revise the last part of this paragraph to state: "A regional funding source was proposed as part of a ballot measure (that failed) in 2016 to help offset the preserve implementation costs to local jurisdictions. Without a new regional funding source, securing crucial land acquisitions and long-term management and monitoring, which are essential to the success of these plans to protect species and their habitats from extinction, falls into question. In 2011, the estimated unfunded regional cost to ensure implementation of the regional habitat conservation plans was \$3.0 billion. SANDAG will work with the member agencies to develop and promote the establishment of the regional funding source that complements the infrastructure and operations components of the 5 Big Moves."

(Sierra Club) The Regional Plan must include a strong commitment to provide adequate funding for the Habitat Conservation Plans.

Page AA-6. Recommend revising the sentence "Connect habitat areas through wildlife corridors and linkages and connect people to local species and San Diego's natural habitats." to "Connect habitat areas through wildlife corridors and linkages, and enhance peoples' access, where appropriate, to natural habitat areas."

Page AA-7. Recommend adding a sentence to the end of the paragraph: "It is essential that the remaining habitat conservation plans be completed, which will then establish the necessary core habitat areas and key connections across the region."

Page AA-8. Recommend revising the following sentence "In addition to acquiring more properties to connect wildlife, in the following years, San Diego's North County will complete their MSCP, which will prioritize acquisitions that establish critical connections for high-risk species that reside in North County communities." To state "In addition to acquiring more properties to connect wildlife, in the following years, when the North and East County MSCPs are completed, they will prioritize acquisitions that establish critical connections for high-risk species that reside in North/East County as well as connections to preserve lands in Orange and Riverside counties."



Page AA-10. The paragraph that describes regional funding should reference - or reiterate - our recommended new statement (Page AA-6) regarding SANDAG's commitment to work with its member agencies to develop and establish a new regional funding source for habitat conservation.

Please incorporate these comments into the revised RTP/SCS and include them in the project's public record. Our contact for these comments is Bill Tippetts (billtippetts@gmail.com).[SWIA]

Appendix BB: Regional Aviation Strategic Plan and San Diego Airport Multimodal Accessibility Plan

Appendix CC: The 2020 Coordinated Plan

Appendix DD: 2021 Regional ITS Architecture Update Technical Memorandum/Primer

2021 Regional Plan Glossary

Appendix	Page	Section	Comment
A	General	General	Several projects that were in the Early Action Plan appear in Appendix A. How do the projects in the EAP differ than the projects here?
	General	General	In general, the dollar amount spent on managed lanes rather than mode-shift is concerning. More funding and increased timelines for active transportation & transit leap projects should be prioritized.
	A-14	TL58	How does the San Diego - Coronado Military Ferry connect to the Central Mobility Hub?
	A-42	Table A.13	In general, the Arterials section neglects to mention active transportation and public transportation facilities along arterial corridors. If SANDAG wants to get San Diegans out of their cars, then arterial streets need to prioritize pedestrians, bicycles, and public transportation over cars.
	A-42	CB04B	This intersection's bike lanes are in need of protection and better visibility for drivers. NCTD Bus 309 stops at this intersection as well, is SANDAG planning on providing any infrastructure improvements for bus and pedestrian connectivity?
	A-42	CB22	SANDAG should prioritize building safe active transportation infrastructure to and from the Carlsbad Poinsettia Station along this corridor. Sidewalks and bike lanes heading north disappear at the station, and this project makes it appear that SANDAG isn't planning on including those elements. SANDAG should not widen Avenida Encinas from Palomar Airport Road to Embarcadero Lane. Instead, SANDAG should keep the current configuration and build wide sidewalks and protected bicycle facilities.
	A-42	CB31	The bike lane along this segment of El Camino Real is often subject to vehicle intrusion. SANDAG should add protection to the bicycle facility here to keep cyclists safe.
	A-42	CHV69	SANDAG must include in this project upgrades the existing bicycle connection to the North Island Credit Union Amphitheatre. The currently existing Class II lanes on Heritage Road are often subject to vehicle intrusion.
	A-42	CNTY14A	SANDAG must build Class IV protected bike lanes in addition to pedestrian safety improvements along this corridor to improve connectivity to the Sprinter and NCTD Busses 305 & 332.
	A-43	CNTY21	Additional pedestrian safety measures are needed for the Overpass at SR-67, including bulb-outs and more visible crosswalks.
	A-43	CNTY34	SANDAG must be specific about what bike facilities are planned for the Dye Road Extension in Ramona.
	A-43	CNTY98	The current condition of Otay Lakes Road has Class III bike facilities. What facilities are planned for this project?
	A-43	ESC04	SANDAG has forgotten to include what happens to the currently-existing Class II buffered bike lanes with this project. Bicycle lanes should be included in the bridge design over Escondido Creek.
	A-43	ESC08	SANDAG should include safe bicycle facilities in this project.
	A-43	ESC24	What intersection improvements are planned? How will SANDAG maintain or upgrade the existing bicycle facilities? In addition, Mission Road is misidentified. The street becomes Mission Avenue after it crosses I-15.
	A-43	NC01	SANDAG should include safe bicycle facilities in both Phase II and Phase III of this project.
	A-43	O22	The street Avenida de la Plata is misspelled here. SANDAG should add protected bicycle facilities along this corridor.
	A-44	SD34	SANDAG has forgotten to include what happens to the currently-existing Class III sharrows with this project. Bicycle lanes and sidewalks should be included in the design to connect to future planned bus service at Via de la Valle.
	A-44	SD70	What bridge is SANDAG planning on replacing? These bridges are extremely busy and bicycle facilities should be protected Class IV, not Class II.
	A-44	SM19	The six-lane arterial street from Craven to Grand Avenue must include safe, protected bicycle infrastructure to provide a complete network. The intersection of Craven Road and Discovery Street should be redesigned to close the slip lane and provide safe crossing for cyclists and pedestrians.
	A-44	SM24	SANDAG should add protected bicycle lanes along this project, and include a safer pedestrian crossing under SR-78.
	A-44	SM31	The proposed widening of Discovery Street from Via Vera Cruz to Craven Road must include safe, protected bicycle facilities and pedestrian infrastructure.
	A-44	SM32	This project must include safe, protected bicycle facilities and pedestrian infrastructure to provide network connectivity.
	A-44	SM42	This project must include safe, protected bicycle facilities and pedestrian infrastructure to provide network connectivity to CSU San Marcos.
	A-45	SM48	This project's bike path should not meander, but provide clear connectivity along the route to promote bicycle commuting.

	A-45	SM69	The intersection of Twin Oaks Valley Road and Barham Drive in San Marcos is currently hostile to pedestrian and bicycle traffic, with slip-lanes and disappearing bicycle lanes. What plans are in place to increase use of active transportation at this intersection?
	A-45	CB212	What classification of bicycle facilities are being planned for College Boulevard Reach A?
	A-45	CNTY35	What classification of bicycle facilities are being planned for the Ramona Street Extension? SANDAG should also consider re-striping and adding more signage to Ramona Street's currently-existing lanes.
	A-45	SD190	What bicycle facilities will SANDAG include in the Palm Avenue Bridge project?
	A-54	Table A.17	Support for increased funding for GO by BIKE, and an e-bike incentive program.
	A-54	Table A.18	What is the cost breakdown of the local bike program?
	A-55	Table A.19	SANDAG should consider incentivising alternative cargo delivery vehicles for local delivery services under this table. For example, incentivise the usage of cargo e-bikes for parcel delivery in dense, urban neighborhoods.
	A-68	Figure A.11	Segments of the Bayshore Bikeway that are already completed seem to be missing from this map.
<b>B</b>	B-4	3 (b)	Support updating the evaluation and monitoring procedures of projects using TransNet local streets and roads funds, including prioritization of safety for vulnerable road users in the development of complete streets. The procedures should include a mechanism for the public to comment.
	B-4	3 (c)	Support the development of a Regional Active Transportation Plan, including updating the San Diego Regional Bike Plan to reflect need for safe bicycle infrastructure county-wide.
	B-4	3 (d)	Support the development of a Regional Vision Zero Action Plan, including a Regional Safety Policy. This regional safety policy should establish clear procedures that allow for the collection of accurate crash data, and the usage of that data to make changes to dangerous designs.
	B-7	7 (a)	Support the implementation of the 2021 Regional Transportation Improvement Program (ETIP) & building bike early action program projects
	B-7	7 (d)	Support building projects with an emphasis on safety for all road users to implement Vision Zero
	B-7	8 (b)	Support for updating evaluation criteria and provisions of SANDAG grant programs to improve social equity, advance roadway design with an emphasis on safety for vulnerable road users, implement climate action plans, and others listed.
	B-8	8 (e)	Support for incentivizing implementation of complete streets projects that complement regional investments within Mobility Hubs, along Complete Corridors, and supporting Flexible Fleets. We absolutely support a formalized Quick Build implementation program that develops complete streets solutions.
	B-9	9 (g)	Support for transportation demand management grant and incentive programs, including e-bike, carpool, and vanpool incentives
	B-10	10 (a)(b)(c)(d)(e)	Support for policies outlined under this heading
	<b>D</b>	D-8	Table D.3
D-8		Table D.3	What model is SANDAG using to determine that 36% of privately owned bikes will be e-bikes by 2035?
<b>E</b>	E-2	Housing	Support the addition of using Housing as a Performance Indicator.
	E-2	Quality of Life	Support the addition of using unemployment, social equity, telework, and homelessness as a Performance Indicator.
	E-3	Transportation Planning	Support the addition of using Bike Lane Miles and Annual Transit Ridership as a Performance Indicator.
	G-50	3.0	Support the inclusion of SANDAG's Commitment to Equity Statement
	G-50	3.1	Support for Social Equity and Environmental Justice Considerations
	G-51 & G-52	3.2 - 3.5	Support for working in partnership with Tribes, Mexico, Military, and other stakeholder agencies
	G-53	4.0, Table 1, Public Workshops	Rather than increasing the amount of public workshops by an arbitrary number (10%), SANDAG staff should use data to calculate public engagement by geographic region throughout the county, and use that data to determine low engagement rates where more public workshops are needed.

G	G-53	4.0, Table 1, Pre-document consultation	Add: "Gather an additional" to "5,000 individual remarks" so context is more clear
	G-53	4.0, Table 1, Opportunities for engagement	Rather than "increasing variety of platforms for public engagement by 15%", the goal should be to re-evaluate the effectiveness of current platforms being used during a certain time period and then determine if another platform could be more effective. In addition, special topic/targeted workshops should be made available in as many languages as possible and include dedicated outreach to stakeholder groups who have not participated in or have been historically excluded from the public engagement process prior to the 2021 Draft Regional Plan.
	G-57	Appendix A.1	In order to reach a younger audience, "San Diego County Media Outlets" should be expanded to include student publications at the region's school systems and colleges/universities. In addition, many young people engage with social media accounts for local news information, so SANDAG should research where they could make an impact through social media channels besides their own.
H	H-15	Existing Conditions in Disadvantaged Communities in the Region	SANDAG notes that 5.7% of households in the region have "zero vehicles available" but hasn't defined what a vehicle is outside of being "dependent on transit services." How does SANDAG define "transit services?" If a person didn't own a car, but used a personal bike, skateboard, or rented a micro-mobility solution to travel, would that person be considered as "not having access to a vehicle"?
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K	K-29	5: Objectives and Factors	Support the promotion of shared-use mobility, including bike sharing
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August 4, 2021

San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, CA 92101.  
Attn: Coleen Clementson

**RE: Airport Authority Comments on Draft 2021 Regional Plan**

Ms. Clementson:

On behalf of the San Diego County Regional Airport Authority (Airport Authority), I am submitting this comment letter in response to the Draft 2021 Regional Plan (Draft Plan) released by the San Diego Association of Governments (SANDAG) for public review on May 28, 2021. The Airport Authority acknowledges SANDAG's hard work over the last 3 years in developing a new vision for the region's surface transportation system and appreciates the opportunity to provide productive feedback on it.

Created in 2003, the Airport Authority is responsible for operating San Diego International Airport (SAN) and planning for the region's long-term air transportation needs. SAN is the only major commercial airport in the region, connecting San Diego to over 70 domestic and international markets and generating over \$12 billion annually in local economic benefit. In addition, the Airport Authority acts as the Airport Land Use Commission in the County of San Diego, pursuant to the California State Aeronautics Act, to help ensure compatibility between all 16 airports in the region and future land use development in the surrounding areas.

As SANDAG further refines the 2021 Regional Plan, and completes its environmental review under the California Environmental Quality Act, the Airport Authority requests that the following items be considered:

**1. Aligning Air & Surface Transportation Planning**

In 2011, the Airport Authority and SANDAG led the development of a Regional Aviation Strategic Plan (RASP) and Airport Multimodal Accessibility Plan (AMAP), respectively, to ensure a seamless and efficient connection between the region's air and surface transportation infrastructure. The Draft 2021 Regional Plan's Appendix BB (page BB-1) states that "routes included in the 2011 AMAP continue to be identified in the 2021 Regional Plan." However, the following

ground access improvements, which were prioritized in the 2011 AMAP, do not appear to be programmed into the Draft Plan:

Page 2 of 6

*San Diego International Airport*

- Heavy Rail Grade Separation (Whitherby St. to Laurel St.)
- I-5 Direct Access Ramps

*McClellan-Palomar Airport*

- Palomar Airport Road Widening (I-5 to Hidden Valley Rd.)
- Additional Airport Access at Owens Ave.
- Modification of Future Route 445

*Gillespie Field*

- Gillespie Field Trolley Station Relocation
- New Bus Rapid Transit (BRT) Station
- Marshall Avenue Intersection Improvements
- BRT Routes (90, 870, & 890) Modifications

*Cross Border Xpress*

- SR 905/Britannia Interchange Capacity Increase
- Britannia Road Widening
- Siempre Viva Road Widening
- Local Bus Route (661) Modifications

As such, the Airport Authority requests that the 2021 Regional Plan clarify whether these AMAP-identified priorities will be implemented or have been substituted with alternative implementation options.

**2. Connecting Regional Transit Network to SAN**

The Airport Authority has been working closely with SANDAG and other public agency partners to identify opportunities to better connect SAN to the regional transit network. As noted in the Draft 2021 Regional Plan, one of the concepts is a fixed-rail transit connection, such as an Automated People Mover (APM), between a Central Mobility Hub at the Old Town Campus and the SAN terminal area. This airport transit connection is anticipated in the Draft Plan to be built in 2035. The Airport Authority looks forward to continuing its collaboration with SANDAG to further refine the APM's alignment and station location concepts.

The 2016 Airport Transit Plan, which was developed in partnership between the Airport Authority, Metropolitan Transit System (MTS), and SANDAG, identified more near-term opportunities for increasing ridership on public transit to and

from SAN. As recommended in the Airport Transit Plan, the Airport Authority will be launching a new all-electric shuttle service to Old Town Transit Center this fall, in conjunction with the start of the Mid-Coast Trolley Extension operations and increased Coaster service frequency.

Another recommendation in the Airport Transit Plan is the transition of MTS Bus Route 992, which is currently the main transit connection to the Airport, to a Rapid Bus service. It also suggested that combining the new Rapid 992 with other Rapid bus routes, such as the 215 along the El Cajon Boulevard corridor and 235 along the Interstate 15 corridor, could improve airport transit ridership by better linking to major regional destinations and by increasing single-seat access to the San Diego International Airport.

As such, the Airport Authority requests that the 2021 Regional Plan assess the potential ridership benefits from upgrading MTS Bus Route 992 to a Rapid service and extending other existing and planned Rapid routes to serve the SAN terminal areas.

### **3. Considering Airport Compatibility in New Development Siting**

All 16 public-use and military airports in the San Diego region now have an adopted Airport Land Use Compatibility Plan (ALUCP), which provides guidance on appropriate land uses surrounding them to protect the health and safety of people and property within their vicinity. The Draft 2021 Regional Plan states in Chapter 1 (Page 12) that 3.7 million people will be living in the San Diego region by 2050 (13% greater than 2016 levels), creating a need for 440,000 more jobs and 274,000 more homes. Figure 2.4 (Page 27) in the Draft Plan identifies regional mobility hub areas that could accommodate this increased demand for jobs, housing, shopping, and recreation, while being served by expanded transit networks. In the Airport Authority's initial review, it appears that many of these hub areas are in close proximity to airports.

As such, the Airport Authority requests that the 2021 Regional Plan ensure that new incompatible land uses are not introduced near airports, as outlined in each ALUCP. The Draft Plan's Environmental Impact Report should also formally assess any land use conflicts with the applicable ALUCPs. Important factors include:

- Limiting new noise-sensitive development within an airport's noise contours and ensuring that any new noise-sensitive development includes sound insulation

- Prohibiting certain sensitive land uses within an airport's safety zones and limiting the number of people in areas subject to the highest risk of aircraft accidents
- Assuring aircraft safety and preserving airport operations by limiting the height of new structures and objects

#### 4. Clarifying SAN Air Cargo Information

The Draft 2021 Regional Plan acknowledges the importance of air cargo in moving goods into and out of the region. Specifically, Appendix Y of the Draft Plan discusses freight movement between the region's highways and arterials, rail corridors, land ports of entry, maritime port, and the San Diego International Airport. The Airport Authority has identified the following inaccuracies in the presented narrative and data:

- Page 21 in Appendix Y states that "when combined with the rate at which trucks produce emissions per day, neighborhoods in close proximity to the airport are put at a higher [air quality] risk" without citing any environmental impact study to substantiate this conclusion.

The Airport Authority has ensured that current and future emissions from the San Diego International Airport's activities are included in the most recent 2020 State Implementation Plan (2020 SIP) for attaining air quality standards in the San Diego region under the federal Clean Air Act. The 2020 SIP determined that SAN's emissions can be accommodated without causing the region to experience additional exceedances of criteria pollutant standards.

- Figure 2.10 in Appendix Y is an outdated map of SAN, which doesn't properly reflect the airport property boundaries and onsite aeronautical uses.
- Page 78 in Appendix Y incorrectly states that Capital International Cargo operates at SAN.
- Page 78 in Appendix Y includes statements that air cargo operations are constrained due to limited airport space for expansion.

As identified in its 2013 Northside Improvements Environmental Assessment, the Airport Authority is proposing a new *SAN Northside Cargo Development* project. The project would include a consolidated



warehouse to fully accommodate onsite cargo sorting and staging, as well as expanded apron to accommodate additional cargo aircraft parking.

Additionally, the Airport Authority opened a new 93,000-square-foot Airline Support Building on North Harbor Drive this year, which will allow for more efficient processing of bulky cargo items shipped in the bellies of passenger jets. Approximately 15% of SAN's freight volumes are transported as "belly cargo."

- Page 78 in Appendix Y relies on the outdated 2009 Destination Lindbergh Study to estimate SAN's air cargo capacity and identify cargo operational deficiencies.

The FAA approved the most recent SAN aviation activity forecast in June 2019, which is publicly available at [www.san.org/plan](http://www.san.org/plan). The forecast anticipates that the number of cargo aircraft operations (i.e. takeoffs or landings) will increase by nearly 71% by 2050, even with the Airport's single-runway configuration.

As such, the Airport Authority requests that the 2021 Regional Plan be updated to incorporate the more accurate information presented above.

##### **5. Updating Airport Ground Access Modeling Assumptions**

Similar to other regional transportation plans, the Draft 2021 Regional Plan relies on an integrated forecasting model to determine future population, housing, and employment growth. This information is then applied to an activity-based model to simulate detailed transportation behaviors, such as where, when, and how people travel on a daily basis.

On page 20 in Appendix C, the Draft Plan states that its model relies on airport passenger survey data from 2008 to estimate airport-related travel patterns and demands on local and regional transportation facilities. The Airport Authority notes that ground access characteristics have changed dramatically over the last decade, especially with the introduction of rideshare companies. The Airport Authority also noticed that the modeling appears to be based on SAN aviation activity forecasts that were developed in 2013 (Figure S.18 in Appendix S). As previously stated, the FAA approved the most recent aviation activity forecast in June 2019, which is publicly available at [www.san.org/plan](http://www.san.org/plan). The new "constrained demand scenario" forecast estimates that SAN will serve approximately 20.3 million enplaned passengers in 2050.

As such, the Airport Authority requests that the 2021 Regional Plan's modeling be updated to be based on more accurate modal assumptions for airport users and the more recent SAN aviation activity forecast.

Page 6 of 6

Again, the Airport Authority appreciates the opportunity to provide feedback on the Draft 2021 Regional Plan. Please feel free to contact me at [breed@san.org](mailto:breed@san.org), if you have any questions or need additional information.

Sincerely,



**Brendan Reed**

Director of Airport Planning & Environmental Affairs

cc: Dennis Probst, Airport Authority, Vice President - Development  
Ted Anasis, Airport Authority, Airport Planning Manager  
Ralph Redman, Airport Authority, Airport Planning Manager  
Michelle Brega, Airport Authority, Senior Director of External Relations  
Matt Harris, Airport Authority, Director of Government Relations

## Questions Regarding the 2021 RTP- Revenue and Cost Estimates

1. What assumptions (i.e. debts service and length of projects) are going into estimating costs in YOY dollars?
2. All existing TransNet funding has been claimed by currently running projects. How is the \$15 billion in TransNet funding estimated? Is the \$15 billion based on the assumption that San Diego voters will approve of a new extension to the program in 2024? How much of the \$15 billion relies on the assumption that there will be TransNet revenue between 2048 and 2050?
3. Is the Quarterly TransNet Forecast a reliable source for estimating revenue from the Transportation Development Act (TDA) even though there have been observed “small differences” in TransNet and TDA growth rate? Is TDA growing faster than TransNet, or is it the other way around?
4. Has the growth of General Fund/Miscellaneous Local Road Funds been linear historically? Are you assuming that they will continue to be linear (why or why not)? If the 5-year average growth in these funds is 2.7, how did you derive a 3% growth during the period of the 2021 RTP implementation. Is this a weighted average or an average of averages across jurisdictions?
5. How much of the value capture estimate (2.7 billion) relies on the estimated value of Central Mobility Hub Enhanced Infrastructure Financing as opposed to existing agreements and programs?
6. What is the Managed Lanes Feasibility Tool mentioned in Appendix V? What model or data did SANDAG use to estimate the \$22 billion from FasTrak revenue?
7. How did SANDAG achieve a passenger farebox recovery rate of 35%, and what is the basis of SANDAG’s assumption that the recovery rate will be linear? Is the assumption that operating costs would be linear and that farebox recovery would follow the same linear growth? With proposed free fares, how will the estimated revenue be achieved?
8. What will be the source of funding for reduced or free fares? Is it sales tax based?
9. **What source of revenue is each project listed in Appendix A tied to? If a source of revenue runs low, are there alternative ways to fund the projects associated with that source of revenue?**
10. **What is the timeline for the development of each of the projects in Appendix A? Are delays in these timelines considered in the cost estimates?**
11. Have there been or will there be changes in the 2021 RTP to account for the impacts of the Covid-19 pandemic? Is SANDAG assuming that the effects of the pandemic on people’s lifestyles and the economy will be short term? How do SANDAG’s assumptions about the pandemic impact the RTP?
12. Are there technological assumptions as well in the RTP? Is the plan based on all current technology, or are there plans that are based on expected future technology? If some plans are dependent on future technology, how are you making sure that people will feel comfortable with using the new technology?
13. Have there been changes related to the 2021 RTP already? If so, is there any feedback from users? Please provide a detailed response.

14. What assumptions are made in the Transit Leap Capital Cost Estimate? Based on observed figures in the SF Bay Area, it seems that, for commuter rail alone, every mile requires \$1 billion. How does \$55 billion for all Transit Leap capital costs break down into its modes? Answer to question 9 would probably address this if sufficiently detailed. .
15. Since \$27.7 billion of the total estimated revenue will depend on the Regional Road User Charge, It seems that SANDAG is confident that the fee will be implemented in 2026. Why does SANDAG think that this fee would be popular among San Diego voters? Is the \$27.7 billion based on the assumption that every kind of vehicle will be charged? If the fee is not approved by voters, is there a source of revenue that would replace it?
16. The total estimated revenue is about \$30 billion more than the total estimated expenditure (in YOY dollars) for the 2021 RTP. Where would the extra revenue go?
17. What is the assumption for increase in construction costs? What is the assumption for inflation? Do the construction cost estimates take into account both an increase in construction costs and inflation in the conversion to \$2020?
18. Who participated in the peer review of your models and assumptions?
19. What is the time period when State Transit Assistance funding is expected to grow at 3% per year versus 5% per year? Is SANDAG's goal to encourage use of public transportation being considered in making assumptions about the growth rate of STA revenue?
20. Does the State Highway Operations Protection Program only last for 10 years? When did it start, and, if it only lasts a decade, how will it be able support the 2021 RTP projects throughout their lifetimes?
21. How much of the Cap-and-Trade Revenue is, separately, from the Transit and Intercity Rail Capital Program, Affordable Housing and Sustainable Communities program, and Carbon Transit Operations program? Given that the Transit and Intercity Rail Capital Program and AHSC are competitive programs, how are revenues from these programs estimated through 2050? Is there a source that shows prior success in receiving the competitive funds?
22. What percentage of total revenues are assumed to come from competitive funding sources?
23. Why are Motorist Aid Services mentioned twice as a source of revenue (once as state and once as local revenue)? Are they referring to different sources of revenue?
24. SANDAG assumes that the State FASTLANE will receive 20% of the state share of TCEP. In 2020, the revenue reflected 19% of the shares. How much does 1% represent in funding money? Also, what is the basis for the different growth rate estimates?
25. How much of the \$2.8 billion in revenue estimate from State Managed Federal Programs come from each of the programs? What is the basis for the assumption that there would be additional revenue from Federal Highway Administration discretionary funds, and how much of the \$2.8 billion depends on it? What is the basis for each of the estimated growth rates?
26. What is the short-term growth rate of the Solutions for Congested Corridors program that funds the Road Maintenance and Rehabilitation Account?

27. How much of the revenue from the Federal Transit Administration Formula programs go to Sections 5307, 5337, 5339, and 5310 each? What is the basis for the change in the growth rate of this revenue from 2% per year to 10% per six years?
28. What is the basis for the assumption that the growth rate of CMAQ and regional STP revenue will change from 5% annually to 10% per six years in 2030?
29. What is the growth rate of the Federal Highway Administration Discretionary revenue before 2030? What is the basis? What is the basis of the growth rate estimation beyond 2030? What years are the estimates based on?
30. How was the \$294 million in Grant Anticipation calculated?
31. Are Ridehailing Company Service Fees anticipated to be on the 2024 ballot? Do ride hailing companies, separately, have to pay for the Road User Charge? What is the basis of the assumption that Ridehailing Company Service Fees would be popular among voters?
32. Have other states been successful so far in transitioning to a Road User Charge?
33. How is the growth rate of Regional Road User Charge revenue 2.7% until 2050 when the assumption is that more people will use transit, as opposed to personal vehicles, with the success of the 2021 RTP?
34. Which projects would be eliminated if Federal and State discretionary grants were not received?
35. What projects would be impacted if the New Sales Tax and MTS Local Revenues measures do not pass?
36. How do the Federal Transit Administration and CMAQ estimated growth rates reflect revenue from recent years?
37. What is the impact of reduced VMT on revenues from fuel taxes and tolls. Is this accounted for?
38. Current Transportation Development Act (TDA) funds are currently used to support existing transportation services and state of good repair capital projects. Are the \$7.6 billion TDA revenues in Appendix V existing TDA revenues or new sources of TDA revenues?
39. Where can we find the “2021 Regional Plan Transit Operations Costing” Excel workbook mentioned in Appendix U?

Please Fill out the tables on the following pages.







## State Revenue Estimates

Source of Revenue : State	Growth Rate (Short Term and Long Term)	Support for and assumptions behind Growth Rate Estimate	Is there an assumption that there will be changes in the growth rate through 2050? If so, why is the growth rate increasing/ decreasing? If not, why not?	Model(s) and Data that Support Revenue Estimate	What year(s) is the Data from and Why?	Reliability - Should this be the standard for the SD region?	If this source of revenue is competitive, what is the basis of the assumption that SANDAG will secure the estimated revenue?	On a scale of conservative to ambitious, where does this revenue estimate stand?	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens through 2025	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens between 2025-2035?	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens between 2035-2050?
State Transportation Improvement Program - Regional Shares											
State Transportation Improvement Program - Interregional Shares											
State Transit Assistance											
State											



## Federal Revenue Estimates

Source of Revenue: Federal	Growth Rate (Short Term and Long Term)	Support for and assumptions behind Growth Rate Estimate	Is there an assumption that there will be changes in the growth rate through 2050? If so, why is the growth rate increasing/decreasing? If not, why not?	Model(s) and Data that Support Revenue Estimate	What year(s) is the Data from and Why?	Reliability - Should this be the standard for the SD region?	If this source of revenue is competitive, what is the basis of the assumption that SANDAG will secure the estimated revenue?	On a scale of conservative to ambitious, where does this revenue estimate stand?	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens through 2025	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens between 2025-2035?	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens between 2035-2050?
Federal Transit Administration Discretionary											
Federal Transit Administration Formula Programs											
Congestion Mitigation and Air Quality Improvement/Regional Surface Transportation Programs											





### Estimates from New Sources of Revenue

New Revenue s	Growth Rate (Short Term and Long Term)	Support for and assumptions behind Growth Rate Estimate	Is there an assumption that there will be changes in the growth rate through 2050? If so, why is the growth rate increasing/decreasing? If not, why not?	Model(s) and Data that Support Revenue Estimate	What year(s) is the Data from and Why?	Reliability - Should this be the standard for the SD region?	If this source of revenue is competitive, what is the basis of the assumption that SANDAG will secure the estimated revenue?	On a scale of conservative to ambitious, where does this revenue estimate stand?	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens through 2025	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens between 2025-2035?	Sensitivity - If you change rate by $\pm 0.1\%$ , what change happens between 2035-2050?
Future Local Revenues											
Future MTS Local Revenues											
Ridehailing Company Service Fees											
Future State Revenues for Transportation											
Regional Road User Charge											
State											





## Details Requested by NCTD

### Project Information Request

Project	Estimated Total Project Cost	Current Planned Year of Construction	Draft RTP Assumed Year of Construction	Assumed Federal/State Matching Funding (%)
San Dieguito Lagoon Double Track and Platform				
Batiquitos Lagoon Double Track and Bridge Replacement				
Eastbrook to Shell Double Track				
Carlsbad Village Trench				
La Costa to Swami Double Track				
San Onofre Bridge Replacements				
Rose Canyon Bridge Replacements				







August 6, 2021

SANDAG Board of Directors  
401 B Street  
San Diego, CA 92101

## **RE: Recommendations on how to include San Diego's 10 Transit Lifelines in the Regional Plan**

Respected Chair Blakespear and Board Members,

The San Diego Transportation Equity Working Group (SDTEWG) and ally organizations support the 10 Transit Lifelines and request their inclusion in the 2021 Regional Plan (RP). They represent the priorities that residents at the frontlines of the climate crisis in Barrio Logan, City Heights, and National City have identified through a community-driven process. Though identified by South Bay residents, the 10 lifelines reflect a vision to advance affordable and frequent transit solutions that will benefit all San Diegans.

The San Diego Transportation Equity Working Group was established in 2018 by community-based organizations in an effort to elevate transportation and environmental justice opportunities in Mid-City and South Bay for years to come. The core organizations are the Center on Policy Initiatives (CPI), City Heights Community Development (CH CDC), Environmental Health Coalition (EHC), Mid-City CAN (MCC), and San Diego 350 (SD350). Supporting organizations include Casa Familiar (CF) and the Urban Collaborative Project (UCP). The SDTEWG core organizations took a closer look at the Draft Regional Plan and would like to offer recommendations on how to best reflect inclusion of the 10 Transit Lifelines in the RP.

### **The 10 Transit Lifelines & Recommendations**

#### **1. A Regional Plan that Prioritizes environmental justice:**

Demonstrate environmental justice (EJ) communities are a priority by identifying projects that will improve their access to public transportation by 2025. These primarily low-income communities of color face the most pollution in the San Diego region and rely most on transit. The projects should include the development of a Safe Routes To Transit strategy and an early action project Mobility Hub at Euclid Transit Center.

#### **Recommendation:**

Include an equity specific project list as part of *Appendix A: Transportation Projects, Programs, and Phasing* document that provides all details including the expected project completion year.

#### **2. Youth opportunity Passes (YOP):**

Provide no-cost transit passes for all youth ages 24 and under to build generations of lifelong transit riders and connect youth to school, work, internships, and early career opportunities.

**Recommendation:**

Amend the Plan to explicitly state that transit fare subsidies will be allocated to fund no-cost transit for youth ages 24 and under. The plan currently lacks a commitment to no-cost passes for this age group.

**3. Bus service every 10 minutes:**

Make bus service reliable and affordable now – we can't afford to wait. Buses are one of the most cost-effective ways to get us where we need to go while cutting climate pollution. We need immediate solutions while big infrastructure projects are being built.

**Recommendation:**

Projects TL63, TL64, and TL65 on page A-52 of Appendix A, should include cost and bus frequency improvement details to demonstrate they will be prioritized, particularly those planned to be completed 2025. Simultaneously, only one of all the Transit Leap projects within the South Bay to Sorrento Corridor has a 2025 year implementation. The Transit Leap rapids listed on page A-12 through A-14 that will service environmental justice communities should be prioritized for a 2025 completion. Finally, MTS should be included as an agency to collaborate as part of the partnerships listed on page B-3 of Appendix B and near-term actions for the implementation of bus frequency enhancements.

**4. Blue Line express:**

Build a 24-hour Express Blue Line. The Blue Line already has the highest ridership and is one of the best-performing transit lines in the region. However, it is overcrowded, has limited frequency, delayed connections, and no 24-hour service.

**Recommendation:**

The RP needs to outline clear construction of an additional track that can provide express 24-hour service. Currently, the project details fail to demonstrate that a third track will be implemented. According to project description TL13 on page A-14, a Blue Line (San Ysidro to UTC, Double/Third tracking and Grade Separations at Taylor/Ash) are planned for a 2050 implementation.

**5. 24-hour service:**

By 2025, provide 24-hour service on popular transit routes to connect workers to their destinations. Participants in San Diego's MTS community engagement efforts ranked this as their highest priority.

**Recommendation:**

Project ID TL63, TL64 and TL65 should include bus frequency increase to 24 hours. As well as all the Transit Leap projects within the South Bay to Sorrento that will service environmental justice communities.

**6. The Purple Line:**

Fund the planning, environmental, engineering, and construction work for the Purple Line as a rail line that connects environmental justice communities in central City Heights and the South Bay to Sorrento.

**Recommendation:**

The detailed ridership analysis of the Purple Commuter Rail alignment listed on page A-15 is promising and points to a purple line that will include stations in City Heights. The RP should include project phasing that prioritizes the development of stations in central City Heights and the South Bay region with a 2035 project completion.

**7. An all-electric bus fleet by 2030:**

Accelerate the electrification of buses, because our communities cannot afford to wait 20 years to breathe cleaner air and reduce climate pollution.

**Recommendation:**

The transition to zero-emission buses, including rapid routes, should be accelerated for a 2030 completion with the support of recently approved state and federal funding sources. Page A-53 outlines program investments for Zero-Emission Buses and Infrastructure. The funding should be redistributed to prioritize the program's implementation to meet the 2030 completion goal.

**8. Anti-displacement strategies:**

Protect low-income communities of color living near transit corridors from gentrification with proactive strategies that include building affordable housing while preserving naturally occurring affordable housing, community ownership, and tenant protections. We need comprehensive solutions!

**Recommendation:**

We commend SANDAG for including a Regionwide Displacement Study for near-term implementation. The study is listed on page B-3 of Appendix B and should be completed before the adoption of the RP in order to truly inform and prevent displacement due to the plan's implementation.

**9. Restroom access:**

Create a plan to make restrooms available to the public and provide MTS with funding for a clean and accessible restroom network with access at all major transit stations.

**Recommendations:**

Include restroom access as an item in the capital operations budgets. The 2021 Regional Plan states that "mobility needs to be widely accessible, affordable, easy to use, and tailored to a person's individual needs. In short, mobility must be viewed as a basic human right". State-of-the-art bathrooms are mobility and key to a successful transit system.

**10. Emergency-ready transit system:**

Provide transit for environmental justice communities to evacuate during emergencies. EJ communities are more vulnerable to climate disasters and more likely to live near industries, military operations and other dangerous activities that may have accidents that cause fires, leak toxins, and other crises.

**Recommendations:**

Include a study and implementation strategies to establish an emergency-ready transit as part of the near-term action in Appendix B within the Social Equity Planning Framework section.

Finally, the SDTEWG strongly recommends that SANDAG develop an equity pricing program, a Next OS equity plan, and policies that safeguard the privacy of Black, Indigenous, People of Color (BIPOC). The SDTEWG supports the efforts to implement a regional pricing strategy and the Next OS as long

as they are implemented with an equity framework, which is not reflected in the Draft RP. All regional pricing strategies must include mechanisms to protect low-income families who cannot afford to pay to be able to drive. All Next OS infrastructure should give development priority to environmental justice communities. And, policies must be in place to ensure data collected does not target BIPOC or use the information to over-police our communities.

Sincerely,

**The San Diego Transportation Equity Working Group (SDTEWG)**

**Center on Policy Initiatives** Keara Piña

**City Heights Community Development Corporation**, Randy Torres-Van Vleck

**Environmental Health Coalition**, Laura Benavidez & Carolina Martinez

**Mid-City CAN**, Diana Ross

**SanDiego350**, Toshihiko Ishihara & Steven Gelb





Honorable Members of SANDAG Board of Directors  
 401 B Street, Suite 800  
 San Diego, California 92101  
 Sent via Email: [clerk@sandag.org](mailto:clerk@sandag.org)

RE: Include the 10 Transit Lifelines in the 2021 Regional Plan

Chair Blakespear and Honorable Members of the SANDAG Board of Directors:

The San Diego Transportation Equity Working Group and ally organizations support the 10 Transit lifelines and request their inclusion in the 2021 Regional Plan (RP). They represent the priorities that residents at the frontlines of the climate crisis in Barrio Logan, City Heights, and National City have identified through a community-driven process. Though identified by South Bay residents, the 10 lifelines reflect a vision to advance affordable and frequent transit solutions that will benefit all San Diegans.

Environmental Justice (EJ) communities are at the frontlines of toxic air pollution and the nearing climate disaster. The RP is the region's biggest opportunity to dramatically address the course of climate change in the region. According to Appendix X of the SANDAG 2021 Draft Regional Plan, "passenger car and light-duty vehicles emissions category is the largest contributor of GHG emissions in the San Diego region, accounting for **41% of total GHG emissions.**" In addition, "**only 7%** of our region's low-income residents have access to fast and frequent transit"<sup>1</sup>. According to the American Lung Association, San Diego **has the seventh - worst**

<sup>1</sup> SANDAG, Data Driven Process, <https://sdfoward.com/mobility-planning/data-driven-planning> Accessed July 27, 2021.

ozone pollution in the U.S.,<sup>2</sup> and EJ communities are disproportionately impacted. Inadequate investment in the mass transit system harms our most vulnerable communities' health and quality of life.

The RP should include EJ specific solutions to be completed by the year 2025. The climate emergency is here and frontline communities cannot continue to wait for relief. The RP is a visionary document by nature, however, it must outline immediate benefits to improve the region's economy, quality of life and sharply reduce air pollution and GHGs in most climate-impacted communities.

## 10 Transit Lifelines Summarized Descriptions

1. **A Regional Plan that Centers Environmental Justice:**  
Prioritize environmental justice (EJ) communities by identifying projects that will improve their access to public transportation by 2025, which should include the development of a Safe Routes To Transit strategy and an early action project Mobility Hub at Euclid Transit Center.
2. **Youth Opportunity Passes (YOP):**  
Provide no-cost transit passes for all youth ages 24 and under to build generations of lifelong transit riders and connect youth to school, work, internships, and early career opportunities.
3. **Bus Service every Ten Minutes:**  
Make bus service reliable and affordable now - we can't afford to wait. Buses are one of the most cost-effective ways to get us where we need to go while cutting climate pollution.
4. **Blue Line Express:**  
Build a third track for a 24-hour Express Blue Line. The Blue Line already has the highest ridership and is one of the best-performing transit lines in the region.
5. **24 Hour Service:**  
Connect late-night and early-morning workers by 2025. Provide 24-hour service on popular transit routes to connect workers to their destinations.
6. **The Purple Line:**  
Fund the planning, environmental, engineering, and construction work for the Purple Line as a rail line that connects environmental justice communities in central City Heights and the South Bay to Sorrento Valley.
7. **An All-electric Bus Fleet:**  
Accelerate the electrification of buses, because our communities cannot afford to wait 20 years to breathe cleaner air and reduce climate pollution.
8. **Anti-displacement Strategies:**  
Protect low-income communities of color living near transit corridors from gentrification with proactive strategies that include building affordable housing while preserving naturally occurring affordable housing, community ownership, and tenant protections. We need comprehensive solutions!
9. **Restroom Access:**  
Create a plan to make restrooms available to the public and provide MTS with funding for a clean and accessible restroom network with access at all popular transit stations.
10. **Emergency-ready Transit System:**  
Provide transit for environmental justice communities to evacuate during emergencies. EJ communities are more vulnerable to climate disasters and more likely to live near industries, military operations and other dangerous activities that may have accidents that cause fires, leak toxins, and other crises.

We urge the SANDAG Board to support the 10 Transit Lifelines and ensure their inclusion in the 2021 RP.

---

<sup>2</sup> American Lung Association, <https://www.lung.org/research/sota/city-rankings/most-polluted-cities>, Accessed July 29, 2021

Sincerely,

**The San Diego Transportation Equity Working Group (SDTEWG):**

**Center on Policy Initiatives**, Researcher & Policy Advocate, Keara Piña

**City Heights Community Development Corporation**, Director of Policy & Planning, Randy Torres-Van Vleck

**Environmental Health Coalition**, Community Organizer, Laura Benavidez & Climate Justice Campaign Director, Carolina Martinez

**Mid-City CAN**, Executive Director, Diana Ross

**SanDiego350**, Transportation Committee, Toshihiko Ishihara, Phil Birkhahn & Steven Gelb

**Supporting Organizations:**

**Bayside Community Center**, Director of Programs and Operations, Rose M Ceballos

**Casa Familiar**, President & CEO, Lisa Cuestas

**Clean Earth 4 Kids**, Founder and Educational Director, Suzanne Hume

**Climate Action Campaign**, Transportation Policy Advocate, Noah Harris

**Coastal Environmental Rights Foundation**, Program Director, Sara Kent

**DSA San Diego Ecosocialist Working Group**, Member, Kyle Knoebel

**Environmental Center of San Diego**, Board of Directors, Pamela Heatherington

**Escondido Neighbors United**, Board Member, Laura Hunter

**First Unitarian Universalist Church of SD**, Social Justice Executive Team & Lead Minister, Reverend Kathleen Owens

**Hammond Climate Solutions**, Founder, Tara Hammond

**Interfaith Worker Justice San Diego**, Executive Director, Cheri Metier

**International Brotherhood of Electrical Workers 569**, Business Manager, Jeremy Abrams

**Muslim American Society**, National Executive Director, Ismahan Abdullahi

**Planned Parenthood**, Director of Public Affairs, Neal Ortiguerra

**Sierra Club San Diego**, Transportation Chair, David Grubb

**Southwest Wetlands Interpretive Association**, President, Mike McCoy

**Sunrise Movement**, Hub Coordinator, Alexander Han

**The Climate Reality Project San Diego Chapter**, Chair, Cherry Robinson Psy. D

**The Urban Collaborative Project**, Executive Director, Brian Pollard

**Transcen DANCE Youth Arts Project**, Co-Founder & Artistic/Executive Director, Cat Corral

**University Professional and Technical Employees CWA Local 9**, Vice President, Brooke Donner

**Youth Will**, Youth Organizer, Safia Haidari



Members of SANDAG Board of Directors  
401 B St.  
San Diego, CA 92101

**Re: 2021 Regional Plan**

Respected Chair Blakespear and Board Members,

SanDiego350 is an inclusive, mostly volunteer organization building a movement to prevent the worst impacts of climate change and climate injustice. We strive to create a future that supports a livable planet and just society through education and outreach, public policy advocacy, and mobilizing people to take action.

Previous regional transportation plans, including the 2015 plan, mistakenly prioritized freeway expansion over public transit, which resulted in increased air pollution and greenhouse gas emissions and the inability for those without cars to get where they need to go. Public transportation is a critical lifeline for many, especially the residents of environmental justice and low-income communities and people of color, to get to work, school, and services.

Only 7% of low-income residents have access to fast and frequent transit. Frontline communities have disproportionately experienced harm from transportation and land use policies, so solutions to restore equity to these groups should be prioritized, incentivized, and subsidized in SANDAG's climate strategy. Additional coordination with equity-based planning efforts will further support integrated and collaborative solutions. The infrastructure that links our network of homes, businesses, parks, and schools, must allow community members to meet their needs without driving.

The SANDAG Board has the power and responsibility to implement the bold vision that our communities need for universal mobility, and to reduce pollution and emissions. Therefore, SanDiego350 requests that the SANDAG Board ensures the 2021 Regional Plan recognizes and addresses, as described below, the climate challenges our region is facing and the needs of historically marginalized segments of our society.

### **1: Reduce GHG emissions from cars and light trucks to fight the Climate Crisis**

We ask you to meet bolder GHG emission reduction targets. Climate change is accelerating and its effects are devastating environmental justice communities. For our families and children to have a liveable future we cannot wait any longer to respond. Transportation accounts for half of the GHG emissions in the San Diego region. The targeted 20% reduction per capita of GHG emissions from cars and light trucks below 2005 levels by 2035 will have only a small impact on the GHG emissions from transportation, even if we successfully reach that goal. The emissions reduction goal must be at least 50% by 2030.

To rapidly reduce GHG emissions, we ask you to accelerate the timeline for development and improvement of transit (trolleys, trains, and buses) and active transportation (biking and walking). Also, the plan must include effective strategies to encourage a rapid shift away from cars to public transit and from fossil fuel burning vehicles to zero-emission vehicles. Managed lanes on freeways should be implemented to enable buses to run faster and on-time and so that they are a more attractive means of transportation than cars.

### **2. By 2023 or sooner, implement no-cost youth transit passes for those 24 and younger.**

This would advance social justice by helping youth, who often lack resources, to travel to education, employment, and services. This would immediately improve transit ridership numbers and contribute to transit being seen as a viable alternative to car travel.

Youth passes are an investment in the success of transit, as youth who are accustomed to using transit become adults who will choose buses and trains over cars.

### **3: Improve the transit system now to make it more frequent, reliable, accessible, affordable and fast.**

The 2021 Regional Plan must prioritize improvements in public transit. We need a real alternative now in order to begin the transition away from cars without delay. The current transit system needs to improve by increasing passenger capacity, frequency and service hours on popular lines to make it more convenient, reliable, accessible, and fast. This means 24 hour service and 10 minute frequency on many popular bus routes currently in service. This should be done immediately to introduce the public to a new transit era by providing MTS and NCTD with the necessary financial support.



### **3: Prioritize the needs of Disadvantaged, Environmental Justice Communities.**

Disadvantaged, Environmental Justice Communities, which disproportionately suffer from the effects of climate change, cannot afford to wait; they need immediate improvements while long-term infrastructure projects are developed. This means not building new roads, accelerating the Purple Line, and collaborating with MTS and NCTD to make improvements to the Blue Line and Sprinter and add Bus Rapid Transit routes to serve those communities.

We ask for the completion of the Purple Line via City Heights all the way to the border by 2035 instead of stopping in National City per the draft Regional Plan. That is because half of the Purple Line ridership will come from Chula Vista, Imperial Beach, and Tijuana. We also ask for enhancement to the Blue Line to reduce travel time from the border and South Bay region to downtown to provide faster access to the jobs in the downtown area.

Road improvements such as grade separations at railroad crossings should be included in the plan to reduce traffic gridlock, congestion, and idling that cause air pollution and health problems.

### **4: Transition to a Zero Emission Bus Fleet by 2030**

Fund the implementation of California's Innovative Clean Transit rule. Our communities of concern suffer with high levels of toxic pollution and cannot wait 20 years to reduce toxic and greenhouse gas emissions. Investment in zero emission buses now will improve residents' health and help people thrive in San Diego County. These actions taken now will save money in the long term. The scale of our ambitions must reflect the magnitude of the challenge. SANDAG must invest heavily in infrastructure to continue and accelerate that transition.

### **5: Identify Anti-Displacement strategies:**

Develop an anti-displacement strategy that includes affordable/low-income housing and preservation of existing affordable housing, community ownership, and tenant protections as part of the comprehensive solutions for any possible impacts of new transit infrastructures. We ask SANDAG to provide an update on the status of the anti-displacement study.

## **6: Develop an Emergency Ready Transit System:**

There is a need for Environmental Justice Community residents to have an escape route from a community - wide emergency situation such as occurred recently in a ship fire at the Port. We ask for planning and implementation of a transit emergency response strategy that is fully funded. Communities of concern are most vulnerable to climate disasters.

## **7: World Class Transit System with Amenities**

We ask for a truly world class transit system that all members of our society and visitors, regardless of their age and physical condition, can use without hesitation. This requires amenities including clean bathrooms at major transit stations and hubs, electronic information on trolley, train, and bus schedules, routes, and transfer information, seats and sun shelters at all stations and stops, safety provisions for all transit users including persons with disabilities. These amenities would provide comfort and dignity to all transit riders.

We urge the SANDAG Board to align the final 2021 Regional Plan with these recommendations.

Sincerely,

SanDiego350 Transportation Committee  
Bee Mittermiller, Chair



2 August 2021

Keith Greer  
San Diego Association of Governments  
Via electronic distribution  
[keith.greer@sandag.org](mailto:keith.greer@sandag.org) [SDForward@sandag.org](mailto:SDForward@sandag.org)  
[clerk@sandag.org](mailto:clerk@sandag.org)  
[pio@sandag.org](mailto:pio@sandag.org)  
[tessa.lero@sandag.org](mailto:tessa.lero@sandag.org)  
[hasan.ikhrata@sandag.org](mailto:hasan.ikhrata@sandag.org)  
401 B Street, Suite 800  
San Diego, California 92101

**RE: Comments on the 2021 Regional Plan Sierra Club San Diego Chapter**

Dear Mr. Greer:

Sierra Club San Diego has been a consistent voice for conservation and sustainable planning in the San Diego region for more than 70-years. Sierra Club is pleased to provide comments regarding the SANDAG 2050 Regional Transportation Plan (RTP). The scope and breadth of the RTP is immense and beyond mere descriptors of bold, aggressive, and futuristic. The concepts, scale and anticipated budget of the RTP are unprecedented, possibly in the entire state of California. The takeaway from this letter is this: SANDAG must work to procure the same aggressive funding for environmental protection and mitigation that was devoted to capital projects.

Sierra Club San Diego supports the goals and conceptual components of the RTP with a cautionary approach. There are concerns with the inherent capabilities of the Sustainable Communities Strategy (SCS) should the plans be revenue starved, bled, or never funded. These essential strategies are the underpinnings of future RTP project success, designed as guides for the San Diego region towards a more sustainable future by integrating land use, housing, and transportation planning to create communities that are conducive to being sustainable, walkable, transit-oriented, and compact.

The requirements of Senate Bill 375 codify the essential features of the RTP to protect and sustain our region's vital social, environmental, and economic resources, while making significant reductions in Greenhouse Gas (GHG) generation from autos and small trucks. All aspects of the RTP are important, although consistent and reliable funding of the plan requirements are essential to achieving the RTP goals. The very backbone of RTP realization is early environmental mitigation, planned, funded and ready to be implemented within San Diego County. The same careful planning should include provisions

for maintenance of the Multi Species Conservation Program (MSCP) and conserving Multiple Habitat Planning Areas (MHPA). Not only are these lands invaluable in their own right for the preservation of plant and animal species, they are essential to any Climate Action Plan due to their ability to sequester carbon.

***This initiative for early environmental mitigation is expected to expedite the implementation of transportation projects and reduce the costs associated with mitigation or permit delays.***

To be absolutely clear, Sierra Club endorses the earliest possible environmental conservation, mitigation, or remediation. Any delays associated with Capital projects should not reflect on the mitigation capabilities of the environmental community or SANDAG.

In the introductory section of the RTP numerous potential funding sources are provided. On the subject of funding, we are reminded of the fragility of transportation appropriations at the state and regional level. Gasoline sales tax revenue offers a lesson on the ephemeral nature of voter approved gasoline sales tax revenue increases. In this instance, cars and light trucks have simultaneously improved in miles per gallon along with the advent of increased electric vehicles (EVs) both of which have contributed to a substantial reduction in gasoline sales tax revenue. This eye-opening shortfall at the state level reflects a local focus when evaluating ballot box funding. The San Diego region failed to fund the proposed 2016 Proposition A Transnet sales tax increase of one quarter cent, although vigorously supported by SANDAG and numerous environmental organizations. At that point SANDAG was left with the barest of funding options.

This stark demonstration of the unreliability of voter support for tax increases should not be lost on SANDAG Board members. Reliance on temporary budget sources are unstable and insufficient if they are based on assumption of bond debt refinancing, stock market appreciation, population increases, or property or sales tax increases. Funding must be secured with initial and sustainable investments for a minimum of the first 10-years of the RTP approved environmental mitigation projects. Without such funded safety measures the RTP is confronted with speculative-by-nature “Revenue Assumptions”. The ***below italicized and bolded*** statements are taken directly from the RTP supporting documents.

#### **Appendix V: Funding and Revenues Assumptions**

***The assumptions made for each major revenue source included in the Plan’s financial analysis are provided below. All revenues have been escalated to the year that dollars are expended, and they are based on the escalation factor appropriate for that specific revenue source. Additional details for each fund source also are included in Technical Appendix 1.***

By its very definition, the conjecture surrounding proposed long-term financing and funding is apparent in the fundamental terms ***Assumptions*** and ***Escalation***, which indicate the uncertainty regarding this 29-year duration RTP. The SANDAG Board members must do everything possible to remove the associated uncertainty and doubts of reliable and assured revenue. This initiative for early environmental mitigation is the keystone to the RTP realization and must be securely funded upon SANDAG Board approval and initiation of the RTP 2050 Transportation Plan.

***“Without a regional funding source, the implementation—and ultimately, the success—of these plans to protect species and their habitats from extinction falls into question.”*** Regional funding:AA-6

The environmental community has repeatedly advised SANDAG staff and Board members that this SANDAG statement is clearly factual, warranted, and long predicted. It would behoove senior staff,

under direction of the Board of Directors, to lobby for state and federal environmental grant funding or appropriations. The current, unprecedented state budget surplus is too great an opportunity to ignore in light of the devastating consequences of doing nothing for lack of funding and planning.

[https://www.sandag.org/uploads/publicationid/publicationid\\_1236\\_5646.pdf](https://www.sandag.org/uploads/publicationid/publicationid_1236_5646.pdf)

\$2.59 billion is the sum of potential grants from the year 2018 titled Transportation Funding in the San Diego Region. While this budget would be stunning news in the environmental community, this grant funding is only available for SANDAG's CAPITAL projects. This would include new construction, expansion, renovation, or replacement projects for an existing facility, however there would be no mitigation funding for the environmental impacts of the new infrastructure or associated construction. It appears staff went to a great effort in meticulous searches to locate these CAPITAL grants. We request that staff accomplish the same depth of research for environmental mitigation and remediation grants. The rhetoric of "early environmental mitigation" will be far more convincing when SANDAG becomes a proactive source of grant funding information for San Diego's NGOs. The equity chasm between Capital projects and the mitigation funding to initiate projects is breathtaking and unacceptable.

***"The estimated unfunded regional cost to implement the regional habitat conservation plans was \$3.0 billion."***

SANDAG Board members please compare this TransNet EMP land grant program to the CAPITAL projects multibillion dollar budget. To say the environmental community is "challenged" speaks to this massive funding and equity disparity. Please consider that in 2011 the deficit was \$3 billion. In 2021 the equivalent dollar shortfall is \$3.62 billion.

***"Allocation of \$4 million is done annually by the SANDAG Board of Directors pursuant to a two-year work plan. A portion of this funding is allocated and distributed through a competitive TransNet EMP Land Management Grant Program to maintain the integrity of existing regional habitat preserves through enhanced land management."***

While the environmental community is grateful, \$4 million a year will require 75-years to catch up to 2011 environmental standards and funding deficit, to say nothing of funding the present Regional Habitat Conservation Vision:

***A steady, secure regional funding source is needed to complete the land acquisitions as proposed and to provide for ongoing land management. San Diego Forward: The 2021 Regional Plan AA-10***

Simply stated, SANDAG's **PROTECT**, **RESPECT** and **CONNECT** current environmental theme will largely remain a slogan until funding becomes a serious SANDAG Board of Directors priority. As San Diego's premier and leading planning organization, the environmental community is mystified by the seeming lack of Board direction for the required environmental reviews and mitigation for CAPITAL projects.

***When developing the Regional Habitat Conservation Vision, several barriers were identified that have slowed efforts to fully address regional habitat conservation within the region, including a lack of ongoing secure regional funding, a lack of institutional knowledge and public awareness, and waning political focus on habitat conservation.***

***Similarly, the focus on habitat conservation as a major public policy issued (SIC) has waned since the 1990s. Public policy focuses on imminent issues. Over the years, environmental public policy has***



***shifted towards stormwater issues and climate adaption as the top-of mind issues. Ironically, habitat conservation contributes towards resolving each of these issues. In some respects, regional habitat conservation is a victim of its own success; being perceived as an issue that has been resolved by the region without an understanding of the current gaps.***

As we evaluate potential funding for existing conserved lands, MSCP Preapproved Mitigation Areas (PAMA), defined reserves, preserve and managed properties, it becomes abundantly clear that there are no planned funding objectives of substance for the San Diego Region's natural lands. Natural lands protection is currently limited to \$4 million. This defect is delineated in the void of conservation funding in **Appendix U: Cost Estimation Methodology of 18 different forecast costs budget totaling \$163,536,000,000**. In this unprecedented budget no funds are planned for maintaining MSCP conservation lands and the required mitigation for Capital projects.

[https://sdforward.com/docs/default-source/2021-regional-plan/appendix-aa---regional-habitat-conservation-vision.pdf?sfvrsn=bb44fd65\\_2\\_AA-4](https://sdforward.com/docs/default-source/2021-regional-plan/appendix-aa---regional-habitat-conservation-vision.pdf?sfvrsn=bb44fd65_2_AA-4)

***The TransNet Environmental Mitigation Program (EMP) also established the San Diego Management and Monitoring Program (SDMMP) to provide a coordinated, scientific approach to management and biological monitoring of conserved lands in San Diego County.*** Appendix AA, addressing The Regional Habitat Conservation Vision contradicts the illusion of effective planning by the \$3.0 billion funding deficiency from 2011 to date. Essentially, the natural lands preservation budget is bereft of new funding sources, relying exclusively on the existing \$4,000,000 per year of the original TransNET sales tax funding.

***Without a regional funding source, the implementation—and ultimately, the success—of these plans to protect species and their habitats from extinction falls into question. In 2011, the estimated unfunded regional cost to implement the regional habitat conservation plans was \$3.0 billion.*** This SANDAG RTP statement could not be more timely or appropriate for discussions and decisions to cure the unfunded regional cost. Hesitation to address funding requirements accomplishes nothing. Sierra Club can only speculate on the huge shortfall confronting SANDAG and the San Diego region environment the RTP claims to safeguard. The 2011 deficit in today's dollar value would be \$3.62 billion and climbing.

The bottom line of this Sierra Club communication, is that the RTP plan does not address the on-the-ground reality of SANDAG acting as though the agency did not bear planning responsibility for the huge, and growing, natural land MSCP conservation and preservation costs. Instead, regardless of environmental mitigation first claims, SANDAG has devoted their economic resources solely to CAPITAL projects, disregarding the costs of maintaining already preserved and reserved MSCP lands and mitigating the carbon associated with these capital projects.

With a \$196 billion California budget passed, it is inappropriate that the entirety of San Diego's MSCP conserved and MHPA protected lands are hobbled with a \$4 million spending limit. SANDAG must exert the same efforts researching state and federal environmental protection grants or state appropriations as it demonstrates with the vastly more expensive CAPITAL project grants.

Most sincerely,

George Courser, Chair,  
Conservation Committee  
Sierra Club San Diego

Peter Andersen, Vice Chair  
Conservation Committee  
Sierra Club San Diego

August 5, 2021

Mr. Hasan Ikhrata  
SANDAG, Executive Director  
401 B St, Suite 800  
San Diego, CA 92101

**Re: Support incorporating *Reconnect Logan, 5 Freeway Lid Project* in the San Diego Association of Governments' (SANDAG) 2021 Regional Plan**

Dear Mr. Ikharata,

My name is Teresa Montero and I have been a Logan Heights resident (OR BUSINESS OR NON PROFIT) for 10 years. I live 1 blocks from Interstate 5 writing to express my support for the incorporation of a project which goal is to address social and economic inequity, rising levels of health concerns aggravated by greenhouse gas emissions, and transportation injustices in San Diego's Barrio Logan and Logan Heights communities. **Specifically, we request the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan (Draft Plan)**

Our once united community was devastated by Interstate 5 which forcibly displaced hundreds in the 1950's and has burdened those who remained. Pursuant to Chapter 1: Equity Focus (p. 11) of Draft Plan, we know *ReConnect Logan Freeway Lid* will transform and reconnect our community. A freeway lid can help our community by dismantling the barriers that the I-5 created by bringing the community together, addressing health concerns by capturing GHG emissions, creating non-existing green spaces, and allowing for development of affordable housing. All goals in line with the Draft Plan of creating efficient movement of people and goods, providing affordable, reliable, and safety mobility options, and allowing for healthier air.

As mentioned, the construction of the I-5 forced many families to be displaced, and while the construction allowed for transportation advancements, since the 1950's our community has been subject to inequality, misrepresentation, and systemic injustices in transportation and racism, to mention a few. We continue to be a working-class neighborhood composed of nearly 90% Mexican Americans, and while our we are proud of our heritage and activism deeply rooted in our National Landmark of Chicano Park, the reality is that I-5 has created much insecurity by facilitating gang turfs, separating families from places of worship, and limiting children's access to neighborhood schools. It is time for our community to heal – a freeway lid is the answer.

Given the significant investment and planning of projects in the Barrio Logan/Logan Heights communities in the Draft Plan as identified in Appendix A: Transportation Projects, Programs, and Phasing, it is appropriate to identify and call out *ReConnect Logan Freeway Lid* as a project on this list. A few of the multiple projects that will impact Barrio Logan/Logan Heights are:

- The creation of Managed Lanes on Interstate 5, Project ID CC002 Complete Corridor: ML/Goods Movement (p. A-8)
- Additional cargo due to the Harbor Drive 2.0 proposal that will facilitate cargo in the community of Barrio Logan, Project ID GM06 Goods Movement: Roadways (p. A-11)
- Harbor Drive Corridor, project ID GM05 2050 Goods Movement: Roadways Harbor Drive Multimodal Corridor Improvements that will facilitate Trucks for the Port of San Diego (p. A-12)

Besides being in line with the 2021 Draft Regional Plan, *ReConnect Logan Freeway Lid* is also pursuant to Appendix H in relation to California Assembly Bill 805 which requires the reduction of pollution exposure in disadvantaged communities. Furthermore, our project is also pursuant to the Sustainable Communities Strategy per California SB 375 since it would help reach the overall goal of reducing GHG emissions of 15% (p. 18 of Draft Plan), as well as allowing for accommodation to the Regional Housing Needs Assessment Determination. For all these reasons, our community is looking forward to **the addition of a Freeway Lid as a priority project as identified in SANDAG's 2021 Draft Regional Plan.**

If you have any questions, you may contact me at [labucky.montero@gmail.com](mailto:labucky.montero@gmail.com)(email or phone).

Sincerely,

Teresa Montero

2029 Julian Avenue, San Diego ca 92113.



July 28, 2021  
SANDAG Board of Directors  
401 B Street  
San Diego, CA 92101

**RE: 10 Transit Lifelines**

UNIVERSITY  
PROFESSIONAL  
AND TECHNICAL  
EMPLOYEES

CWA Local 9119  
AFL-CIO

■  
Representing  
Employees at the  
University of  
California

■  
7548 Trade Street  
San Diego, CA 92121

Phone (858) 458-0862

Fax (858) 458-0853

sandiego@upte-cwa.org

■  
www.upte.org

Respected Chair Blakespear and Board Members:

As President of UPTE-CWA 9119 UCSD Local 9 (representing UCSD Hospital Professionals, Researchers, and Technical Employees), I am writing in support of the San Diego Transportation Equity Working Group's (SDTEWG) proposed changes to the 2021 Regional Plan. While the Regional Plan is the boldest that SANDAG has proposed in decades, it is still highway first, which perpetuates a state of structural immobility, and will take too long to create necessary changes for public transit to be an alternative to cars and address our climate crisis. As transportation accounts for 41% of greenhouse gas emissions in San Diego, we have the opportunity to greatly reduce GHG emissions *and* create a more socially equitable region, by improving our transit system.

Therefore, I urge you on behalf of the SDTEWG to support these proposed changes:

1. Meet the required greenhouse gas emission targets, and ensure measures actually get us to those goals, by using the federal and state funds available to create high quality union jobs. Climate change is accelerating and we are currently seeing the results, which is especially devastating to frontline communities, so the emissions reduction goal of 40% by 2030 is inadequate to meet the climate crisis.
2. Accelerate the timeline for all transit (trolleys, buses, rail) and biking infrastructure improvements and prioritize the Environmental Justice communities that need transit solutions the most. Environmental Justice communities cannot afford to wait; they need immediate improvements while the long-term infrastructure projects are being planned. This means no new roads but rather accelerating the purple line and collaborating with MTS to make improvements to the blue line, both of which serve these communities.
3. Develop a transit system that is fast, frequent, reliable, and accessible by increasing passenger capacity and frequency on popular lines. This should be done immediately to introduce the public to a new transit era by providing MTS and NCTD with the necessary financial support for implementation.
4. Create and fund an anti-displacement strategy to protect vulnerable communities living near transit corridors by developing new affordable housing, preserving existing affordable housing, encouraging community ownership.
5. Make immediate improvements to current amenities surrounding transit stops with dedicated funding. Amenities include benches, shade from the elements, and bathrooms which should all be accessible according to ADA regulations.
6. Begin no-cost transit passes for youth 24 years old and younger in 2023, not 2027. No-cost transit passes encourage significant participation in public transportation and help shift expectations for how San Diegans use transit.

Please incorporate the SDTEWG proposed changes into the 2021 Regional Plan.

Sincerely,

Sarah Martin, President, UPTE-CWA 9119, Local 9 UCSD





June 28, 2021

Chair Catherine Blakespear  
Executive Director Hasan Ikhata  
San Diego Association of Governments  
401 B Street, Suite 800  
San Diego, California 92101

Dear Chair Blakespear and Executive Director Ikhata:

We are writing in regards to the current draft of the San Diego Forward: The 2021 Regional Plan. We are very concerned that the plan does not address both AB 686 Affirmatively Furthering Fair Housing and Sustainable Communities Strategy as interpreted by the California Air Resource Board (CARB) “to reduce greenhouse gas emissions from driving, which can also foster healthier and more equitable and sustainable communities.”

In 2018, the California Legislature passed AB 686 (Author: Assembly-member Miguel Santiago; Co-Author: Assembly-member Todd Gloria) - Affirmatively Furthering Fair Housing (AFFH) which requires public agencies to administer their programs and activities relating to housing and community development in a manner of "taking meaningful actions ... that overcome patterns of segregation and foster inclusive communities" and "address significant disparities in housing needs and in access to opportunity."

In 2018, California Air Resources Board released their Progress Report analyzing the progress made under SB 375 - Sustainable Communities and Climate Protection Act of 2008. The report stated that, “California will not achieve the necessary greenhouse gas emissions reductions to meet mandates for 2030 and beyond without significant changes to how communities and transportation systems are planned, funded, and built.” The report further identified the need to “increase homes in high-opportunity areas for low-income households.”

LISC San Diego and a coalition of nonprofits has requested that the City of San Diego allow all 5000 – 7000 square foot parcels of land to be subdivided into 4 individual land parcels for sale or rent in high-wealth, low-crime neighborhoods and concentrated areas of affluence. This would satisfy AB 686 - AFFH to take “aggressive” actions that “overcome...contributing factors [to fair housing problems, and thus] meet the ‘meaningful impact’ requirement in statute” (*HCD AFFH Guidance Memo*, p. 52).

Our coalition of nonprofits will soon be launching a first-time homebuyer grant program targeted at BIPOC families. We have commitments from charitable foundations totaling \$2.5 million to

support this program. Our goal is to build for-sale homes in high wealth, low crime neighborhoods and concentrated areas of affluence that are accessible to households making 80% AMI. The single greatest barrier we face is restrictive single-family zoning that makes it impossible to construct smaller, more affordable homes in these neighborhoods.

SANDAG through the 2021 Regional Plan has an opportunity under AB 686 and the CARB 2018 Progress Report to begin the process of ending the current legal apartheid that exists in our communities and ensure that California meets its greenhouse gas emissions reductions targets for 2030 and beyond with how communities are “planned, funded, and built.” We strongly urge SANDAG to use their role as the Metropolitan Planning Organization and with the 2021 Regional Plan to comply with AB 686 and Sustainable Communities Strategy to encourage and assist cities like the City San Diego to begin desegregating their neighborhoods and provide meaningful opportunities for all residents and families while lowering car emissions and climate change.

Finally, we strongly urge SANDAG to create an Office of Equity that will ensure that proposals like the Regional Plan and are advancing equity and reducing barriers to inequality, structural racism while enhancing opportunity.

Thank you,

**Ricardo Flores**  
Executive Director  
LISC San Diego

**Al Abdallah**  
Chief Operating Officer  
Urban League of San Diego County

**Shane Harris**  
President & Founder  
People's Association of Justice Advocates

**Abdur-Rahim Hameed**  
National President/ CEO  
National Black Contractors Association

Cc: SANDAG Board of Directors  
Diane Takvorian, California Air Resource Board member  
Hon. Nathan Fletcher, California Air Resource Board member

# WEBSTER COMMUNITY COUNCIL

4973 Elm Street • San Diego, CA 92102 • (619) 264-5496

August 6, 2021

San Diego Association of Governments  
401 B Street Suite 800  
San Diego, CA 92101

## **Subject: PUBLIC COMMENT, 2022 REGIONAL TRANSPORTATION PLAN**

Ladies and Gentlemen:

Stephen  
Lamprides,  
President

Margaretta  
Hickman, 1<sup>st</sup>  
Vice President

Kristen Hurst,  
Secretary

Derryl Williams,  
Corresponding  
Secretary

Rosangle Armas,  
Treasurer

Juanita Williams,  
Financial  
Secretary

I write to you on behalf of the eight hundred homes in the Webster Community; all of us vote and we are interested in the future of our community as regards to the 2022 Regional Transportation Plan. Our demand for goods and services delivered to the urban section of a sprawled city are unique. We are an aged community with traditional values commensurate with our gentry.

We see development of our region occurring as planned, as an impediment to our traditional lifestyle and as such, desire a more gentle approach to the conversion a sprawled California city to a high-density commuter city. The use of transportation agency owned parking lot lots next to noisy, government-owned, transit center facilities such as trolley lines is objectionable as is the obvious feeling that our automobiles are being taken away from us. Yes we believe in growth, but it must be phased to include our life styles. We request a plan that will be prepare our community to receive proposed changes occurring in the near future.

Our voice is changing! We have a sophisticated community council who now has experienced the flawed logic of, "oh you are not ready," for changes that are inclusive in the new modal plans. We ask for a mobility center/hub located within our existing fledgling transportation center near the intersection of Euclid Avenue and Market Street. This together with communication and information system infrastructure requires fiber optic cable readiness equal to that of other San Diego communities. We ask for assurance that the community will be ready for the state of the art transportation system that is in the design stage at this time. At the very least we ask for an inventory of our existing transportation facilities to demonstrate how far we have been left behind. We want all of our streets to be designed with "Complete Streets" designs enabling all modes of transportation, including unshared bicycle paths where appropriate. We ask for coverings for all of our MTS bus stops.

Thank you for the opportunity to comment on the proposed plan.

Please call with any questions, or if I may provide additional information.

Sincerely,



Stephen Lamprides

Appendix P.3

**Attached References to Comments on the Draft EIR**

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**References provided by  
Mike Bullock**

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# **Deriving a Climate-Stabilizing Solution Set of *Fleet-Efficiency and Driving-Level* Requirements, for Light-Duty Vehicles in California**

**Paper #796315**

**Mike R. Bullock**

Retired Satellite Systems Engineer, 1800 Bayberry Drive, Oceanside, CA 92054

## **ABSTRACT**

An Introduction is provided, including the importance of light-duty vehicles (LDVs: cars and light duty trucks) and the top-level LDV requirements to limit their carbon dioxide (“CO<sub>2</sub>”) emissions.

Climate crisis fundamentals are presented, including its cause, its potential for harm, California mandates, and a greenhouse gas (GHG) reduction road map to avoid disaster.

A 2030 climate-stabilizing GHG reduction target value is calculated, using statements by climate experts. The formula for GHG emissions, as a function of per-capita driving, population, fleet CO<sub>2</sub> emissions per mile, and the applicable low-carbon fuel standard is given. The ratio of the 2015 value of car-emission-per-mile to the 2005 value of car-emission-per-mile is obtained.

Internal Combustion Engine (ICE) mileage values from 2000 to 2030 are identified, as either mandates or new requirements. A table is presented that estimates 2015 LDV fleet mileage.

Zero Emission Vehicle (ZEV) parameters are given. Methods are derived to compute equivalent 2030 mileage. Four cases are defined and overall equivalent mileage is computed for each. Those equivalent fleet mileage values are used to compute their corresponding required per-capita driving reductions, with respect to 2005. Measures to achieve the most reasonable per-capita driving reduction are described, with reductions allocated to each measure.

A conclusion is presented.

## **INTRODUCTION**

Humanity’s top-level requirement is to stabilize our climate at a livable level. This top-level requirement must flow down to cars and light-duty trucks, also known as Light-Duty Vehicles (LDVs), due to the significant size of their emissions. As an example, LDVs emit 41% of the GHG in San Diego County<sup>1</sup>.

From a systems engineering perspective, the needed top-level LDV requirements are an upper bound on greenhouse gas (GHG) emissions per mile driven, applicable to all of the vehicles on the road, in the year of interest, and an upper bound on per-capita driving, given population growth. These two upper bounds must achieve the climate-stabilizing GHG emission target level. This paper will do a calculation of required driving levels, based on calculations of how clean our cars and fuels could be, predicted population growth, and the latest, science-based, climate-

stabilizing target, or requirement. All three categories of LDV emission-reduction strategies will be used: cleaner cars, cleaner fuels, and less driving. Four cases will be considered.

## **BACKGROUND: OUR CLIMATE PREDICAMENT**

### **Basic Cause**

Our climate crisis exists primarily because of these two facts<sup>2</sup>: First, our combustion of fossil fuels puts “great quantities” of CO<sub>2</sub> into our atmosphere; second, atmospheric CO<sub>2</sub> traps heat.

### **California’s Primary CO<sub>2</sub> Emission-Reduction Mandates**

California’s Governor’s Executive Order S-3-05<sup>3</sup> is based on the greenhouse gas (GHG) reduction limits that were recommended by climate scientists, for industrialized nations, in 2005. In 2005, climate scientists believed that if the industrialized nations of the world achieved the reduction-targets of S-3-05 (and other nations did something less), the Earth’s climate could be stabilized at a livable level, with a reasonably high level of certainty. More specifically, this executive order aims for an average, over-the-year, atmospheric, temperature rise of “only” 2 degree Celsius, above the preindustrial temperature. It attempts to do this by limiting atmospheric CO<sub>2</sub> to 450 PPM by 2050 and then reducing emissions further, so that atmospheric levels would come down to more tolerable levels in subsequent years. The S-3-05 emission targets are the 2000 emission level by 2010, the 1990 level by 2020, and 80% below the 1990 level by 2050.

It was thought that if the industrialized world achieved S-3-05 (and the non-industrialized world achieved an easier task), there would be a 50% chance that the maximum temperature rise will be less than 2 degrees Celsius, thus leaving a 50% chance that it would be larger than 2 degrees Celsius. A 2 degree increase would put over a billion people on the planet into a position described as “water stress” and it would mean a loss of 97% of our coral reefs.

There would also be a 30% chance that the temperature increase would be greater than 3 degrees Celsius. A temperature change of 3 degree Celsius is described in Reference 3 as being “exponentially worse” than a 2 degree Celsius increase.

The second California climate mandate is AB 32, the *Global Warming Solutions Act of 2006*. It includes provisions for a cap and trade program, to ensure meeting S-3-05’s 2020 target, which is to be emitting at no more than the 1990 level of emissions. AB 32 was to continue after 2020. AB 32 required CARB to always implement measures that achieved the maximum *technologically feasible and cost-effective* (words taken from AB 32) greenhouse-gas-emission reductions.

In 2015 Governor Brown signed B-30-15. This Executive Order established a mandate for 40% below 2020 emissions by 2030, as can be seen by a Google search. If S-3-05 is interpreted as a straight line between its 2020 and its 2050 targets, then the B-30-15 target of 2030 is the same as the S-3-05 implied target of 2035, because 2035 is halfway between 2020 and 2050 and 40% is halfway to 80%. More recently, California adopted SB 32, which made achieving B-30-15 legally binding. Finally, in 2018, the Governors Executive Order B-55-18 established a mandate of zero net emissions by the year 2045.

California achieved the second GHG emission target of S-3-05 (to emit at the 1990 level by 2020) in 2018, which is two years early. However, the world emission levels have, for most years, been increasing, contrary to the S-3-05 trajectory. Because the world has been consistently failing to follow S-3-05's 2010-to-2020 trajectory, if California, still wants to lead the way to human survival, it must do far better than S-3-05, going forward, as will be shown.

## **Failing to Achieve these Climate Mandates**

What could happen if we fail to achieve S-3-05, AB 32, and B-30-15 or if we achieve them but they turn out to be too little too late and other states and countries follow our example or do less?

It has been written<sup>4</sup> that, "A recent string of reports from impeccable mainstream institutions - the International Energy Agency, the World Bank, the accounting firm of PricewaterhouseCoopers - have warned that the Earth is on a trajectory to warm by at least 4 Degrees Celsius and this would be incompatible with continued human survival."

It has also been written<sup>5</sup> that, "Lags in the replacement of fossil-fuel use by clean energy use have put the world on a pace for 6 degree Celsius by the end of this century. Such a large temperature rise occurred 250 million years ago and extinguished 90 percent of the life on Earth. The current rise is of the same magnitude but is occurring faster."

## **Pictures That Are Worth a Thousand Words**

Figure 1 shows (1) atmospheric CO<sub>2</sub> (in blue) and (2) averaged-over-a-year-then-averaged-over-the-surface-of-the-earth, atmospheric temperature (in red). This temperature is with respect to a recent preindustrial revolution value. The data starts 800,000 years ago. It shows that the current value of atmospheric CO<sub>2</sub>, which is over 410 PPM, far exceeds the values of the last 800,000 years. It also shows that we might expect the corresponding temperature to eventually be over 12 degrees above preindustrial temperatures. This would bring about a human disaster<sup>3, 4, 5</sup>.

Figure 2 shows the average yearly temperature (in blue) with respect to the 1960-to-1990 baseline temperature. It also shows atmospheric levels of CO<sub>2</sub> (in red). The CO<sub>2</sub> spike of Figure 1 is seen on Figure 2 to be an accelerating ramp up, starting at the time of our industrial revolution. The S-3-05 goal of 450 PPM is literally "off the chart", in Figure 2. Figure 2 shows that, as expected, temperatures are starting to rise along with the rising levels of CO<sub>2</sub>. The large variations in temperature that are observed are primarily due to the random nature of the amount of solar energy being received by the earth.

## **FURTHER BACKGROUND: CALIFORNIA'S SB 375 AND AN IMPORTANT DATA SET**

As shown in the Introduction, LDVs emit significant amounts of CO<sub>2</sub>. The question arises: will driving need to be reduced or can cleaner cars and cleaner fuels arrive in time to avoid such behavioral change? Steve Winkelman, of the Center for Clean Air Policy (CCAP), worked on this problem and his results probably inspired California's SB 375.



## SB 375, the Sustainable Communities and Climate Protection Act of 2008

Under SB 375, the California Air Resources Board (CARB) has given each Metropolitan Planning Organization (MPO) in California driving-reduction targets, for the years 2020 and 2035. "Driving" means yearly, per capita, vehicle miles travelled (VMT), by LDVs, with respect to 2005. The CARB-provided values are shown at this Wikipedia link, [http://en.wikipedia.org/wiki/SB\\_375](http://en.wikipedia.org/wiki/SB_375). It is important to note that although this link and many other sources show the targets to be "GHG" and not "VMT", SB 375 clearly states that the reductions are to be the result of the MPO's Regional Transportation Plan (RTP), or, more specifically, the Sustainable Communities Strategy (SCS) portion of the RTP. Nothing in the SCS will improve average mileage. That will be done by the state and federal governments by their Corporate Average Fleet Efficiency (CAFÉ) standards and any other laws or regulations that they might adopt. The SCS can only reduce GHG by reducing VMT.

Figure 1 Atmospheric CO<sub>2</sub> and Mean Temperature from 800,000 Years Ago

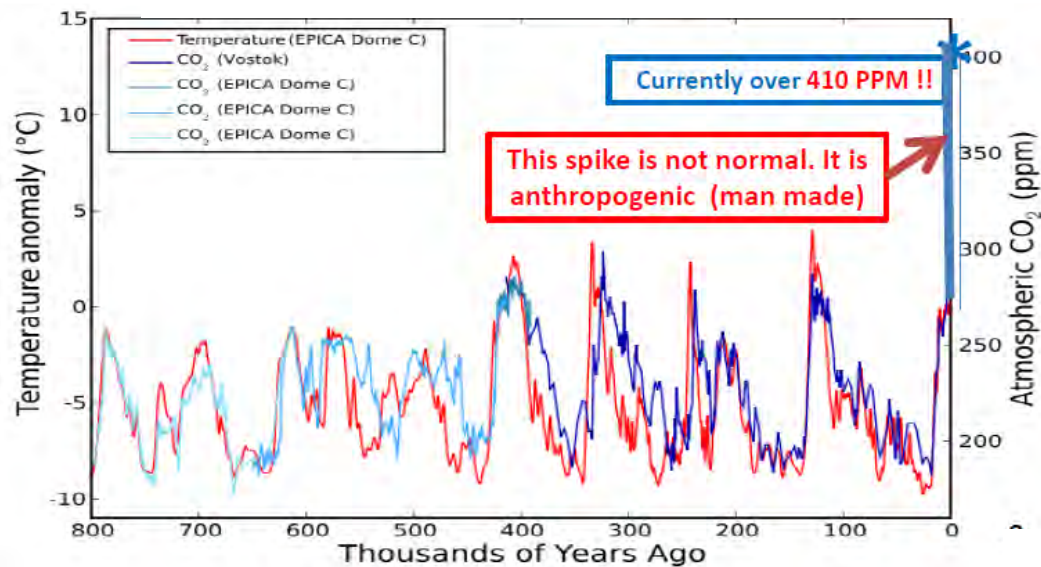
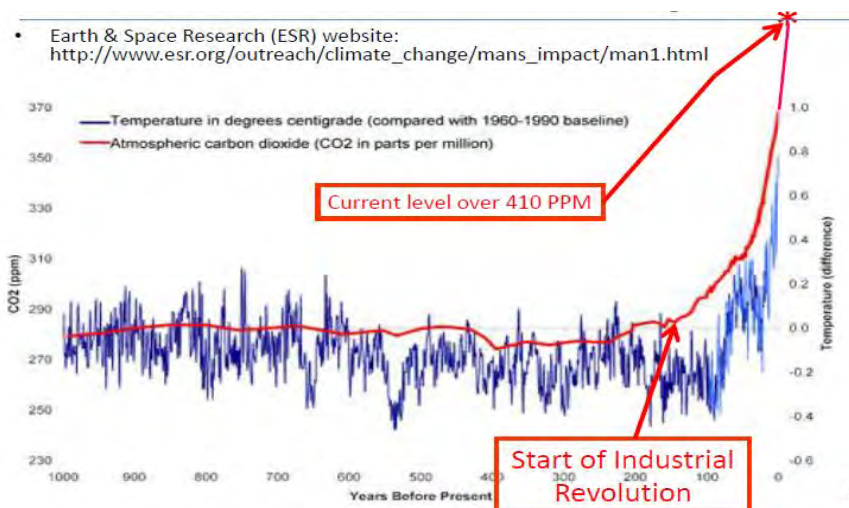


Figure 2 Atmospheric CO<sub>2</sub> and Mean Temperature, Over the Last 1,000 Years



Under SB 375, every Regional Transportation Plan (RTP) must include a section called a Sustainable Communities Strategy (SCS). The SCS must include driving reduction predictions corresponding to the CARB targets. Each SCS must include only *feasible* transportation, land use, and transportation-related policy data. If the SCS driving-reduction predictions fail to meet the CARB-provided targets, the MPO must prepare an Alternative Planning Strategy (APS). An APS uses *infeasible* transportation, land use, and transportation-related policy assumptions. The total reductions, resulting from both the SCS and the APS, must at least meet the CARB-provided targets.

### Useful Factors from Steve Winkelman’s Data

Figure 3<sup>6</sup>. shows 5 variables as a percent of their 2005 value and also the 1990 emission value (turquoise) related to the 2005 CO2 emission value (the blue line). All of the variables are for LDVs. The year 2005 is the baseline year of SB 375. The red line is the Caltrans prediction of VMT. The purple line is California’s current mandate for a Low Carbon Fuel Standard (LCFS). The LCFS also can be used to get the equivalent mileage from the actual mileage by dividing the actual mileage by the LCFS. The LCFS can be used to get the equivalent CO2 per mile driven by multiplying the actual CO2 per mile driven by the LCFS. As shown, by 2020, fuel in California must emit 10% less per gallon than in 2005. As written above, the turquoise line is the 1990 GHG emission in California. As shown, it is 12% below the 2005 level. This is important because S-3-05 specifies that in 2020, state GHG emission levels must be at the 1990 level. The green line is the CO2 emitted per mile, as specified by AB 1493, also known as “Pavley 1 and 2” named after Senator Fran Pavley. The values shown do not account for the LCFS. The yellow (or gold) line is the S-3-05 mandate, referenced to 2005 emission levels. The blue line is the product of the red (miles), the green (CO2 per mile), and the purple line (LCFS, which reduces emission per mile) and is the percentage of GHG emissions compared to 2005. Since VMT is not being adequately controlled, the blue line is not achieving the S-3-05 line. Figure 3 shows that driving must be reduced. For this reason, Steve Winkelman can be thought of as the true father of SB 375.

**Figure 3** The S-3-05 Trajectory (the Gold Line) AND the CO<sub>2</sub> Emitted from Personal Driving (the Blue Line), where that CO<sub>2</sub> is a Function (the Product) of the California-Fleet-Average CO<sub>2</sub> per Mile (the Green Line), The Predicted Driving (VMT, the Red Line), and the Low-Carbon Fuel Standard (the Purple Line)

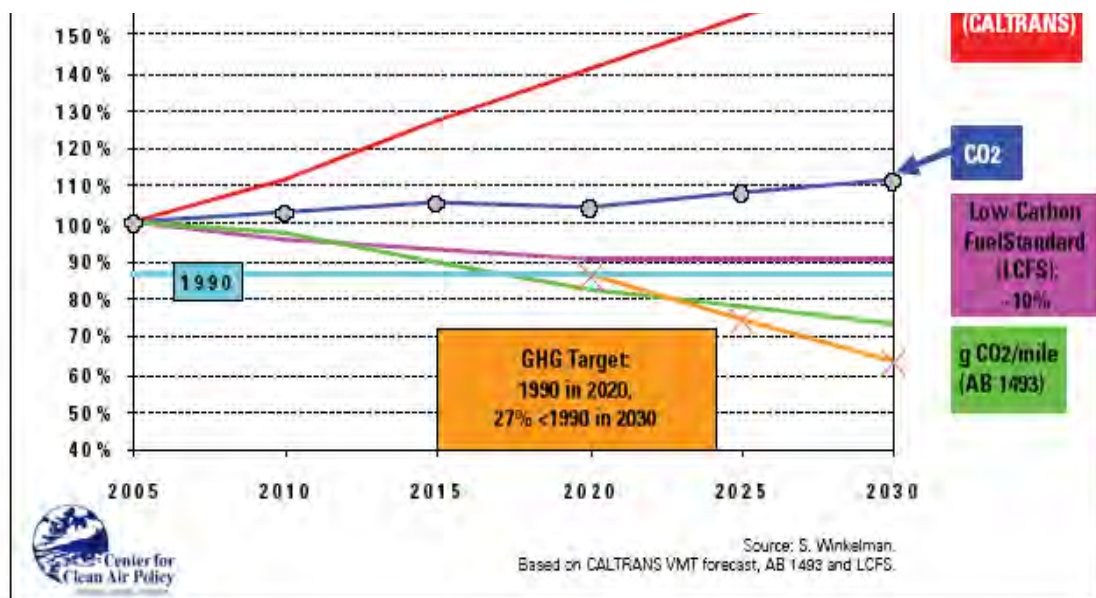


Figure 3 provides inspiration for a road map to climate success for LDVs. Climate-stabilization targets must be identified (from the climate scientists) and achieved by a set of requirements that will increase fleet efficiency and another set that will reduce per-capita driving.

## **THE DERIVATION OF CALIFORNIA'S TOP-LEVEL LDV REQUIREMENTS TO SUPPORT CLIMATE STABILIZATION**

It is clear that more efficient (less CO<sub>2</sub> emitted per mile) LDVs will be needed and this can be achieved with appropriate requirements. Significant improvements in efficiency will be needed if driving reductions are going to remain within what many people would consider politically achievable. Mileage and equivalent mileage will need to be specified. A significant fleet-fraction of Zero-Emission Vehicles (ZEVs, either Battery-Electric LDVs or Hydrogen Fuel Cell LDVs) will be needed. Since mileage and equivalent mileage are more heuristic than CO<sub>2</sub> emissions per mile, they will be used in the derivations. CO<sub>2</sub> per mile driven will not appear in the final equations.

Since the SB-375 work used 2005 as the reference year, that convention will be used. It will be assumed that cars last 15 years.

### **GHG Emission Target to Support Climate Stabilization**

The primary problem with S-3-05 is that California's resolve and actions have been largely ignored by other states, our federal government, and many countries. Therefore, rather than achieving 2000 levels by 2010 (the first target of S-3-05) and 1990 levels by 2020 (the 2<sup>nd</sup> target of S-3-05), world emission has been increasing for nearly all of the years since 2010. (California, on the other hand achieved its 1990 emission level in 2018. This is two years sooner than the 2<sup>nd</sup> target of the S-3-05 requirement.) Reference 7 states on Page 14 that the required rate of reduction, if commenced in 2020, would be 15%. That rate means that the factor of 0.85 must be achieved, year after year. If this were done for 10 years, the factor would be  $(0.85)^{10} = 0.2$ , by 2030. This reduction of 80% down from the 2020 value matches the 2050 target requirement of S-3-5, which is 80% below the 1990 value. According to S-3-05, the 2020 emission value should be the same as the 1990 emission value. As noted above, the S-3-05 emission of 2050 was designed to support capping atmospheric CO<sub>2</sub> at 450 PPM<sup>3</sup>. "Capping" means that the sum of all emissions (anthropogenic and natural) equals the sum of all sequestration (mostly photosynthesis.) Therefore, the author of the Reference 7 statement wanted the world to achieve the third target of S-3-05 to get the atmospheric CO<sub>2</sub> to stop going up 20 years sooner than what S-3-05 was written to achieve. This shows the urgent nature of our climate crisis. Therefore, if California wants to do its part by setting an example for the world, the correct requirement for California is to achieve emissions that are reduced to 80% below California's 1990 value by 2030. The world's reduction rate is not anywhere near the needed 15% as we move towards the end of 2020. Therefore, the target, of 80% below 1990 levels by 2030 is considered to be correct for California. Reference 7 also calls into question the advisability of aiming for a 2 degree Celsius increase, given the possibilities of positive feedbacks that would increase warming. This concern for positive feedbacks is another reason that this paper will work towards identifying LDV requirement sets that will support LDVs achieving 80% below the 1990 value by 2030.

Thinking that LDVs can, for some reason, fail to achieve this target is dangerous thinking. As stated above, LDVs emit, by far, the most CO<sub>2</sub> of all categories.

## Notes on Methods

The base year is 2005. An intermediate year of 2015 is used. The car efficiency factor of 2015 with respect to 2005 is taken directly from Figure 3. The car efficiency factor of 2030 with respect to 2015 is derived herein, resulting in a set of car-efficiency requirements.

It is assumed that cars last 15 years. This is equivalent to assuming that the effect of the cars that last more than 15 years, thus increasing emissions, will be offset by the effect of the older cars that don't last as long as 15 years, thus reducing old-car emissions. As will be seen, there will also have to be some sort of an additional action to remove many of the older Internal Combustion Engine cars that are 15, through just 8 years old. Natural attrition will take care of some of this since as cars get older the probability that they will be taken out of service increases. However, some sort of "cash for gas guzzlers" program will be needed. How this is done is not covered in this paper. This is not unique. As another example, the car manufacturers will have to figure out how to produce the needed cars and batteries.

## Primary Variables Used

Table 1 defines the primary variables that are used.

## Fundamental Equations

The emissions are equal to the CO<sub>2</sub> per mile driven multiplied by the per-capita driving multiplied by the population, since per-capita driving multiplied by the population is total driving. This is true for any given year.

$$\text{Future Year } k: \quad e_k = c_k * d_k * p_k \quad (\text{Eq. 1})$$

$$\text{Base Year } i: \quad e_i = c_i * d_i * p_i \quad (\text{Eq. 2})$$

Dividing both sides of Equation 1 by equal values results in an equality. The terms on the right side of the equation can be associated as shown here:

$$\frac{e_k}{e_i} = \frac{c_k}{c_i} * \frac{d_k}{d_i} * \frac{p_k}{p_i} \quad (\text{Eq. 3})$$

**Table 1 Variable Definitions**

<b>Variable Definitions</b>	
$e_k$	<b>LDV Emitted CO<sub>2</sub>, in Year "k"</b>
$L_k$	<b>Low Carbon Fuel Standard (LCFS) Factor that reduces the Per-Gallon CO<sub>2</sub> emissions, in Year "k"</b>
$C_k$	<b>LDV CO<sub>2</sub> emitted per mile driven, average, in Year "k", not accounting for the Low Carbon Fuel Standard (LCFS) Factor</b>
$c_k$	<b>LDV CO<sub>2</sub> emitted per mile driven, average, in Year "k", accounting for the Low Carbon Fuel Standard (LCFS) Factor</b>

$p_k$	Population, in Year “k”
$d_k$	Per-capita LDV driving, in Year “k”
$D_k$	LDV Driving, in Year “k”
$M_k$	LDV Mileage, miles per gallon, in Year “k”
$m_k$	LDV Equivalent Mileage, miles per gallon, in Year “k” accounting for Low Carbon Fuel Standard (LCFS) Factor, so this is $M_k/L_k$
N	Number of pounds of CO2 per gallon of fuel but not accounting for the Low Carbon Fuel Standard (LCFS) Factor

Since CO2 per mile (“c”) is a constant (use “A”, noting that it is equal to about 20 pounds per gallon) multiplied by the number of Gallons (“G”) and since number of gallons is distance (use “D”) divided by mileage (use “m”), then  $c = A*D/m$ . this shows that the ratio of the “c” values in different years is going to be equal to the reciprocal of the “m” values in those different years because the other variables will cancel out. Therefore:

$$\text{To work with mileage: } \frac{m_i}{m_k} = \frac{c_k}{c_i} \quad (\text{Eq. 4})$$

Putting Equation 4 into Equation 5 results in the following equation:

$$\frac{e_k}{e_i} = \frac{m_i}{m_k} * \frac{d_k}{d_i} * \frac{p_k}{p_i} \quad (\text{Eq. 5})$$

Showing the base year of 2005, the future year of 2030, introducing the intermediate year of 2015 and the year of 1990 (since emissions in 2030 are with respect to the 1990 value) results in Equation 6.

$$\frac{e_{2030}}{e_{1990}} * \frac{e_{1990}}{e_{2005}} = \frac{c_{2030}}{c_{2015}} * \frac{c_{2015}}{c_{2005}} * \frac{d_{2030}}{d_{2005}} * \frac{p_{2030}}{p_{2005}} \quad (\text{Eq. 6})$$

The ratio on the far left is the climate-stabilizing target, which is the factor of the 2030 emission to the 1990 emission. It has been shown that this is 0.20 or 80% less. The next ratio is the emission of 1990 compared to 2005. It is the turquoise line of Figure 3, which is 0.87. The first ratio on the right side of the equation is the fleet emission per mile in 2030 compared to the value in 2015. This ratio will be derived in this report and it will result in a set of car-efficiency requirements. Moving to the right, the next ratio is the car efficiency in 2015 compared to 2005. It can be obtained by multiplying the purple line 2015 value times the green line 2015 value, which is  $0.90 * 0.93$ . The next term, still going from right to left, is the independent variable. It is the per-capita driving reduction required, with respect to the 2005 level of driving. The final term on the far right is the ratio of the population in 2030 to the population in 2005. Reference 8 shows that California’s population in 2005 was 35,985,582. Reference 9 shows that California’s population in 2030 is predicted to be 42,263,654. Therefore,

$$P_{2030}/P_{2005} = 42263654 \div 35985582 = 1.17446076 \quad (\text{Eq. 7})$$

Putting in the known values results in Equation 8:



$$0.20 * 0.87 = \frac{c_{2030}}{c_{2015}} * 0.90 * 0.93 * \frac{d_{2030}}{d_{2005}} * 1.17446076 \quad (\text{Eq. 8})$$

Combining the values, solving for the independent variable (the per-capita driving ratio), and changing from emission-per-mile to equivalent-miles-per-gallon results in the following:

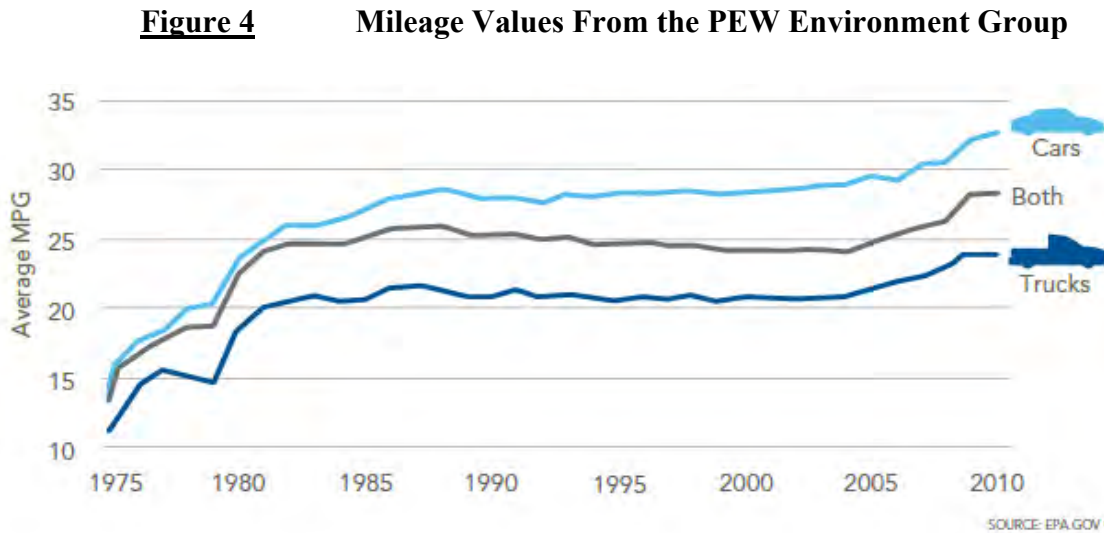
$$\frac{d_{2030}}{d_{2005}} = 0.177004896 * \frac{m_{2030}}{m_{2015}} \quad (\text{Eq. 9})$$

With the coefficient being so small, it is doubtful that we can get the equivalent mileage in 2030 to be high enough to keep the driving ratio from falling below one. The mileage of the 2015 fleet will be based on the best data we can get and by assuming cars last 15 years. The equivalent mileage in 2030 will need to be as high as possible to keep the driving-reduction factor from going too far below 1, because it is difficult to reduce driving too much. The equivalent mileage will be dependent on the fleet-efficiency requirements in the near future and going out to 2030. Those requirements are among the primary results of this report.

### Internal Combustion Engine (ICE) Mileage, from Year 2000 to Year 2030

The years from 2000 to 2011 are taken from a plot produced by the PEW Environment Group, [http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Fact\\_Sheet/History%20of%20Fuel%20Economy%20Clean%20Energy%20Factsheet.pdf](http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Fact_Sheet/History%20of%20Fuel%20Economy%20Clean%20Energy%20Factsheet.pdf)

The plot is shown here as Figure 6. The “Both” values are used.



The values from 2012 to 2025 are taken from the US Energy Information Agency (EIA) as shown on their website, [http://www.eia.doe.gov/federal/executive/vehicle-standards#ldv\\_2012\\_to\\_2025](http://www.eia.doe.gov/federal/executive/vehicle-standards#ldv_2012_to_2025). They are the LDV Corporate Average Fleet Efficiency (CAFÉ) values enacted into law in the first term of President Obama. From 2025 to 2030, it is assumed that the yearly ICE improvement in CAFÉ will be 2.5 MPG.

## Overall Mileage of California’s LDV Fleet in 2015

Table 2 uses these values of the Internal Combustion Engine (ICE) LDV mileage to compute the mileage of the LDV fleet in 2015. It assumes that the fraction of ZEVs being used over these years is small enough to be ignored. The 100 miles driven, nominally, by each set of cars, is an arbitrary value and inconsequential in the final calculation, because it will divide out. It is never-the-less used, so that it is possible to compare the gallons of fuel used for the different years. The “f” factor could be used to account for a set of cars being driven less. It was decided to not use this option by setting all of the values to 1. The Low Carbon Fuel Standard (LCFS) values are taken from Figure 3. The gallons of fuel are computed as shown in Equation 10, using the definition for  $L_k$  that is shown in Table 2.

$$\text{Gallons Used per } f * 100 \text{ miles} = \frac{fx100}{(CAFE\ MPG)/L_k} \quad (\text{Eq. 10})$$

As shown in Table 2, using the definitions in Eq. 9:

$$m_{2015} = 27.63$$

If it is deemed acceptable to have per-capita driving in 2030 be reduced 32% with respect to 2005 driving, then the left side of Eq. 9 becomes 0.68 and it is possible to use Eq. 9 to solve for the 2030 mileage as:

$$m_{2030} = (27.63) * 0.68 * \left(\frac{1}{0.177004896}\right) = 106.1462 \quad (\text{Eq. 11})$$

Likewise if it is decided that the per-capita driving in 2030 should equal the per-capita driving in 2005 then:

$$m_{2030} = (27.63) * 1.00 * \left(\frac{1}{0.177004896}\right) = 156.0974 \quad (\text{Eq. 12})$$

These values will provide the targets for the tables that compute the mileage values for 2030.

## How ICE Mileage Values Will Be Used with ZEV Equivalent Mileage Values

To have LDVs achieve our climate-stabilizing target, after 2015, the net (computed using both ICE and ZEV vehicles) mileage values for each year will need to greatly improve by having a significant fraction of ZEVs. The ICE CAFÉ standards are used in this report as just the ICE contribution to fleet MPG. The ICE MPG values are inadequate by themselves and will therefore need to become less important; the ZEVs sales will need to overtake the ICE sales.

Federal requirements will need to change significantly. Currently, federally-mandated corporate average fuel efficiency (CAFÉ) standards have been implemented, from 2000 to 2025. These standards require that each corporation produce and sell their fleet of cars and light-duty trucks in the needed proportions, so that the combined mileage of all of the cars they sell (total miles driven in all cars sold in the year of interest divided by the total gallons used by all those cars, for any arbitrary distance) at least meets the specified mileage.

**Table 2 Calculation of the Fleet MPG for 2015**

<b>LDV Set</b>	<b>Years Old</b>	<b>Model Year</b>	<b>CAFE MPG</b>	<b>LCFS Factor L<sub>Year</sub></b>	<b>Factor Driven f</b>	<b>Gallons Used Per f*100 Miles</b>
1	14-15	2001	24.0	1.0	1.0	4.17
2	13-14	2002	24.0	1.0	1.0	4.17
3	12-13	2003	24.0	1.0	1.0	4.17
4	11-12	2004	24.0	1.0	1.0	4.17
5	10-11	2005	25.0	1.0	1.0	4.00
6	9-10	2006	25.7	.9933	1.0	3.87
7	8-9	2007	26.3	.9867	1.0	3.75
8	7-8	2008	27.0	.9800	1.0	3.63
9	6-7	2009	28.0	.9733	1.0	3.48
10	5-6	2010	28.0	.9667	1.0	3.45
11	4-5	2011	29.1	.9600	1.0	3.30
12	3-4	2012	29.8	.9533	1.0	3.20
13	2-3	2013	30.6	.9467	1.0	3.09
14	1-2	2014	31.4	.9400	1.0	2.99
15	0-1	2015	32.6	.9333	1.0	2.86
<b>Sum of Gallons:</b>						<b>54.29</b>
<b>Miles = 100*Sum(f's):</b>						<b>1500</b>
<b>MPG = Miles/(Sum of Gallons):</b>						<b>27.63</b>

The car companies want to maximize their profits while achieving the required CAFÉ standard. In California, the car companies are already be required to sell a specified number of electric vehicles, which have a particularly-high, equivalent-value of miles-per-gallon. If the laws are not changed, this situation will allow companies to take advantage of their ZEV vehicles to sell more low-mileage, high-profit cars and light-duty trucks, and still achieve the federal CAFÉ standard.

It will be better to apply the CAFÉ standards to only the ICEs and then require, in addition to the CAFÉ standards, that the fleet of LDVs sold achieve some mandated fraction of ZEVs. The ZEVs will get ever-improving equivalent mileage, as our electrical grid is powered by a larger percent of renewable energy. In other words, their equivalent mileage is not fixed, but will improve over the years. Requirements developed here are for 2030. Therefore a high percentage of all the electricity generated in the state, including both the “in front of the meter” (known as the “Renewable Portfolio Standard” or “RPS”) portion and the “behind the meter” portion is assumed to come from sources that do not emit CO2. The values of 85% and 90% are assumed. The values become one of the important fleet-efficiency requirements for cases that are considered. Hopefully these assumptions are reasonable. San Diego’s Climate Action Plan (CAP) was the first to specify 100% renewable energy by 2035. Many other cities have followed San Diego’s lead in this regard.

## How to Compute the ZEV Equivalent Mileage Values

To calculate the equivalent mileage of the 2030 fleet of LDVs, it is necessary to derive a formula to compute the equivalent mileage of ZEVs, as a function of the percent of electricity that is generated without emitting CO<sub>2</sub> (the mixed case), the equivalent ZEV mileage if the electricity is from 100% fossil fuel (the “West Virginia” case), and the equivalent ZEV mileage if the electricity is from 100% renewable sources (the ideal case), which is not infinity because it is assumed that the manufacturing of the car emits CO<sub>2</sub>. The variable definitions in Table 3 are used.

**Table 3 Variables Used in the Calculation of ZEV Equivalent Mileage**

Variable	Definition
$m_z$	ZEV Equivalent mileage
$m_{zr}$	ZEV Equivalent mileage if the electricity is from renewables
$m_{zf}$	ZEV Equivalent mileage if the electricity is from fossil fuels
$r$	fraction of electricity generated from renewable sources
$G$	Gallons of equivalent fuel used
$D$	Arbitrary distance travelled
$Num$	$m_{zr} * m_{zf}$
$Den$	$r * m_{zf} + (1 - r) * m_{zr}$

The derivation of the equation for equivalent ZEV mileage is based on the notion that the ZEV can be imagined to travel “r” fraction of the time on electricity generated from renewables and “(1-r)” fraction of the time on fossil fuel. If the vehicle travels “D” miles, then, using the definitions shown in Table 4, the following equation can be written.

$$G = \frac{r*D}{m_{zr}} + \frac{(1-r)*D}{m_{zf}} \quad (\text{Eq. 13})$$

$$m_z = D/G = D / \left( \frac{r*D}{m_{zr}} + \frac{(1-r)*D}{m_{zf}} \right) \quad (\text{Eq. 14})$$

Dividing the numerator and the denominator by D and multiplying the numerator and the denominator by the product of the two equivalent mileage values ( $m_{zr}$  and  $m_{zf}$ ) results in Equations 31.

$$m_z = m_{zr} * m_{zf} / (r * m_{zf} + (1 - r) * m_{zr}) \quad (\text{Eq. 15})$$

Using the definitions in Table 3:

$$m_z = Num / (Den) \quad (\text{Eq. 16})$$

Table 4 shows 3 assignments of assumed values in which the fraction of electricity generated from renewables is varied and the results, using Equations 15 and 16, results in the three values of ZEV equivalent mileage. This shows the urgent need to move towards cleaner electricity.

**Table 4 Variable Assignment and the Resulting ZEV Mileages**

$m_{zr}$	$m_{zf}$	r	1-r	Num	Den	$m_z$
5000	70	0.80	0.20	350000.00	1056.00	331.44
5000	70	0.85	0.15	350000.00	809.50	432.37
5000	70	0.90	0.10	350000.00	563.00	621.67

### Additional Variables Needed to Compute the Overall Equivalent Mileage in 2030, Taking Into Account Both ICEs and ZEVs

Table 5 shows the additional definitions that will be used in the calculation of 2030 overall mileage.

**Table 5 Additional Variables Used in the Calculation of 2030 LDV Mileage**

Variable	Definition
$D_i$	Distance travelled by ICE vehicles
$D_z$	Distance travelled by ZEV vehicles
$G_i$	Gallons of equivalent fuel used by ICE vehicles
$G_z$	Gallons of equivalent fuel used by ZEVs

### Computing an LDV Overall Equivalent Fleet Mileage, for the *Balanced\_1* Case

Table 6 shows the calculation for the overall equivalent mileage for all the cars on the road, in the year of 2030, for the *Balanced\_1* case.

The name, *Balanced\_1*, comes from the attempt to *balance* the difficulty of achieving the fleet efficiency-related requirements with the difficulty of achieving the driving-reduction related requirements. The *Balanced\_1* case assumes that electricity is 85% renewable, which is also difficult.

There will also be a *Balanced\_2* case that assumes that electricity is 90% renewable. Both the *Balanced\_1* and the *Balanced\_2* cases assume that it is reasonable to have per-capita driving in 2030 reduced 32%, with respect to 2005 per-capita driving. That assumption, along with the 85% renewable electricity assumption, was used to select the  $z$  values of Table 6 to result in the Equation 11 value of overall 2030 mileage, which is 106.1263 Miles Per Gallon (MPG). From Table 4, 85% renewable electricity results in a ZEV equivalent mileage of 432.37 MPG. That value of equivalent ZEV mileage in 2030, when electricity is 85% renewable, is used for all of the ZEV model years, for



this case. Note that this is overlooking the fact that not all BEVs are equally efficient. In order to simplify this analysis, the Table 4 values of  $m_{zr}$  and  $m_{zf}$  are considered to be applicable to all the ZEV models. Therefore, the 432.37 MPG value can be divided into each  $D_z$  value to compute the corresponding  $G_z$  value, in all of the model years being considered.

To reduce the miles driven in poor-mileage ICE's, the "f" factor is used. For example, if "f" is set to 0.30, as it is in 2016, then the miles driven is reduced by 70%. Achieving the required "f" values may require some type of "cash-for-gas-guzzlers" program. However, it could also be noted that when older cars are second or third cars in multi-car families in which family members have the luxury of choosing which car to drive, family members will usually choose the car that is cheaper to operate, thus making the "f" factors easier to achieve. Finally, the Low Carbon Fuel Standard (LCFS) is assumed to continue to improve from the currently mandated value of 0.9 by the end of 2019. This is another method of reducing the CO2 emissions of the ICE vehicles.

For the ICE vehicles, the  $G_i$  values are computed as the  $D_i$  value divided by the equivalent MPG value. The equivalent MPG is the CAFÉ MPG divided by the LCFS factor.

It is arbitrarily assumed that the cars, for each year being considered (the models for that year, both ZEVs and ICEs), go a total of 100 miles. Although this is an extremely small fraction of the actual miles that will be driven, it doesn't change the result because the number of gallons of equivalent gasoline is always proportional to miles. The fraction of cars that are ZEVs ( $z$ ) is used to divide up this value of 100 Miles. However, the factor "f" reduces the miles driven by the ICE vehicles and this brings down the total miles driven for the years in which the "f" term is less than 1. For each year, the total miles per gallon (MPG) is computed as the total miles driven divided by the total gallons used. However, this value is not used in the calculation of the entire fleet equivalent mileage. The overall equivalent mileage is computed as the total miles driven divided by the total gallons used, where these quantities are summed over all of the 15 categories (years) of LDVs.

The following formulas are used to compute the overall equivalent mileage in 2030, of all of the LDVs on the road.

For the ICE calculations, for 2016, where

- " $L_k$ " is defined in Table 1 (LCFS factor for year "k") and is the value in the "LCFS" column of Table 6 and
- " $z$ " is from the " $z$ " column and is the fraction of cars sold in the year that are ZEVs and
- " $m_i$ " is the value from the CAFÉ MPG column:

$$D_i = 100 * f * (1 - z) \quad (\text{Eq. 17})$$

$$G_i = D_i / (m_i / L_{2016}) \quad (\text{Eq. 18})$$

For the ZEV calculations:

$$D_z = 100 * z \quad (\text{Eq. 17})$$

$$G_z = D_z / (432.37) \quad (\text{Eq. 18})$$

In updating this report from its 2015 version, the fleet fraction of ZEVs (" $z$ "), from 2015 to 2019, had to be reduced to approximate the low values that actually occurred from 2015 to 2019. However,

in 2020, it is assumed that the fraction will be at least as large as 8%, which is not such a trivial value. If it is actually larger than 8%, then there will be some margin built into the requirements derived in this report.

**Table 6 Calculation of 2030 LDV Mileage Assuming the *Balanced\_1* Case**

Year	ICE Parameters and Calculations						ZEVs			Yearly Totals		
	CAFÉ MPG	LCFS	Eq. MPG	f	$D_i$	$G_i$	$z$	$D_z$	$G_z$	Total Miles	Total Gallons	2030 MPG
2016	34.3	.9267	37.01	.3	29.4	0.7943	.02	2	.005	31.40	0.7989	39.30
2017	35.1	.9200	38.15	.4	39.2	1.0275	.02	2	.005	41.20	1.0321	39.92
2018	36.1	.9133	39.53	.5	48.5	1.2271	.03	3	.007	51.50	1.2340	41.73
2019	37.1	.9067	40.92	.6	57.6	1.4077	.04	4	.009	61.60	1.4169	43.47
2020	38.3	.9000	42.56	.7	64.4	1.5133	.08	8	.019	72.40	1.5318	47.26
2021	40.3	.8500	47.41	.8	64.0	1.3499	.20	20	.046	84.00	1.3961	60.17
2022	42.3	.8000	52.88	.9	58.5	1.1064	.35	35	.081	93.50	1.1873	78.75
2023	44.3	.8000	55.38	1.0	45.0	0.8126	.55	55	.127	100.00	0.9398	106.40
2024	46.5	.8000	58.13	1.0	20.0	0.3441	.80	80	.185	100.00	0.5291	188.99
2025	48.7	.8000	60.88	1.0	6.0	0.0986	.94	94	.217	100.00	0.3160	316.48
2026	51.2	.8000	64.00	1.0	3.0	0.0469	.97	97	.224	100.00	0.2712	368.70
2027	53.7	.8000	67.13	1.0	2.0	0.0298	.98	98	.227	100.00	0.2565	389.93
2028	56.2	.8000	70.25	1.0	1.0	0.0142	.99	99	.229	100.00	0.2432	411.17
2029	58.7	.8000	73.38	1.0	1.0	0.0136	.99	99	.229	100.00	0.2426	412.20
2030	61.2	.8000	76.50	1.0	1.0	0.0131	.99	99	.229	100.00	0.2420	413.15
<b>Sum of Miles and then Gallons of Equivalent Fuel:</b>										<b>1235.60</b>	<b>11.64</b>	
<b>Equivalent MPG of LDV Fleet in 2030:</b>										<b>106.17</b>		
<b>Sum of ZEV Miles = 795. Fraction of Miles Driven by ZEVs = 64.3%</b>												

There is probably some margin from the 2016 to 2019 values as well. The difficult values are for 2022, 2023, and 2024, with 2024 requiring that ZEV sales are 80% of all the cars purchased in California. The purple color of the  $z$  values denotes difficulty. This shows that the government will need to require that the car companies achieve the  $z$  values or buy credits from a company such as Tesla, which sells 100% ZEVs.

The Table 6  $z$  values were put into an EXCEL spread sheet that looks like Table 6. It produced the values shown in Table 6. The values were selected to try to get to the 106.1462 value that was computed in Eq. 11.

Using the result of 106.17 MPG into Equation 9, gives the following result:

$$\frac{d_{2030}}{d_{2005}} = 0.17700 * \frac{m_{2030}}{m_{2015}} = 0.17700 * \frac{106.17}{27.63} = 0.68016 \quad (\text{Eq. 19})$$

This is the 32% reduction desired. It will be difficult to achieve. However, the required schedule of ZEV adoption is also difficult. The values of  $z$  from the years 2021 to 2025 will be at least as difficult as achieving the 32% reduction. This situation motivates the next case. If electricity could be made cleaner sooner, the years from 2021 to 2025 could be less difficult.

## Computing an LDV Overall Equivalent Fleet Mileage, for the *Balanced\_2* Case

The *Balanced\_2* case is shown in Table 7.

The *Balanced\_2* case is the same as the *Balanced\_1* case except it includes an assumption that electricity is 90% renewable in 2030 instead of 85%. Table 7 shows the results using that assumption, which becomes a requirement for this case. For the *Balanced\_2* case, the values of  $z$  are once again assigned to achieve the desired driving-reduction value of 32%.

From the second line of Table 4, this means that the equivalent mileage of the ZEV vehicles is 621.67 MPG.

Eq. 18 becomes:

$$G_z = D_z / (621.67) \quad (\text{Eq. 20})$$

This is used to compute the gallons of equivalent fuel from the distance, for the ZEV vehicles in Table 7.

The Table 7  $z$  values were put into an EXCEL spread sheet that looks like Table 7. It produced the values shown in Table 7. The  $z$  values were selected to try to get to the 106.1462 value that was computed in Eq. 11.

Using the Table 7 result of 106.22 MPG into Equation 9, gives the following result:

$$\frac{d_{2030}}{d_{2005}} = 0.17700 * \frac{m_{2030}}{m_{2015}} = 0.17700 * \frac{106.22}{27.63} = 0.68045 \quad (\text{Eq. 21})$$

**Table 7** Calculation of 2030 LDV Mileage Assuming the *Balanced\_2* Case

Year	ICE Parameters and Calculations						ZEVs			Yearly Totals		
	CAFÉ MPG	LCFS	Eq. MPG	f	$D_i$	$G_i$	$z$	$D_z$	$G_z$	Total Miles	Total Gallons	2030 MPG
2016	34.3	.927	37.01	.3	29.4	0.7943	.02	2	.003	31.40	.7975	39.37
2017	35.1	.920	38.15	.4	39.2	1.0275	.02	2	.003	41.20	1.0307	39.97
2018	36.1	.913	39.53	.5	48.5	1.2271	.03	3	.005	51.50	1.2319	41.81
2019	37.1	.907	40.92	.6	57.6	1.4077	.04	4	.006	61.60	1.4141	43.56
2020	38.3	.900	42.56	.7	64.4	1.5133	.08	8	.013	72.40	1.5262	47.44
2021	40.3	.850	47.41	.8	68.0	1.4342	.15	15	.024	83.00	1.4584	56.91
2022	42.3	.800	52.88	.9	67.5	1.2766	.25	25	.040	92.50	1.3168	70.25
2023	44.3	.800	55.38	1.0	55.0	0.9932	.45	45	.072	100.00	1.0656	93.84
2024	46.5	.800	58.13	1.0	30.0	0.5161	.70	70	.113	100.00	.6287	159.05
2025	48.7	.800	60.88	1.0	5.0	0.0821	.95	95	.153	100.00	.2349	425.62
2026	51.2	.800	64.00	1.0	3.0	0.0469	.97	97	.156	100.00	.2029	492.84
2027	53.7	.800	67.13	1.0	2.0	0.0298	.98	98	.158	100.00	.1874	533.52
2028	56.2	.800	70.25	1.0	1.0	0.0142	.99	99	.159	100.00	.1735	576.42
2029	58.7	.800	73.38	1.0	1.0	0.0136	.99	99	.159	100.00	.1729	578.45
2030	61.2	.800	76.50	1.0	1.0	0.0131	.99	99	.159	100.00	.1723	580.31
Sum of Miles and then Gallons of Equivalent Fuel:										1233.60	11.61	
Equivalent MPG of LDV Fleet in 2030:										<b>106.22</b>		
Sum of ZEV Miles = 761. Fraction of Miles Driven by ZEVs = 61.7%												

This is the 32% reduction desired. It will be difficult to achieve. However, the required schedule of ZEV adoption is also difficult. The values of  $z$  from the years 2021 to 2025 will be at least as difficult as achieving the 32% reduction. However, they are easier to achieve than the values needed in the *Balanced\_1* Case. This quantifies the benefit of increasing the renewable fraction of electricity from 85% to 90%.

### **Computing an LDV Overall Equivalent Fleet Mileage, for the *2005\_Driving* Case**

When climate change and transportation policies are discussed, the opinion that we should simply electrify our fleet as soon as possible is often expressed. The idea is that the per-capita driving level does not have to be reduced, if we electrify our fleet fast enough. The relationships developed in this paper enable an analysis to see how this would work. This gives rise to the *2005\_Driving* Case. For this case, it is assumed that electricity is 90% renewable.

From the third line of Table 4, this means that the equivalent mileage of the ZEV vehicles is 621.67 MPG. Therefore, the relationship shown in Eq. 20 is used.

The *2005\_Driving* case is shown in Table 8.

For the *2005\_Driving* case, the values of  $z$  are assigned to achieve the overall equivalent mileage (MPG) value computed in Eq. 12, which is 156.0974, because that value was computed for there being no change in the per-capita driving from the 2005 value.

Using the result of 155.99 MPG into Equation 9, gives the following result:

$$\frac{d_{2030}}{d_{2005}} = 0.17700 * \frac{m_{2030}}{m_{2015}} = 0.17700 * \frac{155.99}{27.63} = 0.99930 \quad (\text{Eq. 22})$$

This is the 0% reduction desired. However, the required schedule of ZEV adoption is not possible. Jumping from 8% in 2020 to 82% in 2021 defies reason. It appears that our best bet, to do our part to avoid human extinction, is to proceed with the assumption (and thus requirement) that we are going to have to reduce per-capita driving, as shown in either the *Balanced\_1* or the *Balance\_2* case.

### **Computing an LDV Overall Equivalent Fleet Mileage, for the *Mary\_Nichols* Case**

Mary Nichols was first appointed to the California Air Resource Board (CARB) in 1975 and became Chair in 1979. After leaving CARB, she founded the Los Angeles Chapter of the Natural Resources Defense Council (NRDC) in 1989. She was reappointed to the position of Chair of



CARB in 2007 by Governor Arnold Schwarzenegger and she is still serving in that position today.

**Table 8 Calculation of 2030 LDV Mileage Assuming the 2005\_Driving Case**

Year	ICE Parameters and Calculations						ZEVs			Yearly Totals		
	CAFÉ MPG	LCFS	Eq. MPG	f	$D_i$	$G_i$	$z$	$D_z$	$G_z$	Total Miles	Total Gallons	2030 MPG
2016	34.3	.9267	37.01	.3	29.4	.7943	.02	2.0	.003	31.40	0.7975	39.37
2017	35.1	.9200	38.15	.4	39.2	1.0275	.02	2.0	.003	41.20	1.0307	39.97
2018	36.1	.9133	39.53	.5	48.5	1.2271	.03	3.0	.005	51.50	1.2319	41.81
2019	37.1	.9067	40.92	.6	57.6	1.4077	.04	4.0	.006	61.60	1.4141	43.56
2020	38.3	.9000	42.56	.7	64.4	1.5133	.08	8.0	.013	72.40	1.5262	47.44
2021	40.3	.8500	47.41	.8	14.4	.3037	<u>.82</u>	82.0	.132	96.40	0.4356	221.29
2022	42.3	.8000	52.88	.9	2.7	.0511	.97	97.0	.156	99.70	0.2071	481.42
2023	44.3	.8000	55.38	1.0	1.0	.0181	.99	99.0	.159	100.00	0.1773	563.99
2024	46.5	.8000	58.13	1.0	1.0	.0172	.99	99.0	.159	100.00	0.1765	566.72
2025	48.7	.8000	60.88	1.0	1.0	.0164	.99	99.0	.159	100.00	0.1757	569.23
2026	51.2	.8000	64.00	1.0	1.0	.0156	.99	99.0	.159	100.00	0.1749	571.84
2027	53.7	.8000	67.13	1.0	1.0	.0149	.99	99.0	.159	100.00	0.1741	574.23
2028	56.2	.8000	70.25	1.0	1.0	.0142	.99	99.0	.159	100.00	0.1735	576.42
2029	58.7	.8000	73.38	1.0	1.0	.0136	.99	99.0	.159	100.00	0.1729	578.45
2030	61.2	.8000	76.50	1.0	1.0	.0131	.99	99.0	.159	100.00	0.1723	580.31
<b>Sum of Miles and then Gallons of Equivalent Fuel:</b>										<b>1254.20</b>	<b>8.04</b>	
<b>Equivalent MPG of LDV Fleet in 2030:</b>										<b>155.99</b>		
<b>Sum of ZEV Miles = 990.0 Fraction of Miles Driven by ZEVs = 78.9%</b>												

The following quote<sup>13</sup> inspires the *Mary\_Nichols* Case:

*Regulations on the books in California, set in 2012, require that 2.7 percent of new cars sold in the state this year be, in the regulatory jargon, ZEVs. These are defined as battery-only or fuel-cell cars, and plug-in hybrids. The quota rises every year starting in 2018 and reaches 22 percent in 2025. Nichols wants 100 percent of the new vehicles sold to be zero- or almost-zero-emissions by 2030*

The mathematical relationships developed in this paper make it possible to determine the driving reduction that would be required if it is desired to stabilize the climate at a livable level, assuming the schedule of fleet electrification implied by the above quote. Electricity is required to be 90% renewable. The results of the *Mary\_Nichols Case* are shown in Table 9.

The corresponding driving reduction is computed using Eq. 9.

$$\frac{d_{2030}}{d_{2005}} = 0.177005 * \frac{m_{2030}}{m_{2015}} = 0.177055 * \frac{77.24}{27.63} = 0.495 \text{ (Eq. 14)}$$

This means that the per-capita driving will need to be about 50% less in 2030 than in year 2005. It is not known if CARB understands this.

The official policy of the California Democratic Party (CDP) is expressed in its Platform. A statement that applies to this report and to CARB can be viewed by looking at the California Democratic Party (CDP) website, then select “About Us”, “Standing Committees”, “Platform Committee”, “2020 Platform”, and finally “Energy and Environment Plank”. In that Plank, the following statement is found

- *Demand a state plan specifying how cars and light-duty trucks can meet climate-stabilizing targets by defining enforceable measures to achieve necessary fleet efficiency and per-capita driving limits;*

However, your author’s efforts to get CARB to do such a “state plan”, or to convince a state legislator to write legislation to direct CARB to do such a plan, have not been successful.

If CARB would do such a plan or would consider the results of this report, they would perhaps decide to push for a more ambitious fleet electrification schedule and would also push for state legislation and regulation to enact measures to reduce VMT.

## **Preliminary Conclusions Drawn from the Results of the Four Cases Run**

Table 10 is a summary showing the most important results of the four cases considered. The purple-colored entries denote difficult requirements; red denotes nearly impossible.

Considering the *Balance\_1* and the *Balanced\_2* cases and the fleet electrification schedules for each, it is first concluded that California needs to work to get its electricity to be at least 85% renewable by 2030 and furthermore that getting it to be 90% from renewables by 2030 would make the electrification schedule much easier.

**Table 9 Calculation of 2030 LDV Mileage Assuming the *Mary\_Nichols* Case**

Year	ICE Parameters and Calculations						ZEVs			Yearly Totals		
	CAFÉ MPG	LCFS	Eq. MPG	f	$D_i$	$G_i$	z	$D_z$	$G_z$	Total Miles	Total Gallons	2030 MPG
2016	34.3	.9267	37.01	.3	29.2	.7886	.027	2.7	.004	31.89	0.7930	40.22
2017	35.1	.9200	38.15	.4	38.9	1.0201	.027	2.7	.004	41.62	1.0245	40.63
2018	36.1	.9133	39.53	.5	47.4	1.2003	.051	5.1	.008	52.56	1.2086	43.49
2019	37.1	.9067	40.92	.6	55.5	1.3560	.075	7.5	.012	63.01	1.3681	46.06
2020	38.3	.9000	42.56	.7	63.0	1.4814	.099	9.9	.016	72.98	1.4974	48.74
2021	40.3	.8500	47.41	.8	70.1	1.4790	.124	12.4	.020	82.47	1.4988	55.02
2022	42.3	.8000	52.88	.9	76.7	1.4509	.148	14.8	.024	91.48	1.4746	62.03
2023	44.3	.8000	55.38	1.0	82.8	1.4957	.172	17.2	.028	100.00	1.5233	65.65
2024	46.5	.8000	58.13	1.0	80.4	1.3834	.196	19.6	.032	100.00	1.4149	70.67
2025	48.7	.8000	60.88	1.0	78.0	1.2813	.220	22.0	.035	100.00	1.3167	75.95
2026	51.2	.8000	64.00	1.0	62.4	0.9750	.376	37.6	.060	100.00	1.0355	96.57
2027	53.7	.8000	67.13	1.0	46.8	0.6972	.532	53.2	.086	100.00	0.7828	127.75
2028	56.2	.8000	70.25	1.0	31.2	0.4441	.688	68.8	.111	100.00	0.5548	180.25
2029	58.7	.8000	73.38	1.0	15.6	0.2126	.844	84.4	.136	100.00	0.3484	287.05
2030	61.2	.8000	76.50	1.0	0.0	0.0000	1.000	100.0	.161	100.00	0.1609	621.67
<b>Sum of Miles and then Gallons of Equivalent Fuel:</b>										<b>1236.00</b>	<b>16.00</b>	
<b>Equivalent MPG of LDV Fleet in 2030:</b>										<b>77.24</b>		
<b>Sum of ZEV Miles = 457.9. Fraction of Miles Driven by ZEVs = 37.0%</b>												

Certainly, achieving a 32% reduction in driving in 2030 compared to the 2005 level will be difficult. However, increasing the rate of fleet electrification, from what is shown in the *Balanced\_1* and *Balanced\_2* cases (z, in Tables 6 and 7) would be even more difficult.

**Table 10**

**Four-Case Summary of Requirements**

	<b>Case Designations</b>			
	<b>Balanced_1</b>	<b>Balanced_2</b>	<b>2005 Driving</b>	<b>Mary Nichols</b>
<b>% Renewable Electricity</b>	<b>85.0%</b>	<b>90.0%</b>	<b>90.0%</b>	<b>90.00%</b>
<b>% ZEVs, Year 2016</b>	2.0%	2.0%	2.0%	2.70%
<b>% ZEVs, Year 2017</b>	2.0%	2.0%	2.0%	2.70%
<b>% ZEVs, Year 2018</b>	3.0%	3.0%	3.0%	5.11%
<b>% ZEVs, Year 2019</b>	4.0%	4.0%	4.0%	7.53%
<b>% ZEVs, Year 2020</b>	8.0%	8.0%	8.0%	9.94%
<b>% ZEVs, Year 2021</b>	<b>20.0%</b>	15.0%	<b>82.0%</b>	12.35%
<b>% ZEVs, Year 2022</b>	<b>35.0%</b>	25.0%	<b>97.0%</b>	14.76%
<b>% ZEVs, Year 2023</b>	<b>55.0%</b>	<b>45.0%</b>	99.0%	17.18%
<b>% ZEVs, Year 2024</b>	<b>80.0%</b>	<b>70.0%</b>	99.0%	19.59%
<b>% ZEVs, Year 2025</b>	94.0%	95.0%	99.0%	22.00%
<b>% ZEVs, Year 2026</b>	97.0%	97.0%	99.0%	37.60%
<b>% ZEVs, Year 2027</b>	98.0%	98.0%	99.0%	53.20%
<b>% ZEVs, Year 2028</b>	99.0%	99.0%	99.0%	68.80%
<b>% ZEVs, Year 2029</b>	99.0%	99.0%	99.0%	84.40%
<b>% ZEVs, Year 2030</b>	99.0%	99.0%	99.0%	100.00%
<b>% Reduction in Per-Capita Driving With Respect to Year 2005</b>	<b>32.0%</b>	<b>32.0%</b>	<b>0%</b>	<b>50.5%</b>

Besides that, it should be recognized that California alone cannot stabilize our earth's climate. California's best hope is to set an example for other states and other countries. Taking too many of the world's production of electric vehicles will not work. For a more specific example, lithium batteries may be in short supply and so it may be counterproductive for California to have more than its fair share, thus preventing other states and countries from electrifying their fleet at the required rate. The rates of electrification shown for the *Balanced\_1* and the *Balanced\_2* cases are aggressive enough, as shown by the purple-colored entries.

California needs to adopt a set of requirements to achieve the 32% reduction. If CARB wants to work to have California legislate requirements to achieve the *Mary Nichol's* case of a 50% reduction in driving, that would also work and allow more electric cars to go to other states and countries. However the 50% reduction in per-capita driving might be politically impossible at this time.

Since the 32% reduction seems prudent, it begs the question as to what this means in terms of roadway congestion.

The net (as opposed to the per-capita) driving change, going from 2005 to 2030 can be computed by multiplying the per-capita driving factor corresponding to the 32% reduction, which is 0.68, by the population factor of 1.1744, computed in Equation 7. The product of these two values is 0.7986. This means that, even with the 17% increase in California's population, the net driving will have to drop by the factor of about 0.80, or by 20%. If this LDV-driving-reduction requirement (of 0.68) is selected, all of California's transportation money can be used to improve transit, improve active transportation (mainly walking and biking), and maintain, but not expand, roads. There can be little or no congestion because California highway capacity now is larger than it was in 2005 while the state's net driving must drop by 20%.

## **ACHIEVING THE REQUIRED DRIVING REDUCTION OF THE *BALANCED\_1* AND THE *BALANCED\_2* CASES**

As shown in Equation 19, for the *Balanced\_1* case, and in Equation 21 for the *Balanced\_2* Case, in 2030, the per-capita driving will need to be 32% below the 2005 value. As shown in this link, [https://en.wikipedia.org/wiki/Sustainable\\_Communities\\_and\\_Climate\\_Protection\\_Act\\_of\\_2008](https://en.wikipedia.org/wiki/Sustainable_Communities_and_Climate_Protection_Act_of_2008), California's Metropolitan Planning Organizations (MPOs) are adopting Region Transportation Plans (RTPs) that will achieve reductions in year 2020 and 2035. The convention adopted in this report for these reductions, specifically the per-capita driving reduction with respect to the per-capita driving in 2005, matches the SB 375 convention. As shown in the link, the targets, for year 2035, range from 0% for the Shasta MPO to 16% for Sacramento Area Council of Governments. However, it may be true that some of the 2035 requirements have been revised upwards, to be as large as 19% for some MPOs. Since the climate stabilization target year here is 2030 instead of 2035, and to be reasonably conservative, it is assumed here that the state (this is for all MPOs) will achieve a 12% reduction in per-capita driving, in 2030, compared to 2005. This leaves approximately 20% to be achieved by new requirements.

The title of each of the following subsections contains the estimated per-capita driving reduction each strategy will achieve, by 2030.



## **Reallocate Funds Earmarked for Highway Expansion to Transit and Consider Transit-Design Upgrades (2%)**

San Diego County has a sales tax measure called “TransNet”, which allocates approximately one-third for highway expansion, one-third for transit, and one-third for road maintenance. It has a provision that allows for a reallocation of funds, if supported by at least two-thirds of SANDAG Board members, including a so-called weighted vote, where governments are given a portion of 100 votes, proportional to their population. This requirement would be to reallocate the TransNet amount, earmarked for highway expansion, to transit and to do similar reallocations throughout California.

This money could be used to fund additional transit systems; improve transit operations; and/or fund the redesign and implementation of the redesign of existing transit systems. The redesign could include electrification and automation (including automation of fare collection and such features as screening passengers to prevent them from boarding if they have a fever or are in a “test positive” database) or even upgrading to a different transit technology.

## **A Comprehensive Road-Use Charge (RUC) Pricing and Payout System to Unbundle the Cost of Operating Roads (10%)**

*Comprehensive* means that pricing would be set to cover all costs (including road maintenance and externalities such as harm to the environment and health); that privacy and the interests of low-income drivers doing necessary driving would be protected; that the incentive to drive fuel-efficient cars would be at least as large as it is under the current fuels excise tax; and finally, as good technology becomes available, congestion pricing is used to protect critical driving from congestion.

The words *payout* and *unbundle* mean that some of the money collected would go to people that are losing money under the current system.

User fees (gas taxes and tolls) are not enough to cover road costs<sup>10</sup> and California is not properly maintaining its roads. Reference 10 shows that in California user fees amount to only 24.1% of what is spent on roads. Besides this, the improved mileage of the ICEs and the large number of ZEVs mean that gas tax revenues will drop precipitously.

This RUC system could be used to help reduce the ICE LDV miles driven in 2016 to 2022, as shown in the “F” column of Tables 6 through 9. This system could probably be implemented in less than 2 years if the urgency of our climate crisis is recognized..

## **Unbundling the Cost of Car Parking (8%)**

Unbundling the cost of car parking<sup>11</sup> throughout California is conservatively estimated to decrease driving by 8%, based on Table 1 of Reference 11. That table shows driving reductions that occur in response to introducing a price, for 10 cases. Its average reduction in driving is 25% and its smallest reduction is 15%. However, these numbers are for individual cases whereas the 8% is the decrease in driving in California, due to introducing value pricing where there is a zero price today, or where the price is below its value price. These concepts are explained in Reference 11.

The first such systems should be installed by a (RFP is Request for Proposal) RFP-process-identified, third-party vendor, such as Google, Qualcomm, Uber, or Lime Bicycle, for municipal government employees, as part of the government’s Climate Action Plan. The system would be operated for the financial gain of the employees, with a hard requirement in the RFP that even

employees that continue to drive every day would at least break even. The winning third-party vendor would be skilled at monetizing parking whenever it is not being used by the employees and skilled at monetizing data. The parking system would be fully automated, like Uber, except with a more useful phone app that would find the best parking at the user-specified price and walk-distance. The parking would be available to all drivers driving a car registered in the system. Briefly stated, the system is value priced, shared, automated, and provides earnings to all the people that are effectively losing wages or paying higher costs because the parking is being provided. The vendor would also be good at expanding the system both geographically and over all types of uses, in an economically disruptive way; as Uber and Lyft did to the taxi cab industry. The system would be as easy to use as “free” parking, once the car is registered. It would utilize congestion pricing to protect the desired maximum-occupancy rate.

## **Good Bicycle Projects**

The best criterion for spending money for bicycle transportation is the estimated reduction in driving per the amount spent. The following strategies may come close to maximizing this parameter.

### ***Projects to Improve Bicycle Access (1%)***

All of the smart-growth neighborhoods, central business districts, and other high-trip destinations or origins, both existing and planned, should be checked to see if bicycle access could be substantially improved with either a traffic calming project, a “complete streets” project, more shoulder width, or a project to overcome some natural or made-made obstacle. For example, in some cases, long stretches of freeways cut off bicycle passage on surface streets that are perpendicular to the freeway. In some of these cases, a bicycle bridge over the freeway would be cost effective.

### ***League-of-American-Bicyclist-Certified (LCI) Instruction of “Traffic Skills 101” (1%)***

Most serious injuries to bike riders occur in accidents that do not involve a motor vehicle<sup>12</sup>. Most car-bike accidents are caused by wrong-way riding and errors in intersections; the clear-cut-hit-from-behind accident is rare<sup>12</sup>.

After attending *Traffic Skills 101*, students that pass a rigorous written test and demonstrate proficiency in riding in traffic and other challenging conditions, in passing an on-road-riding test, would be paid for their time and effort.

As an example of what could be done in San Diego County, if the average class size was 3 riders per instructor and each rider passes both tests and earns \$100 and if the instructor, with overhead, costs \$500 dollars, for a total of \$800 for each 3 students, that would mean that \$160M could teach  $\$160M/\$800 = 200,000$  classes of 3 students, for a total of 600,000 students. The population of San Diego County is around 3 million.

## **Eliminate or Greatly Increase the Maximum Height and Density Limits Close to Transit Stops that Meet Appropriate Service Standards (2%)**

As sprawl is reduced, more compact, transit-oriented development (TOD) will need to be built. This strategy will incentivize a consideration of what level of transit service will be needed, how it can be achieved, and what levels of maximum height and density are appropriate. Having no limits at all is reasonable if models show that the development can function without harming the existing adjacent

neighborhoods, given the level of transit service and other supporting transportation policies (such as car parking that unbundles the cost and supports the full sharing of parking<sup>12</sup>) that can be assumed.

### **Complete Streets (Streets designed for all users), “Road Diets”, and “Traffic Calming”, Such as Replacing Signalized Intersections with Roundabouts (1%)**

These projects will encourage active transportation, such as bicycling and walking. These projects also fit well with the addition of TOD and increasing density. They will reduce speeds and therefore reduce noise. The noise reduction and increased safety will encourage people to want to live on and around the redesigned arterials where they would not want to have lived before. People will also be more inclined to shop and to work in such surroundings.

### **Net Driving Reduction from All Identified Strategies**

By 2030, the sum of these strategies should be realized as shown in Table 11.

## **CONCLUSION**

The urgency of our climate crisis dictates that California should develop plans such as the cases considered in this paper for a climate-stabilizing target year of 2030. The state needs to select a case and move forward with legislation and implementation. The cases considered in this paper indicate that California should achieve electricity that is at least 85% from renewable sources and a per-capita driving reduction of at least 32% with respect to 2005 driving levels. The eight driving-reducing requirements described in this paper are an example of how this could be done.

**Table 11 Requirements to Achieve a 32% Reduction in 2030 Per-Capita Driving, with Respect to 2005**

<b>Driving Reduction Requirements</b>	<b>Percent Reduction</b>	<b>Factor</b>
Legislated (SB 375) Plans to Reduce Driving	12%	0.88
Value-Priced Road Use Charge (RUC)	10%	0.90
Value-Priced Parking (Unbundling the Cost)	8%	0.92
Transfer Highway Expansion Funds to Transit	2%	0.98
Increase Height & Density by Transit Stations	2%	0.98
"Complete Streets", "Road Diet" (walk/bike)	1%	0.99
<i>Pay-to-Graduate</i> Bicycle Traffic-Skills Class	1%	0.99
Bicycle Projects to Improve Access	1%	0.99
<b>Product of Factors</b>		<b>0.68</b>
<b>% Reduction</b>		<b>32%</b>

**ABBREVIATIONS AND ACRONYMS**

<b>AB 1493</b>	California’s Assembly Bill 1493	<b>ICE</b>	Internal Combustion Engine LDV
<b>AB 32</b>	California’s Assembly Bill 32	<b>kW-h</b>	Kilo Watt-hour
<b>APS</b>	Alternative Planning Strategy	<b>LCFS</b>	Low Carbon Fuel Standard
<b>CAFE</b>	Corporate Average Fleet Efficiency	<b>LDV</b>	Light-Duty Vehicle
<b>CARB</b>	California Air Resources Board	<b>MPO</b>	Metropolitan Planning Organization
<b>CBD</b>	Center for Biological Diversity	<b>Pavley</b>	Senator Pavley’s AB 1493
<b>CEQA</b>	California Environmental Quality Act	<b>PPM</b>	Parts per Million
<b>CCAP</b>	Center for Clean Air Policy	<b>RPS</b>	Renewable Portfolio Standard
<b>CNFF</b>	Cleveland National Forest Foundation	<b>RTP</b>	Regional Transportation Plan
<b>SB 375</b>	California’s Senate Bill 375	<b>S-3-05</b>	Governor’s Executive Order S-3-05
<b>CO<sub>2</sub></b>	Carbon Dioxide	<b>SANDAG</b>	San Diego Association of Governments
<b>CO<sub>2</sub>_e</b>	Carbon Dioxide Equivalent GHG	<b>SCS</b>	Sustainable Community Strategy
<b>EHM</b>	“Extra Heroic Measures” LDV Case	<b>TransNet</b>	San Diego County sales tax
<b>GEO</b>	Governor’s Executive Order		

<b>GHG</b>	Greenhouse gas	<b>URL</b>	Universal Resource Locator
<b>GW-h</b>	Giga Watt-Hours	<b>VMT</b>	Vehicle Miles Travelled
<b>HM</b>	“Heroic Measures” LDV Case	<b>ZEV</b>	Zero Emission Vehicle LDV

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## **KEYWORDS**

Driving, climate, mandates, S-3-05, SB 375, RTP, CEQA, Unbundled, GHG, CAFÉ, ZEVs

***Deriving a **Climate-**  
**Stabilizing Solution Set of**  
**Fleet-Efficiency and Driving-**  
**Level Requirements, for**  
**Light-Duty Vehicles in**  
**California*****

AWMA Paper 796315

Mike R. Bullock

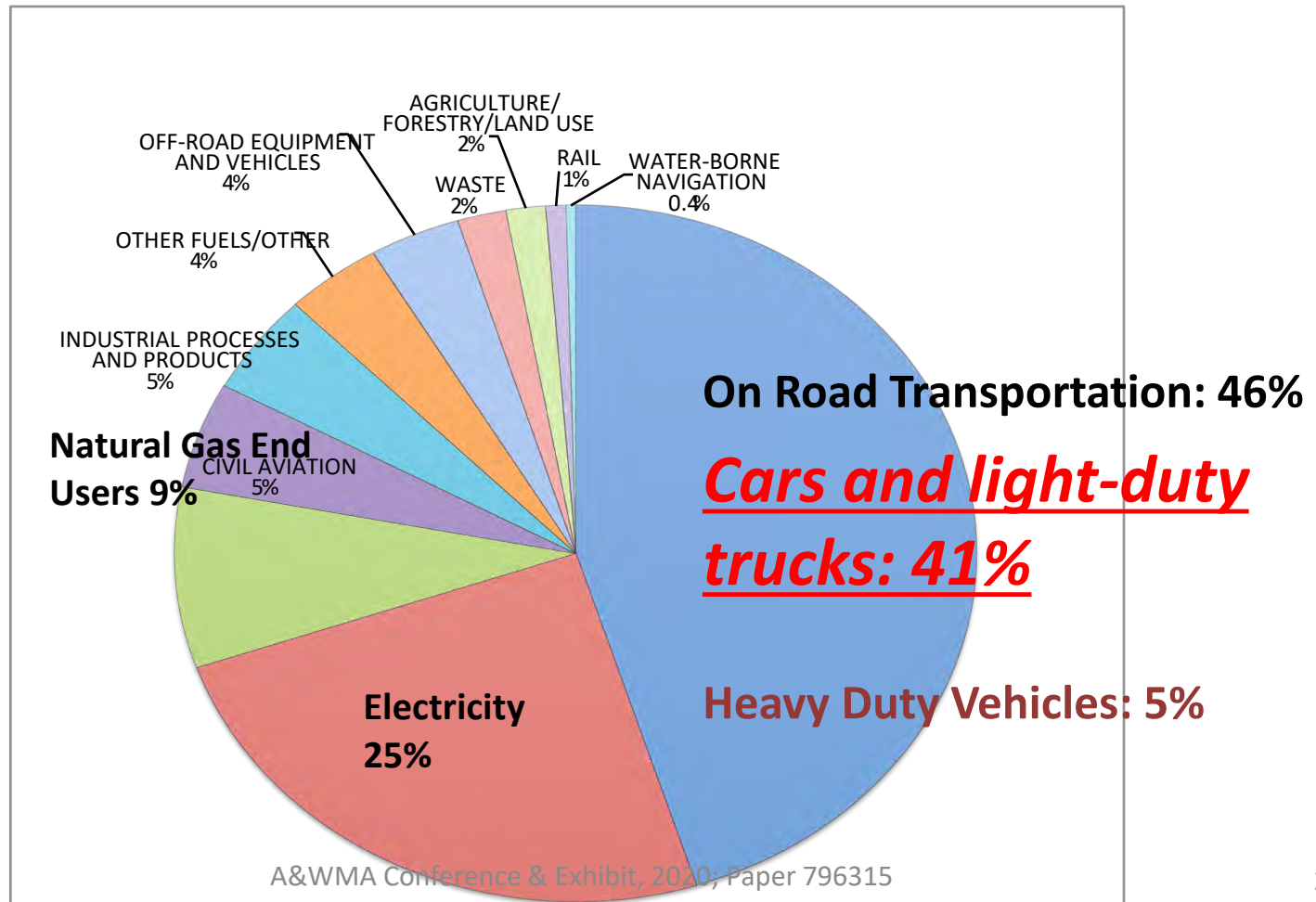
[mike\\_bullock@earthlink.net](mailto:mike_bullock@earthlink.net)

# Why pick on cars?

## Greenhouse Gas (GHG) Emissions, SD County

Source: Energy Policy Initiatives Center (EPIC, USD)

<http://www.sandiego.edu/EPIC/ghginventory/GHG-On-Road1.pdf.pdf>



# Why is there a Climate Problem?

Any Earth Science text book\* contains the following facts:

- **Atmospheric CO<sub>2</sub> traps heat**
  - CO<sub>2</sub> Molecules absorb and then emit, in a random direction, infrared radiation, heat given off by the Earth's surface
  - This effect is significant
- **Combustion of fossil fuels adds **great quantities** of CO<sub>2</sub> to our Earth's atmosphere**
  - The amount of CO<sub>2</sub> in the atmosphere is well known
  - Our yearly emissions are well known

\* For example, Page 539 of *Earth Science*, Tarbuck and Lutgens, Tenth Edition, published by Prentice Hall, 2003.

# How Bad Could It Get?

- *Scientific American* June 2008 issue
  - 550 PPM CO<sub>2</sub> possible in several decades
  - This could (5% probability) lead to 8 Deg. Celsius of warming
  - 8 Deg. Celsius could lead to “a devastating collapse of the human population, perhaps even to extinction”
- December 24/31 2012 Issue of *Nation* magazine:

A recent string of reports from impeccable mainstream institutions—the International Energy Agency, the World Bank, the accounting firm of PricewaterhouseCoopers—have warned that the **Earth is on a trajectory to warm by at least 4 Degrees Celsius**

**[4 Degrees Celsius] would be incompatible with continued human survival.**

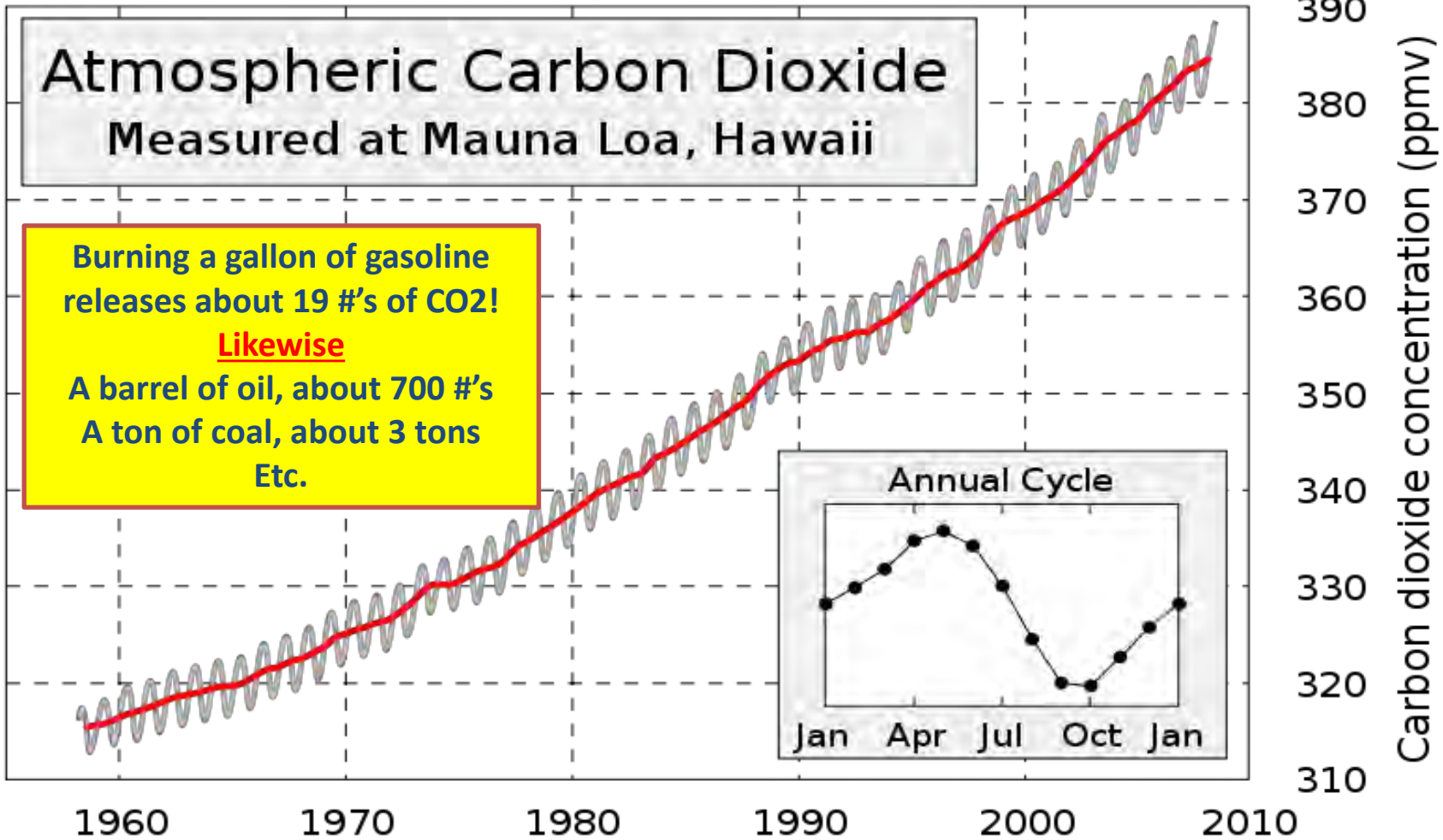
Winter, *UU World* magazine (p. 57) “Lags in the replacement of fossil-fuel use by clean energy use have put the world on a pace for 6 degree Celsius by the end of this century. Such a large temperature rise occurred 250 million years ago and extinguished 90 percent of the life on Earth. The current rise is of the same magnitude but is occurring faster. We must reduce or eliminate all uses of fossil fuels.

# Climate Data

Currently around  
415 PPM!

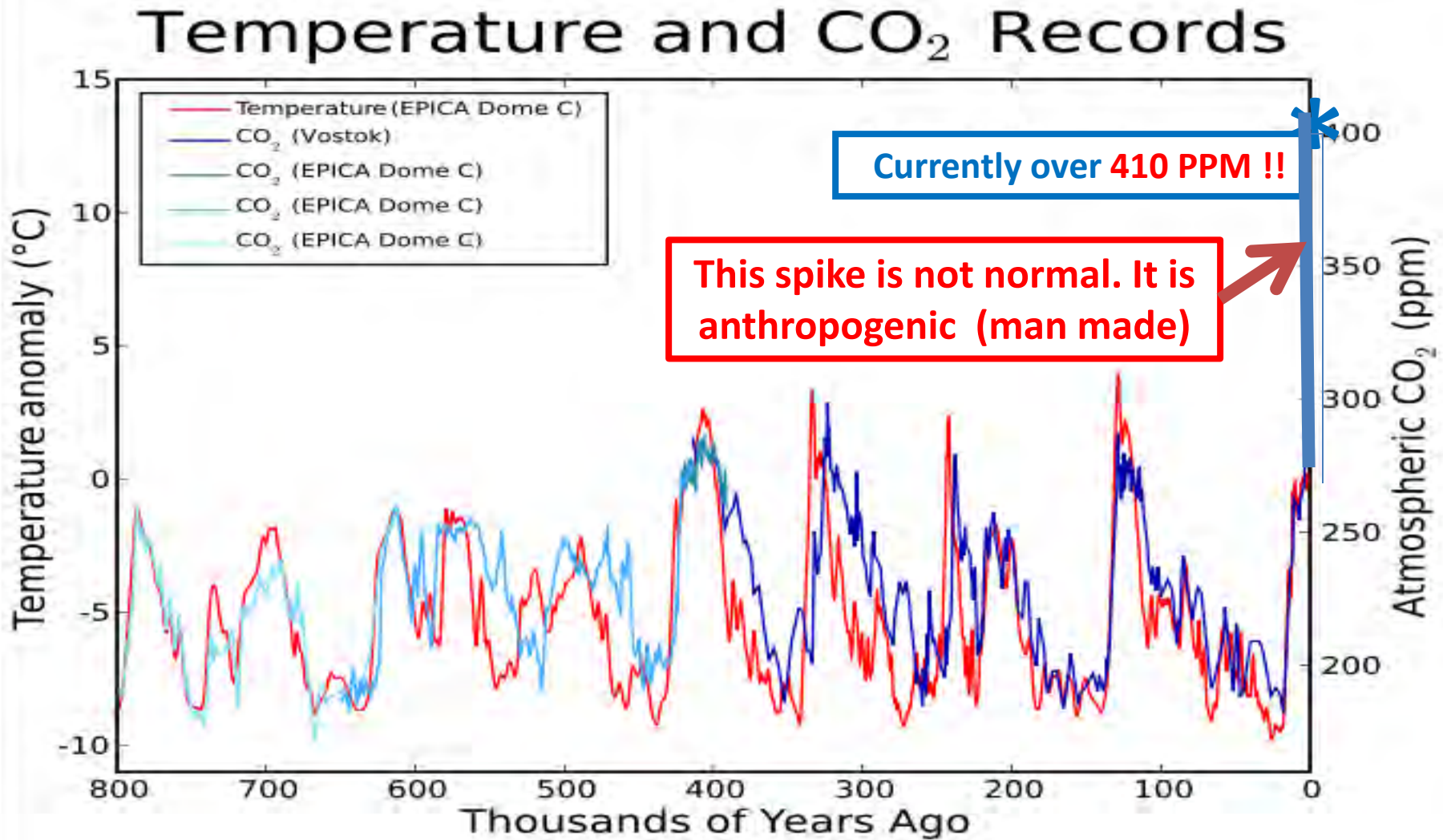
- Keeling Curve:

[http://en.wikipedia.org/wiki/An\\_Inconvenient\\_Truth#Scientific\\_basis](http://en.wikipedia.org/wiki/An_Inconvenient_Truth#Scientific_basis)



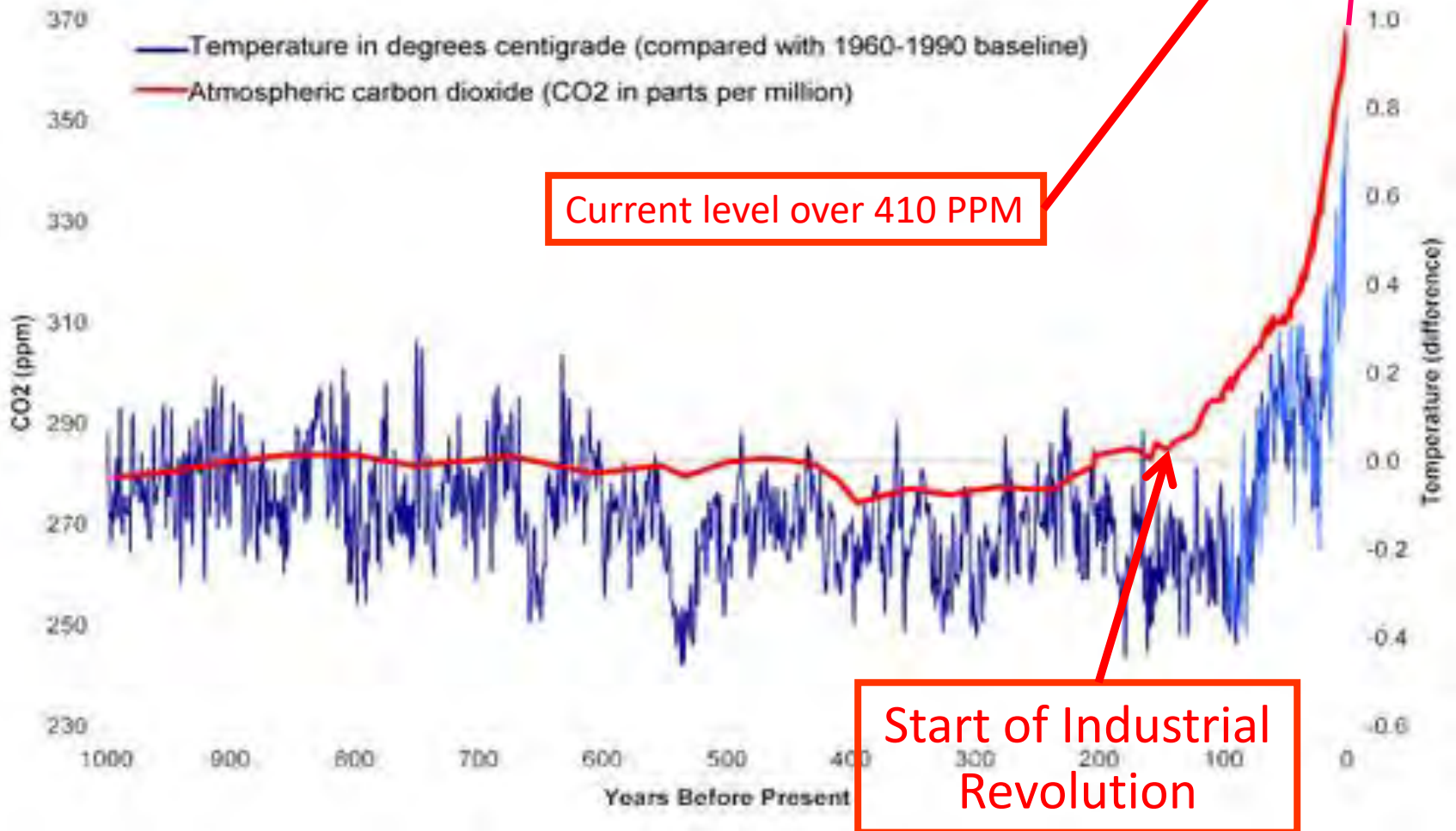


# Climate Change, Mostly Normal



# Let's Zero In on that Spike

- Earth & Space Research (ESR) website:  
[http://www.esr.org/outreach/climate\\_change/mans\\_impact/man1.html](http://www.esr.org/outreach/climate_change/mans_impact/man1.html)



# Fixing the Problem page 1 of 2

**We must stabilize the value of the earth's atmospheric  $CO2_e$**

## $CO2_e$ Emissions

## Sequestration (Photosynthesis)

$E_N$

+

$E_A$

+

$E_{WFB}$

Natural: rotting, fire, digestion, respiration

Anthropogenic: combustion of fossil fuel, methane, other

Warming Feed Back: such as methane from melting permafrost

$>$  → Positive Slope

$=$  → Zero Slope

$<$  → Negative Slope

$S$

Growth of plants on Earth

The Warming Feed Back term,  $E_{WFB}$ , is the wild card. It must not become dominant.

# Fixing the Problem page 2 of 2

*We must **stabilize** the value of the earth's atmospheric **CO<sub>2</sub>\_e**. Here is Step 1:*

**If Anthropogenic emissions were sufficiently low, the slope would be zero, thus **capping** the value of the Earth's atmospheric CO<sub>2</sub>\_e. To achieve this, industrialized nations must limit their emissions to 80% below their 1990 levels.**

**Warning: The **Warming Feed Back** terms must not become dominant.**

# BRIEF OF SCIENTISTS AMICUS GROUP AS *AMICI CURIAE* IN SUPPORT OF PLAINTIFFS- APPELLANTS SEEKING REVERSAL

DANIEL M. GALPERN

Law Offices of Charles M. Tebbutt, P.C.

941 Lawrence St. Eugene, OR 97401-2815

**USCA Case #13-5192 Document #1465822 Filed: 11/12/2013**

**A. Parties and *Amici*.** Except for the following, all parties, intervenors, and *amici* appearing before the district court and in this Court are listed in the Brief for Plaintiffs-Appellants. [James Hansen](#), David Beerling, Paul J. Hearty, Ove Hoegh-Guldberg, Pushker Kharecha, Valérie Masson-Delmotte, Camille Parmesan, Eelco Rohling, Makiko Sato, Pete Smith, and Lise Van Susteren are *amici curiae* in this appeal (referred to hereinafter as “Amici Scientists.”).

# From the Climate Scientists

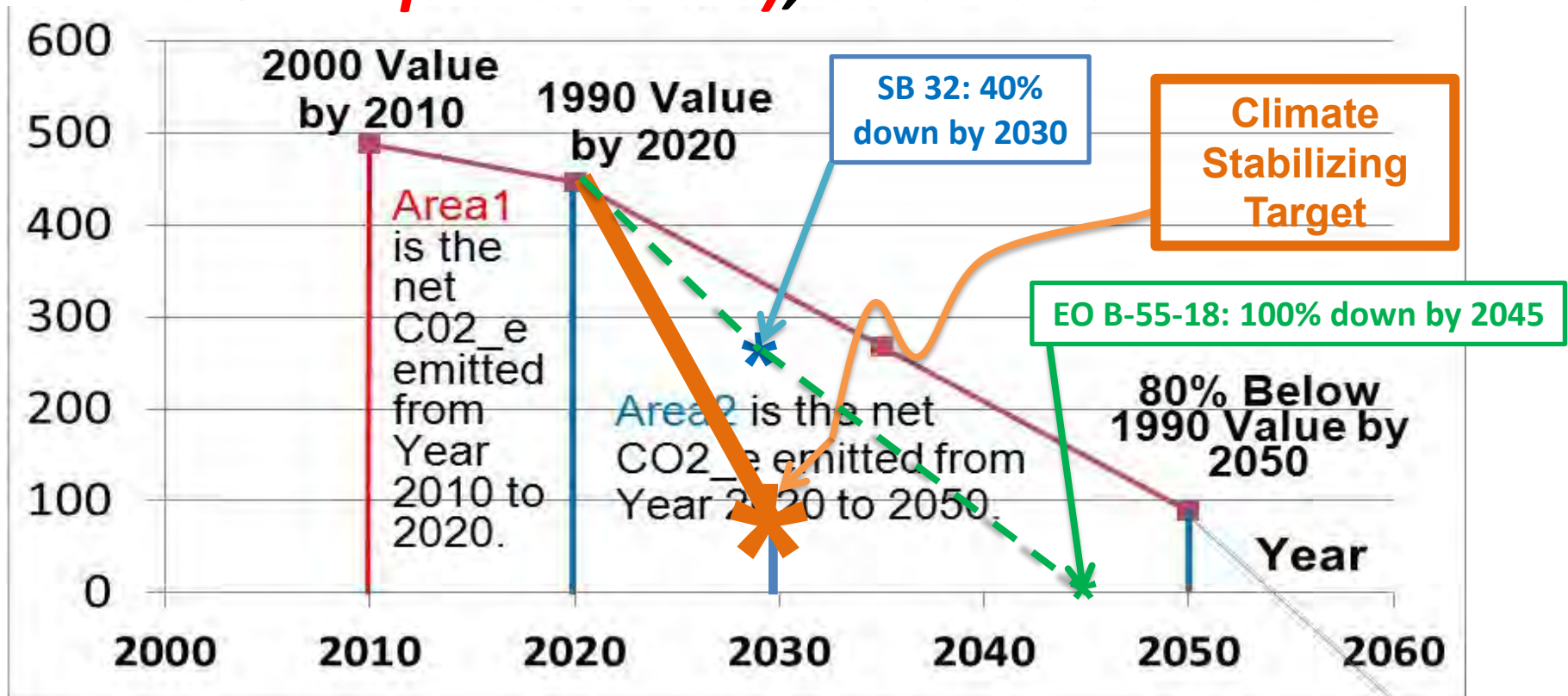
From Page 21: . . . the required rate of emissions reduction would have been about 3.5% per year if reductions had started in 2005, **while the required rate of reduction, if commenced in 2020, will be approximately 15% per year.**

- My math:
  - 15% means a factor of 0.85, year after year
  - Consider the 10 years from 2020 to 2030
  - $(.85)^{10} = .20$ , which is 80% down
  - Other articles, describing Hansen’s work:  
**“decarbonization by 2030”**



# New Climate-Stabilization Prescription

Shown with 3 California Mandates: **EO S-3-05 (Red Line & 4 Square Points)**, **SB 32** and **EO B-55-18**



# How, for LDVs:

*Deriving a **Climate-Stabilizing Solution Set of Fleet-Efficiency and Driving-Level Requirements**, for Light-Duty Vehicles in California*

We have the climate scientist's target. We must now derive the LDV Requirements.

# Notes on Methods

- Base year 2005
- Intermediate year 2015
- Car Efficiency Factor from 2005 to 2015

From a California law (**SB 375**) giving per-capita driving reduction targets to be achieved in Regional Transportation Plans

- Steve Winkelman’s data

- <http://www.nrdc.org/globalWarming/sb375/files/sb375.pdf>

Report on **SB 375**  
See its Table 1.

- Car Efficiency Factor, 2015 to 2030
  - Derived in paper (and here)
  - Results in car-efficiency requirements

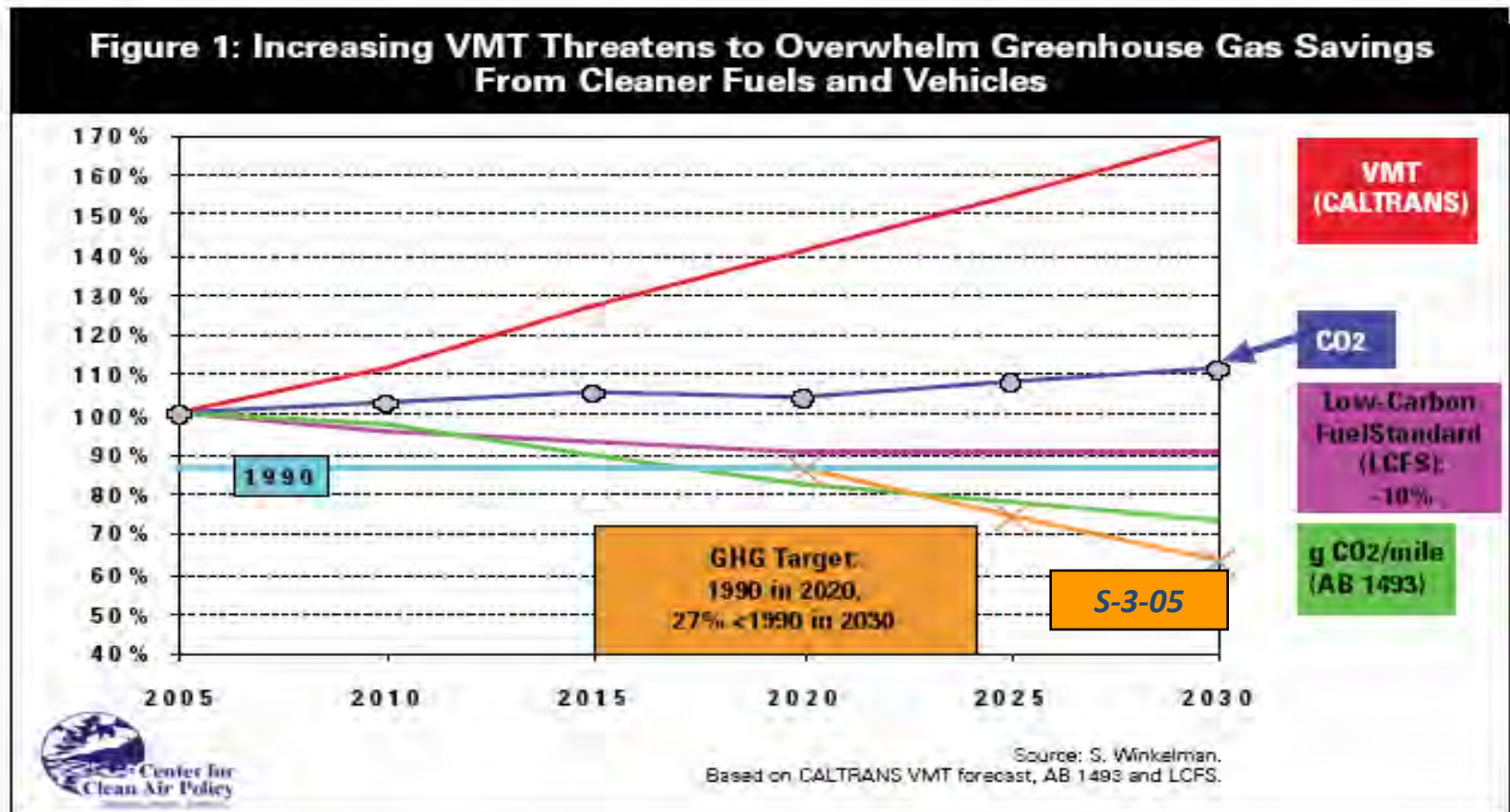
- Cars last 15 years

Cars that survive beyond 2030 are balanced out by those that don’t survive to 2030.

# Data Relating 1990, 2005, & 2015 Data

Purple (Low carbon fuel),  
Green (CO<sub>2</sub>/Mile), & Gold (S-3-05)

Figure 1, from: <http://www.ecovote.org/sites/default/files/pdf/sb375.pdf>



# Variables

## Definitions

$e_k$	LDV Emitted CO2, in Year “k”
$L_k$	Low Carbon Fuel Standard (LCFS) Factor that reduces the Per-Gallon CO2 emissions, in Year “k” (k is denotes Year 2030)
$C_k$	LDV CO2 emitted per mile driven, average, in Year “k”, not accounting for the Low Carbon Fuel Standard (LCFS) Factor
$c_k$	LDV CO2 emitted per mile driven, average, in Year “k”, accounting for the Low Carbon Fuel Standard (LCFS) Factor
$p_k$	Population, in Year “k”
$d_k$	Per-capita LDV driving, in Year “k”
$D_k$	LDV Driving, in Year “k”
$M_k$	LDV Mileage, miles per gallon, in Year “k”
$m_k$	LDV Equivalent Mileage, miles per gallon, in Year “k” accounting for the Low Carbon Fuel Standard (LCFS) Factor, so this is $M_k/L_k$
<b>N</b>	Number of pounds of CO2 per gallon of fuel but not accounting for the Low Carbon Fuel Standard (LCFS) Factor

# Fundamental Equations

Future Year k:  $e_k = c_k * d_k * p_k$

Base Year i:  $e_i = c_i * d_i * p_i$

$$\frac{e_k}{e_i} = \frac{c_k}{c_i} * \frac{d_k}{d_i} * \frac{p_k}{p_i}$$

To work with mileage:  $\frac{m_i}{m_k} = \frac{c_k}{c_i}$



# Solution Overview

“k” denotes Year 2030  
“i” denotes Year 2005

**Car Efficiency Factor**  
From existing mileage requirements and the *requirements defined herein*

From existing and predicted population

$$\frac{e_k}{e_i} = \frac{m_i}{m_k} * \frac{d_k}{d_i} * \frac{p_k}{p_i}$$

From the known 1990-to-2005 factor and the **Climate-Stabilizing-Target**, which is the factor of 2030 emissions to 1990 emissions

***The Independent Variable***  
It becomes the *required per-capita driving reduction with respect to 2005 driving*

# Solution Using Intermediate Year of 2015

From the **Climate-Stabilizing-Target**, which is the factor of 2030 emissions to 1990 emissions

**Car Efficiency Factor**  
From existing mileage requirements and the **requirements defined herein**

From Winkelman. It is the product of the factor from the green line and the purple line.

From known and predicted populations

$$\frac{e_{2030}}{e_{1990}} * \frac{e_{1990}}{e_{2005}}$$

$$= \frac{c_{2030}}{c_{2015}} * \frac{c_{2015}}{c_{2005}} * \frac{d_{2030}}{d_{2005}} * \frac{p_{2030}}{p_{2005}}$$

Taken from the Winkelman data: the known 1990-to-2005 factor of emissions (the light blue line)

***The Independent Variable***  
It becomes the **required 2030 per-capita driving reduction with respect to 2005 driving**

# Putting In the Easy-to-Get Values

From the **Climate-Stabilizing-Target**, which is the factor of 2030 emissions to 1990 emissions (“80% down”)

**Car Efficiency Factor**  
From existing mileage requirements and the *requirements defined herein*

From Winkelman. It is the product of the factor from the green line and the purple line. There is less CO2 per mile, thanks to the LCFS

From known and predicted populations

$$0.20 * 0.87 = \frac{C_{2030}}{C_{2015}} * 0.90 * 0.93 * \frac{d_{2030}}{d_{2005}} * 1.17446$$

Taken from the Winkelman data: the known 1990-to-2005 factor of emissions (the light blue line)

***This ratio is the Independent Variable. It is the required per-capita 2030 driving reduction with respect to 2005 driving***

# Combining the Easy-to-Get Values, Solving for the Independent Variable, and Changing the 2015-to-2030 Car Efficiency from CO2-Per-Mile to Equivalent-Miles-Per-Gallon

$$0.17700 = \frac{C_{2030}}{C_{2015}} * \frac{d_{2030}}{d_{2005}}$$

$$\frac{d_{2030}}{d_{2005}} = 0.17700 * \frac{C_{2015}}{C_{2030}}$$

$$\frac{d_{2030}}{d_{2005}} = 0.17700 * \frac{m_{2030}}{m_{2015}}$$

Equivalent Mileage in 2030 is what we make it. It better be as high as possible, because a large driving reduction will be difficult.  
= “**NUMERATOR MILEAGE**”

The required per-capita 2030 driving with respect to 2005 driving

2015 Fleet Mileage is computed  
= “**DENOMINATOR MILEAGE**”

# Some **Requirements** Defined to Achieve 2030 Fleet Equivalent-Mileage

- Low-Carbon Fuel Standards (LCFS)
- Corporate Average Fuel Efficiency (CAFÉ) Standards from 2015 to 2030
- Driving Reduction Factors ( $f_n$ ) for bad-mileage years (Year n)

Both California's existing and extended, "L<sub>k</sub>"

Existing, to 2025  
**Specified to 2030**

- For example, 0.75 means 25% less driving
- **Cash for Gas-guzzlers?**

# Three More Requirements

## *Defined to Achieve 2030 Fleet Equivalent-Mileage*

- CAFÉ Standards only apply to Internal Combustion Engine (ICE) LDVs
- New Requirement: Fraction of fleet sold that must be Zero Emission Vehicles (ZEVs)
- In 2030, only 15%, or (the other case) 10% of electricity is from fossil fuels

**Define “z” to be the fraction of fleet sold that must be ZEVs**



# Fleet Mileage for Intermediate Year 2015

LDV Set	Years Old	Model Year	CAFE MPG	LCFS Factor $L_{Year}$	Factor Driven $f$	Gallons Used Per $f \times 100$ Miles
1	14-15	2001	24.0	1.0	1.0	4.17
2	13-14	2002	24.0	1.0	1.0	4.17
3	12-13	2003	24.0	1.0	1.0	4.17
4	11-12	2004	24.0	1.0	1.0	4.17
5	10-11	2005	25.0	1.0	1.0	4.00
6	9-10	2006	25.7	.9933	1.0	3.87
7	8-9	2007	26.3	.9867	1.0	3.75
8	7-8	2008	27.0	.9800	1.0	3.63
9	6-7	2009	28.0	.9733	1.0	3.48
10	5-6	2010	28.0	.9667	1.0	3.45
11	4-5	2011	29.1	.9600	1.0	3.30
12	3-4	2012	29.8	.9533	1.0	3.20
13	2-3	2013	30.6	.9467	1.0	3.09
14	1-2	2014	31.4	.9400	1.0	2.99
15	0-1	2015	32.6	.9333	1.0	2.86
<b>Sum of Gallons:</b>						<b>54.29</b>
<b>Miles = 100*Sum(<math>f</math>'s):</b>						<b>1500</b>
<b>MPG = Miles/(Sum of Gallons):</b>						<b>27.63</b>

Computed **DENOMINATOR MILEAGE** 

# ZEV Derivation Variables

Variable	Definition
$m_z$	ZEV Equivalent mileage (miles per equivalent gallon)
$m_{zr}$	ZEV Equivalent mileage if the electricity is from 100% renewables
$m_{zf}$	ZEV Equivalent mileage if the electricity is from 100% fossil fuels
$r$	fraction of electricity generated from sources not emitting CO2
<b>G</b>	Gallons of equivalent fuel used
<b>D</b>	Arbitrary distance travelled
<b>Num</b>	$m_{zr} \times m_{zf}$
<b>Den</b>	$r \times m_{zf} + (1 - r) \times m_{zr}$

# ZEV Derivation

$$G = \frac{r \times D}{m_{zr}} + \frac{(1 - r) \times D}{m_{zf}}$$

$$m_z = D/G = D / \left( \frac{r \times D}{m_{zr}} + \frac{(1 - r) \times D}{m_{zf}} \right)$$

$$m_z = m_{zr} \times m_{zf} / (r \times m_{zf} + (1 - r) \times m_{zr})$$

$$m_z = \text{Num} / (\text{Den})$$

$m_{zr}$	$m_{zf}$	r	1-r	Num	Den	$m_z$
5000	70	0.80	0.20	350000.00	1056.00	331.44
5000	70	0.85	0.15	350000.00	809.50	432.37
5000	70	0.90	0.10	350000.00	563.00	621.67

# Four Variable Definitions & Selecting a Target Numerator Mileage Value

Variable	Definition
$D_i$	Distance travelled by ICE vehicles
$D_z$	Distance travelled by ZEV vehicles
$G_i$	Gallons of equivalent fuel used by ICE vehicles
$G_z$	Gallons of equivalent fuel used by ZEVs

This previously-derived equation was used.

$$\frac{d_{2030}}{d_{2005}} = 0.17700 * \frac{m_{2030}}{m_{2015}}$$

The driving reduction,  $\frac{d_{2030}}{d_{2005}}$ , was set to 0.68, corresponding to a 32% reduction in driving.

Then, using the previously-computed  $m_{2015} = 27.63$  mile per gallon (MPG), the **Numerator Mileage ( $m_{2030}$ )** was computed to be around **106 MPG**.

Finally, the **z** values were selected in the following table, by trial and error, to get the **Numerator Mileage ( $m_{2030}$ )** to be close to that **106 MPG** value.

# “Balanced\_1”, 85% Renewable Electricity

ZevMileage = 432.37 So  $G_z = D_z / 432.37$

Year	ICE Parameters and Calculations						ZEVs			Yearly Totals		
	CAFÉ MPG	LCFS	Eq. MPG	f	$D_i$	$G_i$	z	$D_z$	$G_z$	Total Miles	Total Gallons	2030 MPG
2016	34.3	0.9267	37.01	0.3	29.4	0.7943	0.02	2	0.005	31.40	0.7989	39.30
2017	35.1	0.9200	38.15	0.4	39.2	1.0275	0.02	2	0.005	41.20	1.0321	39.92
2018	36.1	0.9133	39.53	0.5	48.5	1.2271	0.03	3	0.007	51.50	1.2340	41.73
2019	37.1	0.9067	40.92	0.6	57.6	1.4077	0.04	4	0.009	61.60	1.4169	43.47
2020	38.3	0.9000	42.56	0.7	64.4	1.5133	0.08	8	0.019	72.40	1.5318	47.26
2021	40.3	0.8500	47.41	0.8	64.0	1.3499	0.20	20	0.046	84.00	1.3961	60.17
2022	42.3	0.8000	52.88	0.9	58.5	1.1064	0.35	35	0.081	93.50	1.1873	78.75
2023	44.3	0.8000	55.38	1.0	45.0	0.8126	0.55	55	0.127	100.00	0.9398	106.40
2024	46.5	0.8000	58.13	1.0	20.0	0.3441	0.80	80	0.185	100.00	0.5291	188.99
2025	48.7	0.8000	60.88	1.0	6.0	0.0986	0.94	94	0.217	100.00	0.3160	316.48
2026	51.2	0.8000	64.00	1.0	3.0	0.0469	0.97	97	0.224	100.00	0.2712	368.70
2027	53.7	0.8000	67.13	1.0	2.0	0.0298	0.98	98	0.227	100.00	0.2565	389.93
2028	56.2	0.8000	70.25	1.0	1.0	0.0142	0.99	99	0.229	100.00	0.2432	411.17
2029	58.7	0.8000	73.38	1.0	1.0	0.0136	0.99	99	0.229	100.00	0.2426	412.20
2030	61.2	0.8000	76.50	1.0	1.0	0.0131	0.99	99	0.229	100.00	0.2420	413.15
<b>Sum of Miles and then Gallons of equivalent fuel:</b>										<b>1235.60</b>	<b>11.64</b>	
<b>Equivalent MPG of LDV Fleet in 2030:</b>										<b>106.17</b>		
<b>ZEV Miles Driven = 795.0</b>					<b>Fraction of Miles Driven by ZEVs = 64.3%</b>							

**Computed  
NUMINATOR  
MILEAGE**

# Computing the Ratio of Per-Capita 2030 Driving to Per-Capita 2005 Driving

Equivalent Mileage in 2030 = “**NUMERATOR MILEAGE**”

$$\frac{d_{2030}}{d_{2005}} = .1770 * \frac{106.17}{27.63} = .68$$

2015 Fleet Mileage was computed before = “**DENOMINATOR MILEAGE**”

The factor of 0.68 means there is a 32% reduction in per-capita driving, from 2005 to 2030.

Again, for the next case, the **z** values were selected by trial and error, to get the 106 MPG value, corresponding to a 32% decrease in driving.



# “Balanced\_2”, 90% Renewable Electricity

ZevMileage = 621.67    So  $G_z = D_z / 621.67$

Year	ICE Parameters and Calculations						ZEVs			Yearly Totals		
	CAFÉ MPG	LCFS	Eq. MPG	f	D <sub>i</sub>	G <sub>i</sub>	z	D <sub>z</sub>	G <sub>z</sub>	Total Miles	Total Gallons	2030 MPG
2016	34.3	0.927	37.01	0.3	29.4	0.7943	0.02	2	0.003	31.40	0.7975	39.37
2017	35.1	0.920	38.15	0.4	39.2	1.0275	0.02	2	0.003	41.20	1.0307	39.97
2018	36.1	0.913	39.53	0.5	48.5	1.2271	0.03	3	0.005	51.50	1.2319	41.81
2019	37.1	0.907	40.92	0.6	57.6	1.4077	0.04	4	0.006	61.60	1.4141	43.56
2020	38.3	0.900	42.56	0.7	64.4	1.5133	0.08	8	0.013	72.40	1.5262	47.44
2021	40.3	0.850	47.41	0.8	68.0	1.4342	0.15	15	0.024	83.00	1.4584	56.91
2022	42.3	0.800	52.88	0.9	67.5	1.2766	0.25	25	0.040	92.50	1.3168	70.25
2023	44.3	0.800	55.38	1.0	55.0	0.9932	0.45	45	0.072	100.00	1.0656	93.84
2024	46.5	0.800	58.13	1.0	30.0	0.5161	0.70	70	0.113	100.00	0.6287	159.05
2025	48.7	0.800	60.88	1.0	5.0	0.0821	0.95	95	0.153	100.00	0.2349	425.62
2026	51.2	0.800	64.00	1.0	3.0	0.0469	0.97	97	0.156	100.00	0.2029	492.84
2027	53.7	0.800	67.13	1.0	2.0	0.0298	0.98	98	0.158	100.00	0.1874	533.52
2028	56.2	0.800	70.25	1.0	1.0	0.0142	0.99	99	0.159	100.00	0.1735	576.42
2029	58.7	0.800	73.38	1.0	1.0	0.0136	0.99	99	0.159	100.00	0.1729	578.45
2030	61.2	0.800	76.50	1.0	1.0	0.0131	0.99	99	0.159	100.00	0.1723	580.31

Sum of Miles and then Gallons of equivalent fuel: 1233.60    11.61

Equivalent MPG of LDV Fleet in 2030: 106.22

ZEV Miles Driven = 761.0

Fraction of Miles Driven by ZEVs = 61.7%

Computed  
NUMINATOR  
MILEAGE

# Selecting a Target Numerator Mileage Value to Get a 0% Reduction in Driving

This previously-derived equation was used.

$$\frac{d_{2030}}{d_{2005}} = 0.17700 * \frac{m_{2030}}{m_{2015}}$$

The driving reduction,  $\frac{d_{2030}}{d_{2005}}$ , was set to 1.00, corresponding to a 0% reduction in driving.

Then, using the previously-computed  $m_{2015} = 27.63$  mile per gallon (MPG), the **Numerator Mileage ( $m_{2030}$ )** was computed to be around **156 MPG**.

Finally, the **z** values were selected in the following table, by trial and error, to get the **Numerator Mileage ( $m_{2030}$ )** to be close to that **156 MPG** value.

# “2005 Driving Case”, 90% Renewable Electricity

		Zev mileage = 621.67					So $G_z = D_z / 621.67$					
Year	ICE Parameters and Calculations						ZEVs			Yearly Totals		
	CAFÉ MPG	LCFS	Eq. MPG	f	$D_i$	$G_i$	z	$D_z$	$G_z$	Total Miles	Total Gallons	2030 MPG
2016	34.3	0.9267	37.01	0.3	29.4	0.7943	0.02	2.0	0.003	31.40	0.7975	39.37
2017	35.1	0.9200	38.15	0.4	39.2	1.0275	0.02	2.0	0.003	41.20	1.0307	39.97
2018	36.1	0.9133	39.53	0.5	48.5	1.2271	0.03	3.0	0.005	51.50	1.2319	41.81
2019	37.1	0.9067	40.92	0.6	57.6	1.4077	0.04	4.0	0.006	61.60	1.4141	43.56
2020	38.3	0.9000	42.56	0.7	64.4	1.5133	0.08	8.0	0.013	72.40	1.5262	47.44
2021	40.3	0.8500	47.41	0.8	14.4	0.3037	0.82	82.0	0.132	96.40	0.4356	221.29
2022	42.3	0.8000	52.88	0.9	2.7	0.0511	0.97	97.0	0.156	99.70	0.2071	481.42
2023	44.3	0.8000	55.38	1.0	1.0	0.0181	0.99	99.0	0.159	100.00	0.1773	563.99
2024	46.5	0.8000	58.13	1.0	1.0	0.0172	0.99	99.0	0.159	100.00	0.1765	566.72
2025	48.7	0.8000	60.88	1.0	1.0	0.0164	0.99	99.0	0.159	100.00	0.1757	569.23
2026	51.2	0.8000	64.00	1.0	1.0	0.0156	0.99	99.0	0.159	100.00	0.1749	571.84
2027	53.7	0.8000	67.13	1.0	1.0	0.0149	0.99	99.0	0.159	100.00	0.1741	574.23
2028	56.2	0.8000	70.25	1.0	1.0	0.0142	0.99	99.0	0.159	100.00	0.1735	576.42
2029	58.7	0.8000	73.38	1.0	1.0	0.0136	0.99	99.0	0.159	100.00	0.1729	578.45
2030	61.2	0.8000	76.50	1.0	1.0	0.0131	0.99	99.0	0.159	100.00	0.1723	580.31
<b>Sum of Miles and then Gallons of equivalent fuel:</b>										<b>1254.20</b>	<b>8.04</b>	
<b>Equivalent MPG of LDV Fleet in 2030:</b>										<b>155.99</b>		
<b>ZEV Miles Driven = 990.0</b>					<b>Fraction of Miles Driven by ZEVs = 78.9%</b>							

Computed  
**NUMINATOR**  
**MILEAGE** 32

# Computing the Ratio of Per-Capita 2030 Driving to Per-Capita 2005 Driving

Equivalent Mileage in 2030 is what we made it by selecting the “z” values in the previous table. = “**NUMERATOR MILEAGE**”

$$\frac{d_{2030}}{d_{2005}} = .1770 * \frac{155.99}{27.63} = 1.00$$

2015 Fleet Mileage was computed = “**DENOMINATOR MILEAGE**”

For the next case, the **z** values were taken from a published article describing values selected by the Chair of the California Air Resources Board, Mary Nichols.

# “Mary Nichols Case”, 90% Renewable Electricity

		Zev Mileage = 621.67					So $G_z = D_z / 621.67$					
Year	ICE Parameters and Calculations						ZEVs			Yearly Totals		
	CAFÉ MPG	LCFS	Eq. MPG	f	$D_i$	$G_i$	z	$D_z$	$G_z$	Total Miles	Total Gallons	2030 MPG
2016	34.3	0.9267	37.01	0.3	29.2	0.7886	0.027	2.7	0.004	31.89	0.7930	40.22
2017	35.1	0.9200	38.15	0.4	38.9	1.0201	0.027	2.7	0.004	41.62	1.0245	40.63
2018	36.1	0.9133	39.53	0.5	47.4	1.2003	0.051	5.1	0.008	52.56	1.2086	43.49
2019	37.1	0.9067	40.92	0.6	55.5	1.3560	0.075	7.5	0.012	63.01	1.3681	46.06
2020	38.3	0.9000	42.56	0.7	63.0	1.4814	0.099	9.9	0.016	72.98	1.4974	48.74
2021	40.3	0.8500	47.41	0.8	70.1	1.4790	0.124	12.4	0.020	82.47	1.4988	55.02
2022	42.3	0.8000	52.88	0.9	76.7	1.4509	0.148	14.8	0.024	91.48	1.4746	62.03
2023	44.3	0.8000	55.38	1.0	82.8	1.4957	0.172	17.2	0.028	100.00	1.5233	65.65
2024	46.5	0.8000	58.13	1.0	80.4	1.3834	0.196	19.6	0.032	100.00	1.4149	70.67
2025	48.7	0.8000	60.88	1.0	78.0	1.2813	0.220	22.0	0.035	100.00	1.3167	75.95
2026	51.2	0.8000	64.00	1.0	62.4	0.9750	0.376	37.6	0.060	100.00	1.0355	96.57
2027	53.7	0.8000	67.13	1.0	46.8	0.6972	0.532	53.2	0.086	100.00	0.7828	127.75
2028	56.2	0.8000	70.25	1.0	31.2	0.4441	0.688	68.8	0.111	100.00	0.5548	180.25
2029	58.7	0.8000	73.38	1.0	15.6	0.2126	0.844	84.4	0.136	100.00	0.3484	287.05
2030	61.2	0.8000	76.50	1.0	0.0	0.0000	1.000	100.0	0.161	100.00	0.1609	621.67
<b>Sum of Miles and then Gallons of equivalent fuel:</b>										<b>1236.00</b>	<b>16.00</b>	
<b>Equivalent MPG of LDV Fleet in 2030:</b>										<b>77.24</b>		
<b>ZEV Miles Driven = 457.9</b>					<b>Fraction of Miles Driven by ZEVs =</b>					<b>37.0%</b>		

**Computed  
NUMINATOR  
MILEAGE**

# Computing the Ratio of Per-Capita 2030 Driving to Per-Capita 2005 Driving

Equivalent Mileage in 2030 is what resulted from the Mary Nichols statement. It is the “**NUMERATOR MILEAGE**”

$$\frac{d_{2030}}{d_{2005}} = .1770 * \frac{77.24}{27.63} = .495$$

2015 Fleet Mileage was computed  
= “**DENOMINATOR MILEAGE**”

CARB may not understand that the fleet electrification schedule suggested by their Board Chair would require that per-capita driving be about half what it was in 2005, if LDVs are to achieve climate-stabilizing targets.



# Net Driving Decrease with Respect to 2005 Driving for the “Balanced” Cases

(Per-Capita Driving Factor) **x** (Population Factor) =  
Net Driving Factor

This factor corresponds to the 32% reduction in per-capita driving

$$(.68) \times (1.1744) = .80$$

*Therefore, even though the population will grow 17%, net driving must decrease by 20%.*

*Therefore, why add highway lanes?*

*We need enforceable measures to reduce driving so much there will be no more congestion!*

# 4 Cases that Support Climate Stabilization

Note: **Purple** denotes difficult;  
**red**, impossible.

	Case Designations			
	Balanced_1	Balanced_2	2005 Driving	Mary Nichols
% Renewable Electricity	85.0%	90.0%	90.0%	90.00%
% ZEVs, Year 2016	2.0%	2.0%	2.0%	2.70%
% ZEVs, Year 2017	2.0%	2.0%	2.0%	2.70%
% ZEVs, Year 2018	3.0%	3.0%	3.0%	5.11%
% ZEVs, Year 2019	4.0%	4.0%	4.0%	7.53%
% ZEVs, Year 2020	8.0%	8.0%	8.0%	9.94%
% ZEVs, Year 2021	20.0%	15.0%	82.0%	12.35%
% ZEVs, Year 2022	35.0%	25.0%	97.0%	14.76%
% ZEVs, Year 2023	55.0%	45.0%	99.0%	17.18%
% ZEVs, Year 2024	80.0%	70.0%	99.0%	19.59%
% ZEVs, Year 2025	94.0%	95.0%	99.0%	22.00%
% ZEVs, Year 2026	97.0%	97.0%	99.0%	37.60%
% ZEVs, Year 2027	98.0%	98.0%	99.0%	53.20%
% ZEVs, Year 2028	99.0%	99.0%	99.0%	68.80%
% ZEVs, Year 2029	99.0%	99.0%	99.0%	84.40%
% ZEVs, Year 2030	99.0%	99.0%	99.0%	100.00%
% Reduction in Per-Capita Driving With Respect to Year 2005	32.0%	32.0%	0%	50.5%

# Enforceable Measures to Reduce 2030 Driving by 32% With Respect to 2005

California designs and implements this

Local governments do this with a 3<sup>rd</sup> party vendor

Driving-Reduction Requirments	Per-Cent Reduction	Factor
Legislated (SB 375) Plans to Reduce Driving	12%	0.88
Value-Priced Road Use Charge (RUC)	10%	0.90
Value-Priced Parking (Unbundling the Cost)	8%	0.92
Transfer Highway Expansion Funds to Transit	2%	0.98
Increase Height & Density by Transit Stations	2%	0.98
"Complete Streets", "Road Diet" (walk/bike)	1%	0.99
<i>Pay-to-Graduate</i> Bicycle Traffic-Skills Class	1%	0.99
Bicycle Projects to Improve Access	1%	0.99
<b>Product of Factors</b>		<b>0.68</b>
<b>% Reduction</b>		<b>32%</b>

*These enforceable measures are described in the AWMA paper.*

# An Important **Pricing** Strategy

## *A Road-Usage-Charge (RUC) Pricing & Payout System*

**THEREFORE, BE IT RESOLVED**, that the Democratic Club of Carlsbad and Oceanside (DEMCCO) supports a road-usage charge (RUC) pricing & payout system that would (1) cover all road-use costs, including the environmental & health costs caused by driving; (2) mitigate impacts on low-income users; (3) protect privacy; (4) include congestion pricing; (5) keep the per-mile price incentive to drive energy-efficient cars at least as large as it is with today's fuel excise tax; and (6) send its earnings to all citizens and institutions that are currently losing money by subsidizing road use.

# Another Important Pricing Strategy

**A good car-parking system: value-priced (with congestion pricing), shared, automated, and providing earnings to those losing money because the parking is being provided.**

The first such systems should be installed by a third-party vendor (such as **Google, Qualcomm, Uber, or Lime Bicycle**), selected by a RFP (Request for Proposal) process, for municipal government employees, as part of the government's **Climate Action Plan**. It would be operated for the financial gain of the employees. The RFP would specify that even employees that continue to drive every day would at least break even. The winning third-party vendor would be skilled at monetizing parking, whenever it is not being used by the employees; at monetizing data; and at expanding the system. The system would be automated with a useful phone app to find the best parking at the user-specified price and walk-distance.

## **From the 2020 California Democratic Party (CDP) Platform**

- Work to ensure that all graduating high school students are climate literate, including knowing
  - reasons for anthropogenic climate change and its potential for harm;
  - the difference between climate stabilization and destabilization;
  - climate-stabilizing greenhouse gas (GHG) reduction targets;
    - the basis for those targets, and
    - the measures needed to achieve them; and
  - the primary categories of emissions, including the most problematic category: cars and light-duty trucks;
- Demand a state plan specifying how cars and light-duty trucks can meet climate-stabilizing targets by defining enforceable measures to achieve necessary fleet efficiency and per-capita driving limits;
- Demand Regional Transportation Plan (RTP) driving-reduction targets, shown by science to support climate stabilization;
- Work for equitable and environmentally-sound road and parking operations; smart growth; “complete streets”; teaching bicycling traffic skills; and improving transit, from local systems to high-speed rail;
- Support the design and implementation of a single, environmentally-sound technology system that will collect and distribute fees for the use of roads, parking, and transit that is both economically fair and convenient and protects user privacy and the interests of low-income users;
- Work for the electrification of all trucking and transit systems;
- Work to ensure that freeway expansion projects are subordinate to more sustainable alternatives that will result in more jobs and growth.

## **From the 2016 & 2018 Platform (*Dividend Account Parking*)**

- Work for shared, convenient, and value-priced parking, operated with a system that provides earnings to those paying higher costs or receiving a reduced wage, due to the cost of providing the parking.

**Please email comments or questions to [mike\\_bullock@earthlink.net](mailto:mike_bullock@earthlink.net)**



## **Support for an Equitable, Convenient, and Environmentally-Sound Car-Parking System that Protects Privacy and *the Economic Interests of Low-Income Drivers***

**WHEREAS**, (1) our greenhouse gas (GHG) emissions must be reduced, (2) about 40% of California's emissions are from on-road transportation; (3) reducing car parking subsidies would (a) reduce GHG emissions, air-pollution, and congestion by reducing vehicle trips, (b) give employees more control over their potential earnings, and (c) give renters and consumers more control over their costs; and furthermore,

**WHEREAS**, (1) Too often, non-drivers lose money due to parking facilities being provided; (2) "free" employee parking is paid for by lower wages for all workers, including those who do not drive; (3) properly pricing parking would reduce the need to build so much parking and the resulting lower construction costs would help everyone; and (4) "free" parking at an apartment complex can sometimes increase rent by over \$75 dollars per month, for all renters, even those that do not own a car; and finally,

**WHEREAS**, (1) methods to automatically charge car owners based on when and where their car was parked, could be implemented, while having safeguards to protect privacy and the economic interests of low-income drivers; (2) methods to automatically provide car-parking earnings to renters, residents, shoppers, train riders, employees, those residing on streets that have on-street parking, and others, could be implemented, using algorithms tailored to each group; (3) earnings algorithms for employees could ensure that even those that drive everyday would break even; (4) parking is optimized if it is available to all user groups, (5) pricing algorithms for on-street parking could protect neighborhoods from the excessive intrusion of parked cars, and (6) a car-parking phone app could direct users to the best parking space, given the driver's willingness to pay and walk, thus reducing cars being driven around to look for parking.

**THEREFORE, BE IT RESOLVED**, that that the San Diego County Democratic Party supports researching a car-parking system in which the parking is valued-priced, shared; convenient to drivers, provides earnings to those losing money because the parking is being provided, protects privacy by requiring a search warrant to get parking location information, and protects the economic interests of low-income drivers.

**BE IT FURTHER RESOLVED**, that this support be communicated as a co-sponsor for the resolution sent to California Democratic Party (CDP) Resolutions Committee and Platform Committee.

Mike Bullock, 76 AD, 760-754-8025, [mike\\_bullock@earthlink.net](mailto:mike_bullock@earthlink.net)

DEMCCO adopted a similar resolution in 2014 and supports this resolution.

Endorsed by Rob Howard, Oceanside Mayoral Candidate, SD Labor E-Board, Former North County NAACP President; Nora Vargas SDC BOS D1 Candidate; Kyle Krahel-Frolander, NAC Chair and Oceanside Planning Commissioner (Former Chair); **Congressman Mike Levin, 49<sup>th</sup> CD**; Lela Panagides, Carlsbad City Council Candidate D2

# Dividend-Account Parking: Feasible & Enforceable Mitigation

Updated from Air and Waste Management Association Paper 2010-A-554-AWMA

**Mike R. Bullock**

Satellite Systems Engineer (36 years), now retired, 1800 Bayberry Drive, Oceanside, CA 92054

## ABSTRACT

*Bundled-cost* and *bundled-benefit* car-parking systems (generally called “free parking”) are defined, showing that they are not free and that they increase the drive-alone mode, since non-drivers lose just as much money as those that use the parking.

*Dividend-Account Parking* (DAP) is defined as a parking system in which all of the parking spaces are *shared* by all drivers that are driving a car that is registered in the system. “Registered” means that the car can be associated with a person having an *account* in the system. The parking is *value-priced*, with an option for a *congestion pricing overlay*. The critical final feature is that the earnings (*dividends*) are given to the people, for whom the parking is built, such as employees, shoppers, residents of apartments or condominiums, students, or train riders. It is stated that this system is defined in the California Democratic Party (CDP) Platform, making it the official policy of the largest political, environmental, and public-policy-advocacy organization in California. It is also at the center of the Sierra Club’s lawsuit against the San Diego County’s Climate Action Plan (CAP). The court has found in multiple rulings that DAP is feasible mitigation.

Motivations for change are provided, mostly based on an Air and Waste Management Association paper, *Climate-Stabilizing California Light-Duty-Vehicle (LDV) Requirements*. The following is shown:

1. Parking reform is needed, since fleet electrification, while critically needed (ASAP), cannot, under even the most wildly-optimistic assumptions, achieve the needed GHG emission reduction, for light-duty vehicles (LDVs), soon enough to achieve climate-stabilizing targets.
2. Per-capita driving must be reduced.

It is asserted that parking reform has a large role to play.

DAP is presented as a feasible, enforceable, mitigation measure for any Climate Action Plan or for any application where sustainability is a goal.

## 100 word summary:

*Bundled-cost* and *bundled-benefit* car-parking systems (erroneously called “free”) are defined, showing that they are not free and that they increase the drive-alone mode, since non-drivers lose just as much money as drivers, due to the parking.

Dividend Account Parking (DAP) is presented as a mitigation measure for any Climate Action Plan (CAP) or for any application where sustainability is a goal. The parking is shared, convenient, fully automated, and value priced with a congestion-pricing algorithm. Earnings go to those losing money because the parking is provided.

Motivations are provided, based on an Air and Waste Management Association (AWMA) paper.

*Dividend-Account Parking* (DAP) is defined as a parking system in which all of the parking spaces are *shared* by all drivers that are driving a car that is registered in the system. “Registered” means that the car can be associated with a person having an *account* in the system. The parking is *value-priced*, with an option for a *congestion pricing overlay*. The critical final feature is that the earnings (*dividends*) are given to the people, for whom the parking is built, such as employees, shoppers, residents of apartments or condominiums, students, or train riders. It is stated that this system is defined in the California Democratic Party (CDP) Platform, making it the official policy of the largest political, environmental, and public-policy-advocacy organization in California. It is also at the center of the Sierra Club’s lawsuit against the San Diego County’s Climate Action Plan (CAP). The court has found in multiple rulings that DAP is feasible mitigation.

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It is asserted that parking reform has a large role to play.

DAP is presented as a feasible, enforceable, mitigation measure for any Climate Action Plan or for any application where sustainability is a goal.

It shows documented driving reductions due to the pricing of parking. It notes that although the benefits of priced and shared parking are known, such parking has not been widely implemented, due to understandable concerns. It states that a system solution, called *Dividend-Account Parking*, can overcome these concerns, because it would be is easy to use, share, understand, and support. The system operates the parking to maximize the financial gain of those losing money because of the parking. Eight background informational items are provided, including how value-priced parking would help California achieve greenhouse gas (GHG) reduction targets. Arguments for less parking, shared parking, and priced parking are made. Barriers to progress are identified. The fair pricing of parking is described. Seven goals of *Dividend-Account Parking* are listed. Eleven definitions and concepts that define *Dividend-Account Parking* are given. This includes a method to compute a baseline price of parking and how to adjust that price instantaneously to keep the vacancy above 15%. That price adjustment implements “Congestion Pricing.” This information is sufficient to support a “Request for Proposal” (RFP) process to get a *Dividend-Account Parking* design. An implementation strategy is provided.

## **INTRODUCTION:**

It has been well established that appropriately priced parking will significantly reduce driving<sup>1</sup>. Most case studies presented in Table 1 are evaluations of the most general type of “car-parking cash-out”: *a program that pays employees extra money each time they get to work without*

*driving*. They show that a price differential between using parking and not using parking will significantly reduce driving, even when transit is described as poor. Since driving *must* be reduced<sup>2</sup>, the pricing of parking is desirable.

Shared parking is also recognized as desirable because it can sometimes result in less parking being needed.

Although the advantages of pricing and sharing parking have been recognized for many years, these practices are still rare. This paper identifies some of the reasons for this lack of progress. The pricing and sharing method of this paper has a natural transparency and ease of use that would reduce many of the concerns. This paper also suggests that those governments that have the necessary resources can take the lead role in developing and implementing the described systems. These governments will recover their investments, over time.

This paper describes how parking facilities could be tied together and operated in an optimum system, named *Dividend Account Parking (DAP)*. The description of *Dividend Account Parking (DAP)* is sufficient to support a “Request for Proposal” process, leading to full implementation.

There are two distinct parts to *Dividend Account Parking (DAP)*. The first is how to set the price. The second is how to distribute the earnings. Briefly, the earnings go to the individuals in the group for whom the parking is built.

**Table 1      Eleven Cases of Pricing Impact on Parking Demand**

<b>Location</b>	<b>Number of Workers @ Number of Firms</b>	<b>1995 \$'s Per Mo.</b>	<b>Parking Use Decrease</b>
<b><i>Group A: Areas with poor public transportation</i></b>			
West Los Angeles	3500 @ 100+	\$81	15%
Cornell University, Ithaca, NY	9000 Faculty & Staff	\$34	26%
San Fernando Valley, Los Angeles	850 @ 1	\$37	30%
Costa Mesa, CA	Not Shown	\$37	22%
<b>Average for Group</b>		<b>\$47</b>	<b>23%</b>
<b><i>Group B: Areas with fair public transportation</i></b>			
Los Angeles Civic Center	10,000+ @ “Several”	\$125	36%
Mid-Wilshire Blvd, Los Angeles	1 “Mid-Size” Firm	\$89	38%
Washington DC Suburbs	5,500 @ 3	\$68	26%
Downtown Los Angeles	5,000 @ 118	\$126	25%
<b>Average for Group</b>		<b>\$102</b>	<b>31%</b>
<b><i>Group C: Areas with good public transportation</i></b>			
U. of Washington, Seattle, WA	50,000 employees, students	\$18	24%
Downtown Ottawa, Canada	3,500 government staff	\$72	18%
Bellevue, WA	430 @ 1	\$54	39%*
<b>Average for Group, except Bellevue, WA Case*</b>		<b>\$45</b>	<b>21%</b>
<b>Overall Average, Excluding Bellevue, WA Case*</b>			<b>25%</b>

\* Bellevue, WA case was not used in the averages because its walk/bike facilities also improved and those improvements could have caused part of the decrease in driving.

## **PERTINENT BACKGROUND INFORMATION**

- Vehicle miles traveled (VMT) are a major cause of global warming and pollution<sup>2,3</sup>.
- California's Metropolitan Planning Organizations (MPOs) will need to adopt strategies that reduce vehicle miles traveled (VMT), in order to meet SB375 GHG reduction targets, to be issued by the California Air Resources Board in late 2010, for years 2020 and 2035<sup>2</sup>.
- The appropriate pricing of parking is one of the least costly documented tools to reduce VMT.
- New technologies, such as sensors feeding computer-generated billing, offer the potential to efficiently bill drivers for parking and alert law enforcement of trespassers.
- Reformed parking policies can increase fairness, so that, for example, people who use transit or walk do not have to pay higher prices or suffer reduced wages, due to parking.
- Methods to unbundle parking cost are inefficient unless they support the spontaneous sharing of parking spaces. Shared parking with unbundled cost would ultimately allow cities to require significantly less parking.
- Typical systems of timed parking and metered parking are far from ideal. Parking has no automated record keeping, so it is difficult to know where there is too much or too little.
- Good policies will eventually let cities turn parking minimums into parking maximums.

## **A GLIMPSE INTO A POSSIBLE FUTURE**

Jason is driving to work for the first time in several years. He has decided to save money by carrying home a new 3-D, big-screen computer, which he plans to purchase at a store near his office after work. He wanted to avoid paying delivery charges.

Things have been changing around his office development since they unbundled the cost of parking at the near-by train station. Many people who caught the early trains and lived close to the station stopped driving and parking in the best parking spaces; demand for housing close to the station went up; and wealthy riders, who insisted on driving, did so, confident that they could always find parking as close to the platform as their schedules required, due to congestion pricing. Who would have guessed how much those people were willing to pay? It was shocking. Parking-lot earnings, paid to round-trip train riders, meant that the net cost to ride the train went significantly down. Ridership and neighborhood vitality both went significantly up. All Jason knew was that the price to park at his office had been going up yearly because of increased land values. His parking-lot earnings from his office had been increasing almost every month, due to the ripple effect of train riders parking off-site at cheaper parking. Some of them were using his office parking.

As he pulls out of his driveway, he tells his GPS navigation unit his work hours (it already knew his office location), the location of the store where he plans to buy the computer, and his estimated arrival and departure times at the store. He tells the GPS unit he wants to park once, park no more than 1 block from the store, walk no more than 1 mile total, and pay no more than an average of \$2 per hour to park. He is not surprised to hear the GPS tell him that his request is

impossible. He tells the GPS he will pay an average of \$3 per hour and learns that the GPS has located parking.

It guides him into a church parking lot. He hopes the church will use his money wisely. The GPS tells him the location of a bus stop he could use to get to work and the bus's next arrival time at the stop. With automatic passenger identification and billing, the bus has become easy to use, except that it is often crowded. Jason gets out of the car and walks to work, with no action required regarding the parking.

Three weeks later, when Jason gets his monthly statement for his charges and income for automotive road use, transit use, parking charges, and parking earnings, he finds that the day's parking did indeed cost about \$30 for the 10 total hours that he parked. He notes that the parking-lot earnings for his office parking averaged about \$10 per day that month. He then notices the parking lot earnings from the store, where he spent about \$1000 dollars. He sees that the parking-lot earnings percent for the store that month was 1.7%, giving him about \$17. So for the day, Jason only spent a net of about \$3 on parking. Then he realized that he should have had the computer delivered after all. If he would have bicycled that day, as he usually did, he would have still gotten the \$27 earnings from the two parking facilities and he would have paid nothing for parking. So the choice to drive cost him \$30. He remembers that the delivery would have only been \$25 dollars. Oh well. He enjoyed his before-work and after-work walks.

## **THE CASE FOR LESS PARKING**

Less parking will support more compact development.<sup>1</sup> This makes walking and biking more enjoyable and less time consuming. There would certainly be less “dead space”, which is how parking lots feel to people, whether they arrive by car or not, after they become pedestrians.

Since parking can be expensive, less parking can reduce overhead costs significantly, such as leasing expense and parking-lot maintenance cost. Less overhead means more profit and less expense for everyone. A need for less parking can create redevelopment opportunities at existing developments and reduce project cost at new developments.

At new developments, car-parking costs could prevent a project from getting built.<sup>2</sup>

## **THE CASE FOR SHARED PARKING**

Shared parking for mixed uses means that less parking is needed. For example, shared parking could be used mostly by employees during the day and mostly by residents at night.

Fully shared parking means that very little parking would be off limits to anyone. In a central business district with shared parking, drivers would be more likely to park one time per visit, even when going to several locations. Pedestrian activity adds vitality to any area.

## **THE CASE FOR APPROPRIATELY-PRICED PARKING**

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<sup>1</sup> This is especially true of surface parking, which only accommodates 120 cars per acre.

<sup>2</sup> On September 23, 2008, a panel of developers reviewed the Oceanside, Ca. “Coast Highway Vision” [http://www.ci.oceanside.ca.us/pdf/chv\\_finalvisionstrategicplan.pdf](http://www.ci.oceanside.ca.us/pdf/chv_finalvisionstrategicplan.pdf). Parts of this plan were described as smart growth.

At the review, developer Tom Wiegel said, “Parking is the number 1 reason to do nothing,” where “do nothing” meant “build no project.” The other developers at the meeting agreed.



## **To Reduce Driving Relative to Zero Pricing**

### ***Traditional Charging or Paying Cash-out Payments***

As shown in the Introduction, this relationship (pricing parking reduces driving) is not new.<sup>3</sup>

Using results like Table 1, at least one study<sup>4</sup> has used an assumption of widespread pricing to show how driving reductions could help meet greenhouse gas (GHG) target reductions. Dr. Silva Send of EPIC <http://www.sandiego.edu/epic/ghgpolicy/> assumes that all work locations with 100 employees or more in San Diego County will implement cash-out, to result in 12% less driving to work. Currently, almost all employees in San Diego County “park for free”, unless they happen to work in a downtown core area.

### ***Current, Best-Practice “Unbundling”***

The “best-practice” use of the phrase, “unbundled parking cost”, is to describe the case where either the cost of parking, for the case of a condominium, or the rent for parking, for the case of an apartment, is separated from either the purchase price and common fees or the rent of the dwelling unit.

This gives the resident families the choice of selecting the number of parking spaces they would like to rent or buy, including the choice of zero. This would tend to reduce the average number of cars owned per dwelling unit and, in this way, would also tend to reduce driving. Its major drawback is that this method does not encourage sharing.

## **To Increase Fairness and Protect the US Economy**

It is stated above that almost all employees in San Diego County “park for free”. Of course there is really no such thing as “parking for free”. So-called “free parking” always reduces wages or increases costs. At a work site, it reduces everyone’s wage, even those employees that never drive. At an apartment complex, so-called “free parking” increases the rent. Therefore, “free parking” at work or at apartments violates the fundamental rule of the free market, which is that people should pay for what they use and not be forced to pay for what they do not use. Parking should at least be priced to achieve fairness to non-drivers.

The US economy would also benefit. Reductions in driving would lead to reductions in oil imports, which would reduce the US trade deficit.<sup>4</sup>

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<sup>3</sup> For many years the Victoria Transport Policy Institute (VTPI) has been recognized as a source of reliable information on “Transportation Demand Management”, or TDM.

From [http://www.vtpi.org/tdm/tdm72.htm#\\_Price\\_Parking](http://www.vtpi.org/tdm/tdm72.htm#_Price_Parking):

Even a relatively small parking fee can cause significant travel impacts and provide significant TDM benefits. “TDM Benefits” refers to the many public and private benefits of having fewer people choosing to drive.

<sup>4</sup> From [http://en.wikipedia.org/wiki/Balance\\_of\\_trade#Warren\\_Buffett\\_on\\_trade\\_deficits](http://en.wikipedia.org/wiki/Balance_of_trade#Warren_Buffett_on_trade_deficits), Warren Buffet wrote in 2006,

“The U.S. trade deficit is a bigger threat to the domestic economy than either the federal budget deficit or consumer debt and could lead to political turmoil. Right now, the rest of the world owns \$3 trillion more of us than we own of them.”

## **BARRIERS TO PROGRESS**

Given all this, it might seem that the widespread pricing of parking should have happened by now. However there are barriers. In 2007, a majority of the City Council of Cupertino, Ca. indicated that they wanted their City Manger to negotiate reduced parking requirements with any company that would agree to pay sufficient cash-out payments. To this date, no company, including Apple Inc., has expressed an interest. Most companies probably perceive cash-out as expensive. Even if they realize they could get a reduced parking requirement in exchange for paying sufficient cash-out amounts and even if the economics worked in support of this action (quite possible where land is expensive), they want to stay focused on their core business, instead of getting involved in new approaches to parking, real estate, and redevelopment.

On the other hand, simply charging for parking and then giving all the employees a pay raise is probably going to run into opposition from the employees, who will feel that they would be losing a useful benefit.

In addition, neighbors fear the intrusion of parked cars on their streets. Permit parking, which could offer protection, is not always embraced. City Council members know that a sizable fraction of voting citizens believe that there can actually never be too much “free parking”, Professor Shoup’s famous book<sup>5</sup> notwithstanding. Some Council members probably feel that way themselves.

It doesn’t help that current methods of charging for downtown parking are often very inefficient.<sup>5</sup> For example, downtown Oceanside, California has parking meters that will only accept coins. Besides this, all their on-street, downtown parking is timed, with maximums from 10 minutes to 4 hours. These time limits are enforced by a city employee, who applies chalk from a tire to the street and then records the time. However, by watching the time and moving their car soon enough, drivers can avoid getting a ticket. Of course, they could instead drive to the mall and not have to worry about having coins or elapsed time since parking. It is not surprising that downtown merchants often object to charging for parking.

In summary, those that resist charging for parking, *based on their perceptions*, include

- Companies, *who fear the complexity and expense of paying cash-out payments;*
- Employees, *who fear losing a current benefit;*
- City leaders, *who fear the political repercussions;*
- Downtown patrons, *who dislike the inconvenience and worry;*
- Downtown business owners, *who fear that it will drive away customers.*

## **THE COST, VALUE, AND FAIR PRICE OF PARKING**

### **Estimated and Actual Capital Cost**

#### ***Surface Parking***

One acre of surface parking will accommodate 120 cars. Land zoned for mixed use is sometimes expensive. At \$1.2 million per acre, the land for a single parking space costs \$10,000. Construction cost should be added to this to get the actual, as-built cost of each parking space.

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<sup>5</sup> According to Bern Grush, Chief Scientist of Skymeter Corporation <http://www.skymetercorp.com/cms/index.php>, often two-thirds of the money collected from parking meters is used for collection and enforcement costs.

Estimated cost can be determined by using appraised land value and construction estimates. For new developments, after the parking is constructed, it is important to note the actual, as-built cost.

### ***Parking-Garage Parking***

One acre of parking-garage will accommodate considerably more than 120 cars. The construction cost of the garage and the value of its land can be added together to get the total cost. Dividing that total cost by the number of parking spaces yields the total, as-built cost of each parking space. Adding levels to a parking garage may seem like a way to cut the cost of each parking space, for the case of expensive land. However, there is a limit to the usefulness of this strategy because the taller the parking garage, the more massive the supporting structural members must be on the lower levels, which increases total cost. Parking-garage parking spaces are often said to cost between \$20,000 and \$40,000. The actual costs should be noted.

### ***Underground Parking***

In order to compute an estimate for the cost of a parking space that is under a building, it is necessary to get an estimate of the building cost with and without the underground parking. The difference, divided by the number of parking spaces, yields the cost of each parking space. The cost or value of land plays no role in the cost of this parking. However, it does not follow that this parking is cheap. Underground parking spaces are often said to cost between \$60,000 and \$90,000 dollars each. Although there will be an “as built” cost of the building with the parking, there will never be an “as built” cost of the building without the parking. However, after the construction is done, the estimate for the cost of the underground parking should be reconsidered and re-estimated if that is needed. The final, best-estimate cost should be noted.

## **Value**

Initially, value and cost are the same. For surface parking and parking-garage parking, the value would initially be the same as the as-built cost. For underground parking, the value would initially be the same as the best-estimate cost. However, over time, the value must be updated. Both construction costs and land-value costs will change. The value assigned to a parking place should always be based on the current conditions.

## **Fair Pricing**

Parking space “values”, as described above, must first be converted to a yearly price by using a reasonable conversion factor. This conversion factor could be based on either the “cost of money” or the “earnings potential of money”. It is expected that this conversion factor would be 2% to 5% during times of low interest rates and slow growth; but could be over 10% during times of high-interest and high growth. For example, if the surface parking value is \$12,000 and it is agreed upon to use 5% as the conversion factor, then each parking spot should generate \$600 per year, just to cover capital costs. The amount needed for operations, collection, maintenance, depreciation, and any special applicable tax is then added to the amount that covers capital cost. This sum is the amount that needs to be generated in a year, by the parking space.

The yearly amount of money to cover capital cost needs to be re-calculated every year or so, since both the value and the conversion factor will, in general, change each year. The cost of operations, collection, maintenance, depreciation, and any special applicable tax will also need to be reconsidered.

Once the amount generated per year is known, the base price, per unit year, can be computed by dividing it (the amount generated per year) by the estimated fraction of time that the space will

be occupied, over a year. For example, if a parking space needs to generate \$900 per year but it will only be occupied 50% of the time, the time rate charge is \$1800 per year. This charge rate per year can then be converted to an hourly or even a per-minute rate. The estimated fraction of time that the parking is occupied over a year will need to be reconsidered at least yearly.

## **NEW DEFINITIONS TO PROMOTE AN OBJECTIVE VIEW OF PRICING**

- The “fair price” means the price that accounts for all costs.
- The “baseline amount of driving” means the driving that results from the application of the fair price.
- “Zero transportation demand management” (“zero TDM”) is the amount of demand management that results when the fair price is used. It will result in the baseline amount of driving.
- “Negative TDM” refers to the case where the price is set below the fair price. This will cause driving to exceed the baseline amount. Since TDM is commonly thought to be an action that reduces driving, it follows that negative TDM would have the opposite effect.
- “Positive TDM” refers to the case where the price is set above the fair price. This would cause the amount of driving to fall below the baseline amount.

Clearly, so-called “free parking” is an extreme case of negative TDM. The only way to further encourage driving would be to have a system that pays a driver for the time their car is parked.

## **GOALS OF THE “DIVIDEND ACCOUNT PARKING” CAR-PARKING SYSTEM (FORMERLY “INTELLIGENT PARKING”)**

- There is only one third-party vendor (or several, collaborating so closely that users are unaffected compared to a single operator) operating all parking. (“All parking” does not include driveways and garages in single-family homes.) *Dividend Account Parking* is designed and installed by regional or state government, using low-bid contractors, with design and start-up costs covered by the overhead portion of collection fees.
- Nearly all parking is shared. Almost always, anyone can park anywhere. Those who want exclusive rights to parking will pay “24/7” (all day, every day).
- Parking is operated so that the potential users of parking will escape the expense of parking by choosing to not use the parking. This characteristic is named “unbundled” because the cost of parking is effectively unbundled from other costs.
- Parking is priced and marketed to eliminate the need to drive around looking for parking.
- Parking at any desired price is made as easy as possible to find and use.
- Records of the use of each parking space are kept, to facilitate decisions to either add or subtract parking spaces.
- The special needs of disabled drivers, the privacy of all drivers, and, if desired, the economic interests of low-income drivers are protected.

## **DEFINITIONS & CONCEPTS OF *DIVIDEND ACCOUNT PARKING (DAP)***

### **Parking Beneficiary Groups**

There are at least 7 types of beneficiary groups. Note that in all cases, members of beneficiary groups must be old enough to drive.

- 1.) People who have already paid for the capital cost of parking. An example of this type of beneficiary group would be the owners of condominiums, where parking has been built and the cost is included in the price of the condominium. Note that although they have technically already paid for the parking, if they borrowed money to pay for some portion of the price, the cost is built into their monthly payment. This illustrates why the value of parking and the cost of borrowing money (rate of return on money) are key input variables to use to compute the appropriate base, hourly charge for parking.
- 2.) People who are incurring on-going costs of parking. An example of this type of beneficiary group is a set of office workers, where the cost of ‘their’ parking is contained in either the building lease or the cost of the building. Either way, the parking costs are reducing the wages that can be paid to these employees.<sup>6</sup>
- 3.) People who are purchasing or renting something where the cost of the parking is included in the price. Examples of this beneficiary group are people that rent hotel rooms, rent an apartment, buy items, or dine in establishments that have parking.
- 4.) People who own off-street parking as a business. They could be the individual investors or could be a government or government-formed entity.
- 5.) People who are said to benefit from parking, even though the money for the parking has been supplied by a source that may have very little relationship to those that are said to benefit. An example of this group would be train riders that make round trips from a station which has parking that is said to be “for riders”. Students at a school with parking would be another example.
- 6.) People who are considered by many to be the logical beneficiaries of on-street parking. Owners of single-family homes are the beneficiaries of the parking that is along the boundaries of their property. The same status is given to residents of multi-family housing.
- 7.) Governments. Since they build and maintain the streets, they should get a significant benefit from on-street parking.

## **Unbundled Cost and Spontaneous Sharing**

“Unbundled cost” means those who use the parking can see exactly what it costs and those who don’t use the parking will either avoid its cost entirely or will get earnings to make up for the hidden parking cost they had to pay. This conforms to the usual rule of the free market where a person only pays for what they choose to use. Unbundled cost is fair.

“Spontaneous sharing” means that anyone can park anywhere at any time and for any length of time. Proper pricing makes this feasible.

### ***How to Unbundle***

The method of unbundling can be simply stated, using the concept of “beneficiary group” as discussed above. First, the fair price for the parking is charged. The resulting earnings<sup>7</sup> amount is

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<sup>6</sup> Such parking is often said to be “for the benefit of the employees”. Defining this beneficiary group will tend to make this statement true, as opposed to the common situation where the employees benefit only in proportion to their use of the parking.

<sup>7</sup> The earnings amount is the revenue collected minus the collection cost and any other costs that will have to be paid due to the implementation of *Dividend Account Parking (DAP)*. The costs associated with the parking, paid *before*

given to the members of the beneficiary group in a manner that is fair to each member. Methods are described below.

### ***Why this Supports Sharing***

Members of a beneficiary group benefit financially when “their” parking is used. They will appreciate users increasing their earnings. They are also not obligated to park in “their” parking. If there is less-expensive parking within a reasonable distance, they might park there, to save money. This is fine, because all parking is included in the *Dividend Account Parking (DAP)* system.

### ***Computing the Earnings for Individuals***

*Dividend Account Parking (DAP)* must be rigorous in paying out earnings<sup>7</sup>. For a mixed use, the total number of parking spaces must first be allocated to the various beneficiary groups. For example in an office/housing complex, 63.5% of the parking might have been sold with the office. If so, the housing portion must be paying for the other 36.5%. For this case, it would follow that the first step is to allocate 63.5% of the earnings to the workers and 36.5% to the residents.

How the monthly earnings are divided up among the members of the beneficiary group depends on the beneficiary group type. For each member, the group’s total monthly earnings amount is always multiplied by a quantity and divided by the sum (the sum is the denominator) of that quantity, for all members.

For example, for each employee, the multiplier is the number of hours that the employee worked over the month while the denominator is the total number of hours worked by all employees over the month. At a school, for each student, the numerator is the total time spent at the school, over the month, while the denominator is the sum of the same quantity, for all the students.

For a train station with parking being supplied for passengers that ride on round trips of one day or less, the numerator is the passenger’s monthly hours spent on such round trips, over the month; while the denominator is the total number of hours spent by all passengers on such round trips, over the month. Radio Frequency Identification (RFID) units on passengers could support an automated calculation of monthly charges for fares, as well as monthly hours on round trips.

At a shopping center, the numerator is the sum of the money spent by the shopper, over the month, while the denominator is the total amount of money spent by all shoppers over the month.

At a condominium, the numerator is the number of parking places that were paid for (directly or indirectly) by the resident family and the denominator is the total number of parking places at the condominium project; similarly, for apartment complexes.

### ***Where Earnings Are Low***

The goal is that if someone doesn’t park, they don’t pay, either directly or indirectly, because the earnings that they get will balance out their losses (like reduced wages, for example). However, charging for parking that few want to use will not sufficiently compensate the people that have been forced, or are being forced, to pay for such parking. The only remedy in this case is to redevelop the parking or lease the parking in some other way, for storage, for example. The

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the implementation of *Dividend Account Parking (DAP)*, should *not* be subtracted from the revenue because they will continue to be paid as they were before the implementation of *Dividend Account Parking (DAP)*. Therefore, these costs will continue to reduce wages and increase the prices of goods and services.



earnings from the new use should go to those that are in the beneficiary group that was associated with the low-performing parking.

### ***Why This Method of Unbundling Will Feel Familiar to Leaders***

Developers will still be required to provide parking and will still pass this cost on, as has been discussed. There will be no need to force an owner of an exiting office with parking to break his single business into two separate businesses (office and parking).

Parking beneficiaries are identified that conform to traditional ideas about who should benefit from parking.<sup>8</sup>

### ***Unbundling the Cost of On-Street Parking***

The revenue from on-street parking in front of businesses will be split evenly between the city and the business's parking beneficiaries. All of the earnings from on-street parking in front of apartments or single-family homes will be given to the resident families.<sup>9</sup>

### ***Special Considerations for Condominiums***

Unbundling for a condominium owner means that, although their allocated amount of parking has added to their initial cost, their allocated amount of parking also earns money for them. Unbundling for a condominium could also mean that an owner can choose to have control over a single or several parking places. Such parking spaces could be equipped with a red light and a green light. If the red light is lit, this will mean that the space is not available for parking, except for the person who is controlling the spot. If the green light is lit, it will mean that the space is available to anyone. A space that is being reserved with a red light is charged at the full price to the condominium owner that has control over the space. The owner that controls these spaces can change the state of the parking space (available or not available) by either a phone call, on line, or at any pay station system that might be in use for the system. After condominium owners experience the cost of reserving a space for themselves, they might give up on the idea of having their own, personal, unshared parking space; especially since *Dividend Account Parking (DAP)* will give most owners and their guests all the flexibility they need in terms of parking their cars.

Some people think that condominium parking should be gated, for security reasons. However, parking within parking garages needs to be patrolled at the same frequency level as on-street parking, which is enough to ensure that crime around either type of parking is very rare. Cameras can help make parking garages that are open to the public safe from criminal activity.

### ***Special Considerations for Renters***

Unbundling for renters means that, although their allocated amount of parking increases their rent, their allocated amount of parking also earns money for them. Therefore, their traditional rent (includes parking) is effectively reduced by the money earned by those parking spaces allocated to them. Renters will be motivated to either not own a car or to park in a cheaper

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<sup>8</sup> Showing exactly where parking earnings go will reduce the political difficulties of adopting pay parking in a democracy where the high cost of parking is often hidden and rarely discussed.

<sup>9</sup> Although governments own the streets, often, back in history, developers paid for them and this cost became embedded in property values. Admittedly, how to allocate on-street parking earnings is somewhat arbitrary. With congestion pricing and efficient methods, governments may earn significantly more than they are under current practices.

location. Parking in a cheaper location is not a problem because all parking is part of the *Dividend Account Parking (DAP)* system. Renters will welcome anyone to park in “their” parking, because it will increase their earnings.

### ***Special Considerations for Employers***

At first, companies may want the option of offering “free parking” to their employees so as to be able to compete with traditional job sites. This means giving employees that drive every single day an “add-in” amount of pay so that the sum of the add-in and their parking-lot earnings equals their charge, for any given monthly statement. The operator of the parking, which sends out statements, can pay out the “add in” amount, in accordance with the company’s instruction. The company will then be billed for these amounts. There could be no requirement for the company to provide any such “add-in” amount to the employees that don’t drive every day. This would allow the company to treat its every-day drivers better than other employees and so this would be a negative TDM. However, this economic discrimination would be substantially less than the current, status-quo, economic discrimination, where drivers get “free” parking and non-drivers get nothing.

### **Clusters of Parking**

Clusters are a contiguous set of parking spaces that are nearly equal in desirability and thus can be assigned the same price. They should probably consist of from 20 to 40 spaces. For off-street parking, they could be on either side of the access lane to the parking spaces, so that an observer could see the 20 to 40 cars, and get a feel for the vacancy rate. At a train station, clusters will normally be organized so that their parking spaces are approximately an equal distance from the boarding area. On-street clusters would normally conform to our current understanding of what a block is, which is to say from one cross street to the next cross street. The width of the street and the length of the block should be taken into account in defining on-street clusters of parking and in deciding if the parking on either side of the street should or should not be in the same cluster of parking spaces.

### **Examples of Good and Bad Technology**

#### ***Parking Meters or Pay Stations***

Parking meters are a relic of an earlier period, before computers. Pay stations do not add enough usefulness to merit their inclusion in *Dividend Account Parking (DAP)*, except as a bridge technology. Once good systems are set up, pay stations should cost additional money to use because of their expense. It would be best to devise an implementation strategy that will minimize their use when the system is first put into effect and will take them out of service as soon as possible.

#### ***Radio Frequency Identification Backed Up by Video-Based “Car Present” and License Recognition***

Government will eventually enter into an RFID (Radio Frequency Identification) age. Organizers of large athletic events already have. Organizers that put on large open-water swims, foot races, and bike rides have routinely used RFID for many years.<sup>10</sup> An RFID vendor in San Diego<sup>11</sup>

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<sup>10</sup> For example, over 20,000 people ran the 2008 Bay-to-Breakers foot race in San Francisco. Each runner had a “chip” in their shoe lace. Each runner’s start time and finish time were recorded and all results were available as soon as the last runner crossed the finish line.

states that passive RFID units cost less than \$5, are reliable, are durable, and they could be used to identify cars as well as people. He also sees no problem in implementing most of the features of *Dividend Account Parking (DAP)*.<sup>12</sup>

### ***Automatic Data Collection and Sending Out Statements***

Note that the “back end database” of Dr. Carta’s written statement<sup>12</sup> refers to the ability to send statements of earnings and billing to students.<sup>13</sup>

### ***Putting it Together***

Certainly, government, and in particular transit agencies and parking agencies, could use RFID-based technology. For example, when a person with an RFID unit which is tied to a billable address or a credit card with an open account gets on a bus or a train, they should not have to pay at that time, visit a pay station, or “swipe a card” that has a positive balance. Utility customers that pay their bills are not required to pre-pay. The same courtesy should be extended to transit riders, people that drive on roads, people that get parking-lot earnings, and people that park cars. There should be one monthly bill or statement, for all four activities.

### ***Global Positioning Systems GPS***

An alternative model is to have GPS systems in cars that would detect the car’s parking location, that location’s current charge rate, and would perform all of the charging functions in the car. The only information the parking-lot-enforcement system would need is whether or not a car being parked is owned by a bill-paying owner. The car owner’s responsibility would be to pay the bills indicated by the box in the car. The box would need to process a signal that a bill had been paid. It would also need to process pricing signals.

### ***Not Picking Winners***

The purpose of this report is to describe what an ideal system would do, *not* how it is done. How a proposed system works is left to the systems, software, and hardware engineers that work together to submit a proposal based on this description of what an ideal system does.

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<sup>11</sup>David R. Carta, PhD, CEO Telaeris Inc., 858-449-3454

<sup>12</sup> Concerning a Final Environmental Impact Report-approved and funded new high school in Carlsbad, California, where the School Board has signed a *Settlement Agreement* to consider “*unbundled parking*”, “*cash-out*”, and “*pricing*”, Dr. Carta wrote, in a January 13<sup>th</sup>, 2010 written statement to the Board,

I wanted to send a quick note discussing the technical feasibility of tracking cars into a lot without impacting students or requiring the need for gates. Mike Bullock and I have discussed this project; it can be accomplished straightforwardly by utilizing Radio Frequency Identification and/or Video Cameras integrated with automated license recognition systems. The cars would need to register with the system at the start, but it would be fairly painless for the users after the initial installation. The back end database system can also be implemented both straightforwardly and at a reasonable price.

This is not necessarily a recommendation of the proposal for unbundled parking. Rather it is strictly an unbiased view of the technical feasibility of the proposal to easily and unobtrusively track cars, both registered and unregistered, into a fixed lot.

<sup>13</sup> In an earlier email on this subject, Dr. Carta wrote,

This is not too tough - we probably would integrate with a service that already sends physical mail from an electronic submission instead of re-inventing this wheel.

## Privacy

Privacy means that no one can see where someone has parked, without a search warrant. Also, the level of the detail of information that appears on a bill is selected by the customer.<sup>14</sup>

## Ease of Use for Drivers

For credit-worthy drivers that have followed the rules of the system, pay parking will not require any actions other than parking. Paying for all parking fees over a month is then done in response to a monthly billing statement. Parking will feel to the consumer like a service provided by a municipality, such as water, energy, or garbage. One important difference is that users belonging to a “beneficiary group” will get an earnings amount in their monthly statement. Those that earn more than what they are charged will receive a check for the difference. This ease of use will make all parking less stressful.

## Base Price

### *Off-Street*

Off-street parking is priced so that even if demand does not threaten to fill the parking beyond 85%, the money generated will at least equate to an agreed-upon return on the parking value and pay all yearly costs. Equation 1 shows the calculation of the hourly rate.

$$r_{BaselineHourly} = \frac{(r_{Investment} \times v_{Parking}) + c_{YOPD}}{(n_{HoursPerYear} \times f_{TO})} \quad (\text{Eq. 1})$$

where:

$r_{BaselineHourly}$	=	the computed baseline hourly rate to park
$r_{Investment}$	=	yearly return on investment, such as .06
$v_{Parking}$	=	value of a parking space, such as (parking garage) \$40,000
$c_{YOPD}$	=	yearly operations <sup>15</sup> plus depreciation, per space, such as \$100
$n_{HoursPerYear}$	=	number of hours per year, 24 x 365 = 8760 Hours per Year
$f_{TO}$	=	fraction of time occupied, such as 0.55.

For the example values given, the base hourly rate of parking, to cover the cost of the investment, operations<sup>15</sup>, and depreciation is \$0.519 per hour. This could be rounded up to \$0.52 per hour. This price could also be increased to result in positive TDM, to reduce driving more than the fair-price, zero-TDM amount.

### *On-Street*

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<sup>14</sup> License plates that have no RFID tags fail to use the best technology to accomplish the primary purpose of license plates, which is to identify and help intercept cars used in a crime. Identifying cars is a legitimate government goal. Protecting privacy is also a legitimate goal. Both goals can be realized with good laws, good enforcement, and good systems engineering.

<sup>15</sup> This includes money for policing, cleaning, maintenance, any applicable parking tax, and all collection costs. Collection costs will need to include an amount to recover the development and installation costs of *Dividend Account Parking (DAP)*.

If on-street parking is located within walking distance (one-quarter mile) of off-street parking, its base price is set equal to the closest off-street parking's base price. Otherwise, it is set to some agreed-upon value, like fifty cents per hour. However, on-street parking has a special meaning for downtown merchants and for neighborhoods, two powerful political forces in any city. Merchants that have few cars parking on their street, even though it is permitted, are probably failing in their businesses. They would like free parking to help draw visitors to their store front. Neighborhoods that are not impacted by parking would probably prefer no pricing. For these reasons, for any on-street parking cluster, no price is charged until the cluster occupancy reaches 50%. (Time of day is irrelevant.)

## Congestion Pricing

The time-rate price of parking is dynamically set on each cluster of parking, to prevent the occupancy rate from exceeding 85% (to reduce the need to drive around looking for parking). An 85% occupancy rate (15% vacancy) results in just over one vacant parking space per city block<sup>5</sup>. If the vacancy rate is above 30%, the price is left at the baseline hourly rate. If vacancies fall below 30%, the price can be calculated in a stair-step method, such as shown in Table 2.

Equation 2 is an alternative method.

In either case, the total charge is time parked, multiplied by the time-averaged, time-rate price. The base multiplier would be adjusted to be just large enough to keep the vacancy rate from falling below a desired level, such as 15%, so it is always easy to find parking.

**Table 2 Hourly Rates for 2 Base Multipliers and a Baseline Hourly Rate of \$0.52**

Vacancy Rate	Base Multiplier = 2			Base Multiplier = 2.5		
	Multiplication		Hourly Rate	Multiplication		Hourly Rate
	Formula	Value		Formula	Value	
Above 30%	$2^0$	1	\$0.52	$2.5^0$	1	\$0.52
25% to 30%	$2^1$	2	\$1.04	$2.5^1$	2.5	\$1.30
20% to 25%	$2^2$	4	\$2.08	$2.5^2$	6.25	\$3.25
15% to 20%	$2^3$	8	\$4.16	$2.5^3$	15.625	\$8.13
10% to 15%	$2^4$	16	\$8.32	$2.5^4$	39.0625	\$20.31
5% to 10%	$2^5$	32	\$16.64	$2.5^5$	97.6563	\$50.78
Below 5%	$2^6$	64	\$33.28	$2.5^6$	244.1406	\$126.95

$$r_{HourlyRate} = r_{BaselineHourly} \times (B^{(30-V)/5}), \text{ for } V < 30; r_{BaselineHourly}, \text{ otherwise (Eq. 2)}$$

where:

$r_{HourlyRate}$  = the congestion-priced hourly rate to park

$r_{BaselineHourly}$  = the baseline hourly rate to park, such as \$0.52 per hour (taken from from Eq. 1.

$B$  = the base of the multiplier being computed, such as 2.50

$$V = \text{the vacancy rate percent, such as 17.5, for 7 vacancies in a cluster of 40 spaces, } 100*(7/40) = 17.5$$

For the example values given, the hourly rate of parking would be \$9.88 per hour.

## **Pricing Predictions and Notifications**

Drivers will develop strategies for their routine trips. The computer system that keeps records of parking use will also provide help for users. The *Dividend Account Parking (DAP)* website will direct a user to an appropriate cluster of parking if the user provides the destination location or locations, the time and date, and the hourly rate they wish to pay. If the walk is going to be long, the website could suggest using transit to get from the cheaply-priced parking to the destination. In such cases, the website may also suggest using transit for the entire trip.

Another user option is to specify the time, location, and the distance the user is willing to walk. In this case, the computer would give the cheapest cluster of parking available at the specified walk distance. The price prediction would be provided.

All price predictions would also have a probability of correctness associated with them. If a user can show that a computer has predicted a much lower price than what actually occurred, with a sufficiently high probability, it would be reasonable to charge the user the predicted price rather than the actual price.

Websites could routinely inform viewers when occupancy rates are expected to be unusually high, due to a special event (for example, a sporting event). The parking system website will always give current and predicted hourly rates for all locations. The hourly rates of parking will also be available at a phone number and possibly at pay stations. The base-price hourly rate, for any parking cluster, would be stable and could therefore be shown on signs. Parking garage entrances could have large video screens showing both predicted and existing price. Users will also learn to look at parking and judge whether congestion pricing applies, or could apply, while their car is parked. It would not be long before these capabilities are added into GPS navigation systems.

## **Prepaid RFID**

To be inclusive, pay stations or convenience stores will offer a pre-paid RFID that can be set on the dashboard of a car. This will support drivers with poor credit or drivers who have not obtained the necessary equipment to support the normal, trouble-free methods. This will also work for drivers that do not trust the system to protect their privacy for a certain trip (by removing or disabling the permanent RFID) or for all trips. No billing would occur.

## **Enforcement**

The system would notify the appropriate law enforcement agency if an unauthorized car was parked. Authorized cars would need either a pre-paid RFID or equipment indicating that their owners had *Dividend Account Parking (DAP)* accounts and were sufficiently paid up on their bills.

## **IMPLEMENTATION**

This description of *Dividend Account Parking (DAP)* will help to implement efficient parking systems. Parking at train stations, schools, and government buildings could introduce many of these concepts. This description of *Dividend Account Parking (DAP)* is sufficient to support a "Request for Proposal" process, which could lead to full implementation. Widespread



installation should be done by a government agency, to minimize actions required on the part of the private sector. Laws would simply require the cooperation of all private-sector and government entities.

## **SUMMARY**

A parking plan, *Dividend Account Parking (DAP)* has been described.

1. Technology will make it easy to use for most drivers.
2. Its parking is almost always shared, to support mixed uses.
3. It unbundles cost by charging and having earnings go to the parking beneficiaries.
4. Traditional groups, such as single-family home owners, employees, tenants, train riders, and students benefit from parking. The benefit is equal for drivers and non-drivers.
5. Baseline prices are computed primarily from the value of the parking and an agreed-upon rate of return. On-street parking is free until it is half full, at which time its base price often matches that of the closest off-street parking.
6. For all parking, price is dynamically increased to guarantee availability. Earnings are therefore only limited by what people are willing to pay.
7. Technology helps drivers find parking and decide if they want to drive or use transit.
8. Prepaid RFIDs provide service to those who have poor credit or don't want to be billed.
9. Disabled and perhaps low-income drivers will have accounts that allow them to park at reduced prices and perhaps avoid congestion pricing. Specially designated spots might also be required for disabled drivers.
10. The system will provide reports showing where additional parking would be a good investment and where it would be wise to convert existing parking to some other use.
11. Privacy will be protected. Law enforcement officials would need a search warrant to see where someone's car has been parked. The level of detail on billing would be selected by the car's owner.
12. Implementations could begin in carefully selected locations and expand.

Global warming, air pollution, trade deficits, and fairness are some of the significant reasons that governments have a responsibility to implement *Dividend Account Parking (DAP)*.

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## KEYWORDS

A&WMA, Parking, Unbundled, Shared, TDM, cash-out, pricing, beneficiary, greenhouse gas, GHG, GPS, RFID

## 1500-Character Extended Abstract

After two introductory slides, the presentation starts with the definition of two commonly-used, car-parking systems: the bundled-price system and the bundled-cost system. The flaws of these systems are exposed. The Dividend Account Parking (DAP) parking system is introduced; with the motivation for its implementation: the importance of cars in reducing GHG and how DAP fits into a plan to ensure that cars support climate-stabilization.

The rest of the slides present a specific DAP proposal, in downtown Oceanside, CA, for city employees. Outcomes, an overview, and a definition of DAP are given. Charge & payout formulations are specified. Methods to prevent cheating are described. A brief, simplified example of a DAP implementation is shown, where it would be difficult to not drive to work, showing DAP to still be a good choice. Results from cases of car parking cash-out (where employees are paid to get to work without driving) are given, showing that if a price differential (between driving and not driving to work) is introduced (DAP does this), driving alone to work is significantly reduced.

Money cash flow calculations are presented, using reasonable simplifying assumptions and then reasonably-conservative assumptions of how much money could be earned from employee parking, whenever it is not being used by an employee. The results from three cases (“Baseline”, “Worse”, and “Better”) are shown.

Twenty six back up slides appear, but they are NOT part of the presentation.

# COVID-19 Lessons

## Learned (Or Not)

*Intro*  
*Slide 1*

1. Bad things can happen\*
2. Ignoring science can be deadly

\*Suffering from childhood catechism?

Catechism fix: *If there is a God, he or she will **NOT** protect us from physics.*

*Say this 10 times daily for moderate relief 😊*

# 6 Painful Facts

*Intro*  
*Slide 2*

1. To avoid climate destabilization (**human extinction**), industrialized nations must reduce their Greenhouse Gas (GHG) emissions **by 80%, by 2030**
2. Congress-member Ocasio-Cortez: “World’s gonna end in 12 years . . .” (**2030 target meant she had a point!**)
3. Cars are the biggest category of GHG emissions
4. Internal combustion engine cars last 15 years
5. We will not have a sufficiently-electrified fleet by 2030
6. **We must reduce vehicle-miles-travelled (VMT)**

# *Eliminating the Harm* of **Bundled-Cost or Bundled- Benefit Parking**

- Definitions of Parking Systems
- New System: *Dividend-Account Parking*
  - Motivations for change
  - Definition and features
  - A demonstration project

Mike Bullock  
[mike\\_bullock@earthlink.net](mailto:mike_bullock@earthlink.net)  
760-754-8025



# A Bundled-Cost Parking System

The most common of all parking systems. Erroneously called “free”

The **cost** of the parking is contained within some other payment, such as:

- Rent
- Train fare (at least 1 train station with so-called “free” parking)
- Price of consumer items, including food

# **A Bundled-Benefit Parking System**

**The 2<sup>nd</sup> most common of all parking systems. Erroneously called “free”**

**The parking is part of a benefit package being provided, such as:**

- **Compensation for work**
- **Public education**
- **Public anything, such as a library or park**

The harm of a *Bundled-Cost* or a *Bundled-Benefit* car-parking system is that they take *money* from people without their knowledge or consent.

**These systems also  
increase the choice to  
drive alone.**

**Sierra Club Resolution:** Appropriate pricing of parking is the least costly way to reduce vehicle miles travelled.

***Bundled-Cost* or *Bundled-Benefit***  
systems should be replaced with  
the **DAP** Car-Parking system!

## **Dividend Account Parking (DAP)**

### ***Brief System Definition***

1. Automated (nothing to do; just park and run)
2. Value-priced, with a congestion-pricing option
3. **Earnings** (AKA “**Dividends**” or “**Financial Support**”) go to the people for whom the parking is built (for example, employees)
4. Cars must be recognizable & associated with an Account
5. Parking is available to all (“Shared Parking”) driving such a car

# From the California Democratic Party (CDP) 2018 Platform

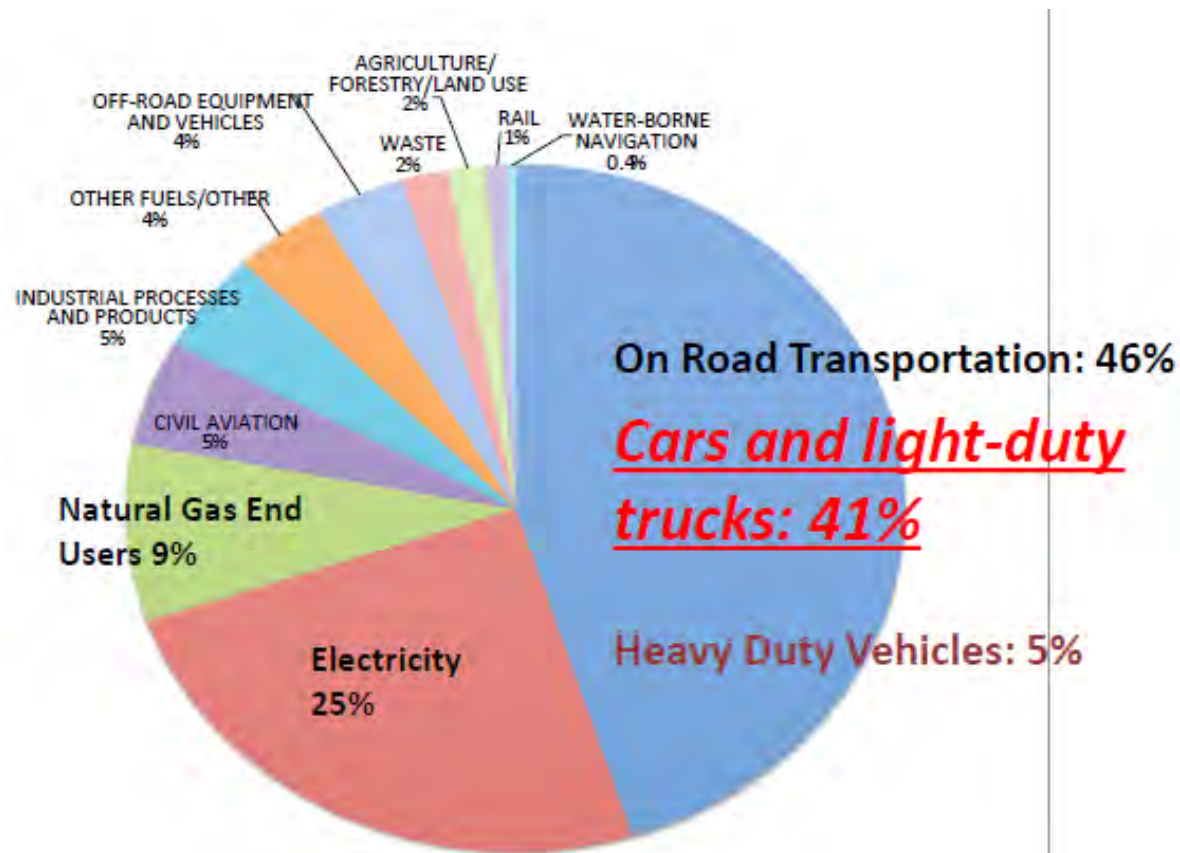
From: <https://www.cadem.org/our-party/standing-committees/body/CDP-Platform-2018.pdf>

## Transportation Sub-Plank Statement

- Work for **shared**, convenient, and **value-priced** parking, operated with a system that **provides financial support** to those paying higher costs or getting a reduced wage, due to the cost of providing the parking **Note: this is DAP!**

# Motivation for Change, 1 of 4

*Cars and Light-duty vehicles (LDVs) emit the most GHG of any category*





# Motivation for Change, 2 of 4

- *Fleet Efficiency **Will Not Come Soon Enough**, as shown in this peer-reviewed report:*

2020 Air & Waste Management  
Association (AWMA) Report

*Deriving **Climate-Stabilizing**  
Solution Sets of Fleet-Efficiency  
and Driving-Level Requirements,  
for California Light-Duty Vehicles\**

\* Available upon request from  
[mike\\_bullock@earthlink.net](mailto:mike_bullock@earthlink.net)

# Motivation for Change, 3 of 4

## Climate-Stabilizing Requirements, for Four Cases

Difficult but possible

Driving as much as we did in 2005 might seem nice, but these % ZEV jumps are not possible

Air Resources Board Mary Nichols has a nice electrification schedule but it would require a very difficult reduction in driving.

	Case Designations			
	Balanced_1	Balanced_2	2005 Driving	Mary Nichols
% Renewable Electricity	85.0%	90.0%	90.0%	90.00%
% ZEVs, Year 2016	2.0%	2.0%	2.0%	2.70%
% ZEVs, Year 2017	2.0%	2.0%	2.0%	2.70%
% ZEVs, Year 2018	3.0%	3.0%	3.0%	5.11%
% ZEVs, Year 2019	4.0%	4.0%	4.0%	7.53%
% ZEVs, Year 2020	8.0%	8.0%	8.0%	9.94%
% ZEVs, Year 2021	20.0%	15.0%	82.0%	12.35%
% ZEVs, Year 2022	35.0%	25.0%	97.0%	14.76%
% ZEVs, Year 2023	55.0%	45.0%	99.0%	17.18%
% ZEVs, Year 2024	80.0%	70.0%	99.0%	19.59%
% ZEVs, Year 2025	94.0%	95.0%	99.0%	22.00%
% ZEVs, Year 2026	97.0%	97.0%	99.0%	37.60%
% ZEVs, Year 2027	98.0%	98.0%	99.0%	53.20%
% ZEVs, Year 2028	99.0%	99.0%	99.0%	68.80%
% ZEVs, Year 2029	99.0%	99.0%	99.0%	84.40%
% ZEVs, Year 2030	99.0%	99.0%	99.0%	100.00%
% Reduction in Per-Capita Driving With Respect to Year 2005	32.0%	32.0%	0.0%	50.5%

# Motivation for Change, 4 of 4

Requirements to Achieve the Needed **32% Reduction**  
in Per-Capita Driving, With Respect to 2005

Driving-Reduction Requirments	Per-Cent Reduction	Factor
Legislated (SB 375) Plans to Reduce Driving	12%	0.88
Value-Priced Road Use Charge (RUC)	10%	0.90
<b>Dividend Account Parking</b>	<b>8%</b>	<b>0.92</b>
Transfer Highway Expansion Funds to Transit	2%	0.98
Increase Height & Density by Transit Stations	2%	0.98
"Complete Streets", "Road Diet" (walk/bike)	1%	0.99
<i>Pay-to-Graduate</i> Bicycle Traffic-Skills Class	1%	0.99
Bicycle Projects to Improve Access	1%	0.99
<b>Product of Factors</b>		<b>0.68</b>
<b>% Reduction</b>		<b>32%</b>

# Conclusion & Path Forward

- A big part of the needed 32% reduction will need to come from car-parking reform.
- The first step will be a simplified demonstration project of a **Dividend Account Parking** System at a work location.
- A proposal is now be presented.

# ***A Dividend-Account Parking System* for Oceanside's Civic Center Garage**

**A System to Eliminate the Harm of Bundled-Benefit  
Car Parking for City Employees  
300 North Coast Highway**

- **Top-Level Outcome & Overview**
- **Some Top-Level Calculations**
- **Who gets to use the system**
- **Overcoming problems & perceptions**
- **Outcomes of a new incentive**
- **Cash flow (“Hey, where does the \$\$ come from?”)**

**Mike Bullock**  
**[mike\\_bullock@earthlink.net](mailto:mike_bullock@earthlink.net)**  
**760-7548025**

# Top-Level Outcomes

- Employees that drive every day break even (Lose no money!)
- Employees that *don't* drive every day get *paid to not drive* (Make more money!)
- Fewer employees drive, reducing Greenhouse Gas (GHG) emissions (Less GHG!)



# Overview

- Fully-automated parking system, implemented by a 3<sup>rd</sup>-party vendor (RFP selection process)
- operated for the financial gain of employees
  - Earnings = Money Generated Minus Vendor Earnings
  - Earnings go to employees
- Price is cost per minute
  - Such as 1.85 cents per minute (= \$1.11 per hour)
- An employee's **Earnings** (“**Dividend**”) is proportional to their time spent at work

# Calculations of an Employee's Earnings

- An employee's earning is proportional to time spent at work (automatic collection of enter/exit times, using employee RFID)

<b>Definitions to Compute an Employee's Monthly Earnings</b>	
<b>T<sub>Employee</sub></b>	The Employee's Monthly Time at the Work Site
<b>T<sub>AllEmployees</sub></b>	Total Monthly Time at the Work Site, All Employees
<b>E<sub>AllEmployees</sub></b>	Total Monthly Earnings from the Employee Parking

$$\text{Employee Earnings} = E_{\text{AllEmployees}} \times \left( T_{\text{Employee}} / T_{\text{AllEmployees}} \right)$$

# “Add In” Payment so Those that Drive Every Day Will Lose No Money

Note: This is for an individual employee, “Joe”

Joe’s Parking Payment =

Joe’s Earnings – Price per Minute x Minutes Joe Parked + Joe’s “Add In”

“Add In” is zero, unless it must take on a positive value so that Joe loses no money

“Add In” payments will be easily covered by Dividend Account Parking parkers that are not employees.

# Charge, Earnings, & Add-In, Payment *For Each Employee*

- **Charge**
  - Total Minutes Parked x Cost per Minute
- **Earnings**
  - As shown on earlier slide (proportional to employee's time spent at work)
- **Add-In**
  - Zero, unless **Charge** > **Earnings**
  - If **Charge** > **Earnings**, **Add-In** = **Charge** – **Earnings**
- **Payment** = **Earnings** – **Charge** + **Add-In**

# Who Gets To Use Dividend-Account Parking

- **Anyone** (not necessarily an employee) driving a car registered in the system
  - There is a person with an account associated with the car
  - The car will be identified
    - License plate reader and/or
    - RFID tag not needed
  - Account can be established on the spot, in less than 5 minutes: credit card info and license number

# Employee Behavior 1 of 2

## Employees Must Park in Their Parking Lot if they Drive to Work Measures to Reduce “Cheating” = Parking in the Neighborhood

- Soft, pre-emptive measure: messaging
  - **Perceived integrity** is every employee’s responsibility
  - **Insufficient perceived integrity** can cost employees
    - Reduced chance of promotion
    - Smaller pay raises
    - More chance of terminated employment
  - Parking free in the neighborhood will not be tolerated
  - The City wants to be a good neighbor: this is the reason for off-street parking ordinances





# Employee Behavior 2 of 2

## *Employees Must Park in Their Parking Lot if they Drive to Work* Measures to Reduce “Cheating” = Parking in the Neighborhood

- Soft, pre-operational measure: data collection
  - Operate the system for a time, perhaps even a year, before actually collecting or distributing money
  - Self-identified non-drivers are recognized, thanked, and asked to provide details as to how they are getting to work without driving
- Soft, In-Operation Mode: New non-drivers are thanked and interrogated as to how they do it
- **Hard: cameras or RFID sensors can identify employees walking into the work perimeter from the neighborhoods**



# Hard-to-Not-Drive Example

## Fictional, Simplified Case with Pricing and Payout Considered per Day, [Page 1](#)

- Employment Center (factory and office)
- Outside Hemet, California
- 100 employees; parking lot has 100 spaces
- No Transit, 110 degree temperature with poor roads for biking, culture of not car-pooling
- Before installing
  - 99 drive
  - 1 bikes

# Hard-to-Not-Drive Example

Fictional, Simplified Case with

Pricing and Payout Considered per Day, [Page 2](#)

- Dividend-Account Parking charges \$10/day
- After installing
  - 99 drive
  - 1 bikes
- Total collected each day: \$990
- Each employee gets \$9.90 earnings per day (\$990/100)
- Each driver loses 10 cents per day
- The “crazy” bike rider gets \$9.90 per day extra

**Hey, isn't this an improvement? I would say the “crazy” bike rider is earning his money!**

If another employee bikes, the drivers would lose 20 cents per day and the bike riders would get \$9.80 per day. If the company president rented out the 2 extra spaces for \$10 per day, the drivers would lose nothing and the bike riders would get \$10 per day. Biking would increase by 100%! **What's wrong with that?**

# Results of 3 Actions, Including Cash-out

Case (#1), Reference Patrick Siegman's article in Bicycle Pedestrian Federation

- Company: CH2M Hill
  - Location: Bellevue, WA (Seattle suburb)
  - Engineering Firm with 430 employees
- Actions
  - \$54/month (1995 \$'s), to not drive
  - Improved Transit
  - Improved Bike/Ped facilities

<b>CH2M Hill Work Trips</b>		
<i>Mode</i>	<i>Before</i>	<i>After</i>
<b>Drive Alone</b>	<b>89%</b>	<b>54%</b>
<b>Carpool</b>	<b>9%</b>	<b>12%</b>
<b>Bus</b>	<b>1%</b>	<b>17%</b>
<b>Bike, Walk</b>	<b>1%</b>	<b>17%</b>
	<b>100%</b>	<b>100%</b>

Since these changes are brought about by more than just cashout, this case is not used in the tabulation of cashout results (next chart)

**Money  
Matters  
!!!!**

# Cash-Out Results

(11 Locations, 3 Groups, 1995 Dollars)

- Reference: *How to Get Paid to Bike to Work: A Guide to Low-traffic, High-Profit Development* by Patrick Siegman\*. Published in *Bicycle Pedestrian Federation of America*, 1995.
- 3 Largest Responses
  - 38%, 36%, 31%
- 3 Smallest Responses
  - **15%**, 18%, 24%
- Responses are the change; car vacancy rates would be larger

\* Patrick Siegman, of Nelson Nygaard



Impact of Financial Incentives on Parking Demand			
Location	Scope	1995 dollars per mo.	Parking Use Decrease <sup>1</sup>
<b>Group A: Areas with little or no public transportation</b>			
CenturyCityDistrict, West Los Angeles	3500 employees at 100+ firms	\$81	15%
Cornell University, Ithaca, NY	9000 faculty & staff	\$34	26%
San Fernando Valley, Los Angeles	1 employer, 850 employees	\$37	30%
Costa Mesa, CA		\$37	22%
<b>Average for Group</b>		<b>\$47</b>	<b>23%</b>
<b>Group B: Areas with fair public transportation</b>			
Los Angeles Civic Center	10000+ employees, several firms	\$125	36%
Mid-Wilshire Blvd., Los Angeles	1 mid-size firm	\$89	38%
Washington DC Suburbs	5500 employees at 3 worksites	\$68	26%
Downtown Los Angeles	5000 employees, 118 firms	\$126	25%
<b>Average for Group</b>		<b>\$102</b>	<b>31%</b>
<b>Group C: Areas with good public transportation</b>			
University of Washington, Seattle Wa.	50,000 faculty, staff & students	\$18	24%
Downtown Ottawa, Canada	3500+ government staff	\$72	18%
Bellevue, WA	1 firm with 430 employees	\$54	39% <sup>2</sup>
<b>Average for Group, but not Bellevue Washington</b>		<b>\$45</b>	<b>21%</b>
<b>Over All Average, Excluding Bellevue Washington</b>			<b>25%</b>
<sup>1</sup> Parking vacancy would be higher! <sup>2</sup> Not used, since transit & walk/bike facilities also improved.			

# **Dividend-Account Parking Oceanside**

## **Civic Center Parking Garage**

### **Money Flow Calculations**

## **Simplifying Assumptions**

1. All workers are at this location for 9 hours, each day they report to work (8 hours of work and 1 hour for lunch)
2. All workers work 8 AM to 5 PM
3. Evening hours are 5 PM to 9 PM
4. All workers that work on week-ends also work on week days, for a total of  $7 \times 9 = 63$  hours at the work location per week



# *Dividend-Account Parking*

## Money Flow Calculations

<u>Notation Conventions</u>	
Letters	Meaning
N	Number
DAP	Dividend Account Parking
VP	Value Priced
WE	Week End
WD	Week Day
WH	Work Hours, Meaning 8 AM to 5 PM
AH	After Hours, Meaning 5 PM to 9 PM

# Dividend-Account Parking

## Money Flow Calculations

**Assume This is the "Value-Price" of the Parking**

*Use \$10 per 9 Hours at the Work Site*

Value

1.8519

1.11

Units

Cents per Minute

Dollars per Hour

# Dividend-Account Parking

## Money Flow Calculations

### Assumed Values Used in the Following Performance Assessment

<u>Description</u>	<u>Name</u>	<u>Value</u>
Number of parking places	N_DAP	250
Number of employees	N_Emp	250
% employees that drive on week day & week end	%Drive	80
Value-price to park, per 9 hours day (8 hours work + lunch)	VP_9Hrs	\$ 10.00
% employees that work on Sat. and on Sun.	%WE	20
Yearly bonus paid to all workers	Y_Bonus	\$100.00
<b><u>Non-Workers Use This Per-Cent of the Parking That Is Not Used by Workers</u></b>		
Week Day, Work Hours	%NonWrkWDWH	50
Week Day, After Hours (5 to 9)	%NonWrkWDAH	30
Week End, Work Hours	%NonWrkWEWH	50
Week End, After Hours (5 to 9)	%NonWrkWEAH	30

# Dividend-Account Parking

## Money Flow Calculations

Calculations to get the Weekly Earnings From Employees & the Weekly "AddIns" Required, per Employee			
Description	Formula	Name	Value
Number of Employees That Drive on a Week Day	$N\_Emp * \%Drive / 100$	<b>N_DrWD</b>	200
Money From Employees on a Week Day	$VP\_9Hrs * N\_DrWD$	<b>\$_AIE_WD</b>	\$ 2,000
Number of Employees That Work on a Week End	$N\_Emp * \%WE / 100$	<b>N_WrkWE</b>	50
Number of Employees Driving on a Week-End Day	$N\_WrkWE * \%Drive / 100$	<b>N_DrWE</b>	40
Money From All Employees Each Week-End Day	$VP\_9Hrs * N\_DrWE$	<b>\$_AIWE</b>	\$ 400
Weekly Money From Employees From Both the Week End & the Week Days	$5 * \$AIE\_WD + 2 * \$\_AIWE$	<b>\$_AIE</b>	\$ 10,800
Total Hours at This Location Per Week	$N\_Emp * 9 * 5 + N\_Emp * \%WE / 100 * 9 * 2$	<b>HrsPerWeek</b>	12150
Weekly Earnings for an Employee at the Location for 45 Hours	$\$_AIE * 45 / HrsPerWeek$	<b>PerWeek45</b>	\$ 40.00
AddIn for an Employee at the Location for 45 Hours per Week	$5 * VP\_9Hrs - PerWeek45$	<b>AddIn45</b>	\$ 10.00
Weekly earnings for an employee at the location for 63 hours	$\$_AIE * 63 / HrsPerWeek$	<b>PerWeek63</b>	\$ 56.00
Per Week AddIn for an Employee at the location for 63 Hours per week	$7 * VP\_9Hrs - PerWeek63$	<b>AddIn63</b>	\$ 14.00

# **Dividend-Account Parking**

## **Money Flow Calculations**

### **Calculation of the Weekly Amount Generated by Spaces Not Used by Workers, Week Day Work Hours (8 to 5)**

<b>Description</b>	<b>Formula</b>	<b>Name</b>	<b>Value</b>
Spaces Available for Non-Workers, Work Day, Work Hours	$N\_DAP - N\_DrWD$	<b>S_4NW_WDWH</b>	50
Spaces Used by Non-Workers, Work Day Work Hours	$S\_4NW\_WDWH * \%NonWrkWDWH / 100$	<b>SNW_WDWH</b>	25
Money from Spaces Used by Non-Workers Per Day	$SNW\_WDWH * VP\_9Hrs$	<b>\$NW_WDWH</b>	\$ 250
Money from Spaces Used by Non-Workers Per Week	$5 * \$NW\_WDWH$	<b>W\$NW_WDWH</b>	\$ 1,250

# **Dividend-Account Parking**

## **Money Flow Calculations**

### **Calculation of the Weekly Amount Generated by Spaces Not Used by Workers, Week Day After Hours (5 to 9)**

Spaces Available for Non-Workers, Work Day, 5 to 9, AKA After Hours	N_DAP	S_4NW_WDAH	250
Spaces Used by Non-Workers, Week Day After Hours	$S\_4NW\_WDAH * \%NonWrkWDAH / 100$	SNW_WDAH	75
Money From Spaces Not Used by Workers, Week Day After Hours	$(4/9) * VP\_9Hrs * SNW\_WDAH$	\$NW_WDAH	\$ 333
Money per Week from Spaces Not Used by Workers, Week Day After Hours	$5 * \$NW\_WDAH$	W\$NW_WDAH	\$ 1,667



# **Dividend-Account Parking**

## **Money Flow Calculations**

### **Calculation of the Weekly Amount Generated by Spaces Not Used by Workers, Week End Work Hours (8 to 5)**

Spaces Available for Non-Workers, Week End Work Hours	$N\_DAP - N\_DrWE$	<b>S_4NW_WEWH</b>	210
Spaces Used by Non-Workers, Week End Work Hours	$S\_4NW\_WEWH * \%NonWrkWEWH / 100$	<b>SNW_WEWH</b>	105
Money From Spaces Used by Non-workers Per Week-End Day, Work Hours	$SNW\_WEWH * VP\_9Hrs$	<b>\$NW_WEWH</b>	\$ 1,050
Money From Spaces Used by Non-workers On the Week End After Hours, Per Week	$2 * \$NW\_WEWH$	<b>W\$NW_WEWH</b>	\$ 2,100

# **Dividend-Account Parking**

## **Money Flow Calculations**

### **Calculation of the Weekly Amount Generated by Spaces Not Used by Workers, Week End After Hours (5 to 9)**

Spaces Available for Non-Workers, Week End After Hours	N_DAP	S_4NW_WDAH	250
Spaces Used by Non-Workers, Week End After Hours	$S\_4NW\_WDAH * \%NonWrk$ WDAH/100	SNW_WDAH	75
Money From Spaces Used by Non-workers Per Week-End Day After Hours	$4/9 * SNW\_WDAH *$ VP_9Hrs	\$NW_WDAH	\$ 333
Money From Spaces Used by Non-workers on Week-End Days After Hours, Per Week	$2 * \$NW\_WDAH$	W\$NW_WDAH	\$ 667

# Dividend-Account Parking

## Money Flow Calculations

**The Weekly Earnings From Non-Employees, the Weekly "AddIns" Required, the Weekly Surplus Generated, the Yearly Surplus, and the Yearly Surplus After Giving Employees a \$100 Per Year Bonus**

Description	Formula	Name	Value
Weekly Money Earned by the spaces not taken by workers	$W\$NW\_WDWH +$ $W\$NW\_WDAH +$ $W\$NW\_WEWH +$ $W\$NW\_WEAH$	<b>W\$NW</b>	\$ 5,683
Weekly Money Required to Pay All of the AddIn Amounts	$N\_DrWD * AddIn45 +$ $N\_DrWE * AddIn63$	<b>AddInPerWeek</b>	\$ 2,560
Weekly Money Left Over After Paying Add Ins	$W\$NW - AddInPerWeek$	<b>\$PerWeek</b>	\$ 3,123
Yearly Money After Paying Add Ins From the Money From Non-Workers	$52 * \$PerWeek$	<b>\$PerYear</b>	<b>\$ 162,413</b>
Yearly Money After Paying Add Ins and Also a \$100 Bonus Per Year for Each Employee	$\$PerYear - \$100 * N\_Emp$	<b>\$PerYear</b>	<b>\$ 137,413</b>

# Dividend-Account Parking

## Money Flow Calculations

<b>3 Cases of Dividend-Account Parking Performance</b>							
<b>Oceanside Civic Center Garage</b>							
					<b>Baseline</b>	<b>Worse</b>	<b>Better</b>
% employees that drive on week day & week end					80%	85%	75%
% employees that work on Sat. and on Sun.					20%	25%	15%
<b>% Parking Not Used by Workers, That is Used by Non-Workers</b>							
Week Day, Work Hours					50%	45%	55%
Week Day, After Hours (5 to 9)					30%	25%	35%
Week End, Work Hours					50%	45%	55%
Week End, After Hours (5 to 9)					30%	25%	35%
Yearly Amount Left Over After Paying Add-Ins					<b>\$ 162,413</b>	<b>\$ 125,242</b>	<b>\$ 210,374</b>
Amount Left After Paying Add-Ins & \$100 Bonus					<b>\$ 137,413</b>	<b>\$ 100,242</b>	<b>\$ 185,374</b>

# Back up Slides

# Measures to Get 32%

Estimated  
Reduction

- Predictions, Regional Transportation Plans 10%
- Stop expanding most roads and all freeways 2%
  - No need, Eliminate congestion with less driving
- Reallocate freeway-expansion \$\$\$ to **transit** 2%
- **Payment methods, to increase fairness & choice**
  - Demonstration projects: Dividend-Account Parking
  - **Legislation**
    - Replace Bundled-Cost or Bundled-Benefit Parking 8%
    - Equitable and environmentally-sound road-use fees 8%
- **Smarter growth, complete streets, bike classes** 2%

**32%**



# Climate Literacy

**THEREFORE BE IT RESOLVED**, that the California Democratic Party reinforces the need for all high school students to know, before they graduate, and elected officials to know, acknowledge, and address, as soon as possible, (1) both the existence of and the reason for anthropogenic climate change; (2) its potential for harm; (3) the difference between stabilizing the climate at a livable level and destabilization; (4) science-based, climate-stabilizing, GHG reduction targets; (5) the primary variables and considerations in identifying those targets and (6) the approximate amount of life style and technology change required to achieve those climate-stabilizing targets.

# XXX Implementation Example

The City could have the vendor operate the system, for the first 10 years. Over those years, the vendor would be motivated to debug the system and continue to look for operational efficiencies. The vendor could receive 10% of the revenue, for the first 5 years; 5% of the revenue, for the next 3 years; and 2%, for the final 2 years. If 600 cars are parked for 8 hours, 200 days per year, at 50 cents per hour, then the yearly revenue would be \$480,000. The vendor would collect \$240,000 over the first 5 years, \$72,000 over the next 3 years, and \$28,800 over the last two years.

# How Bad Could It Get?

**Governor Brown to the Pope:**

***Humanity must***

***Reverse  
Course\****

**or**

***Face  
Extinction***

***\* Must be quantified***



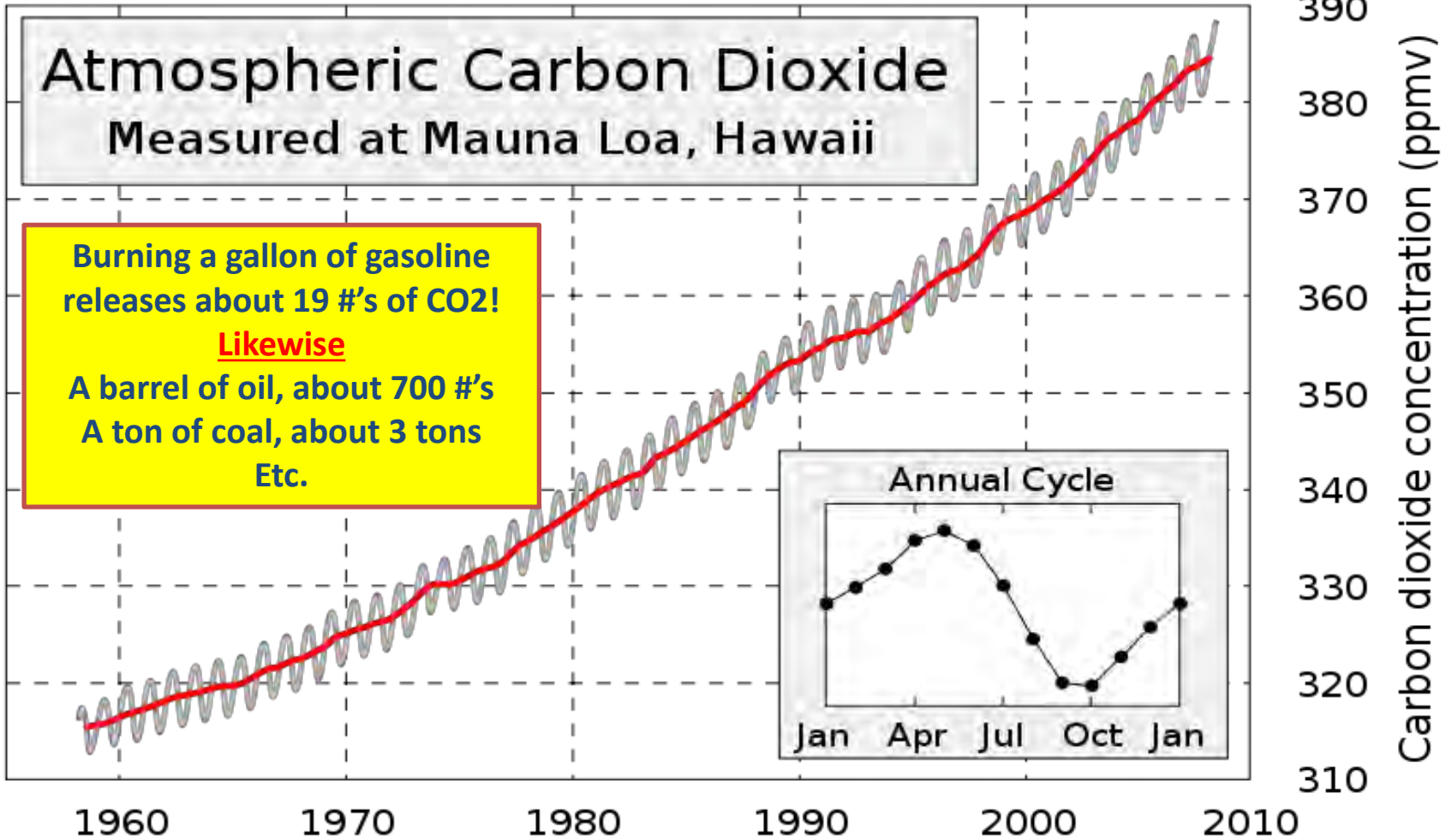
# Climate Data

Currently  
400 PPM!



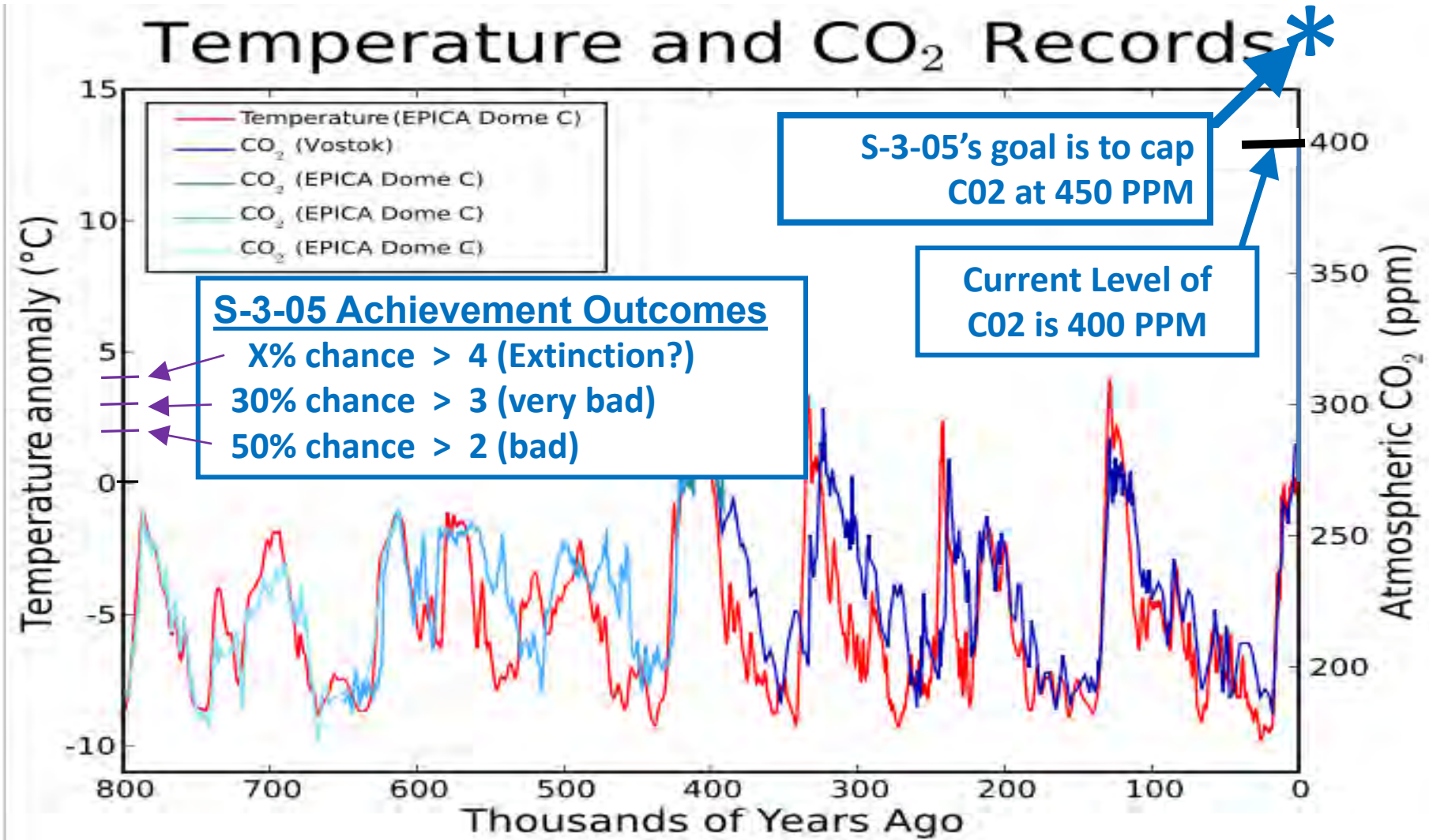
- Keeling Curve:

[http://en.wikipedia.org/wiki/An\\_Inconvenient\\_Truth#Scientific\\_basis](http://en.wikipedia.org/wiki/An_Inconvenient_Truth#Scientific_basis)



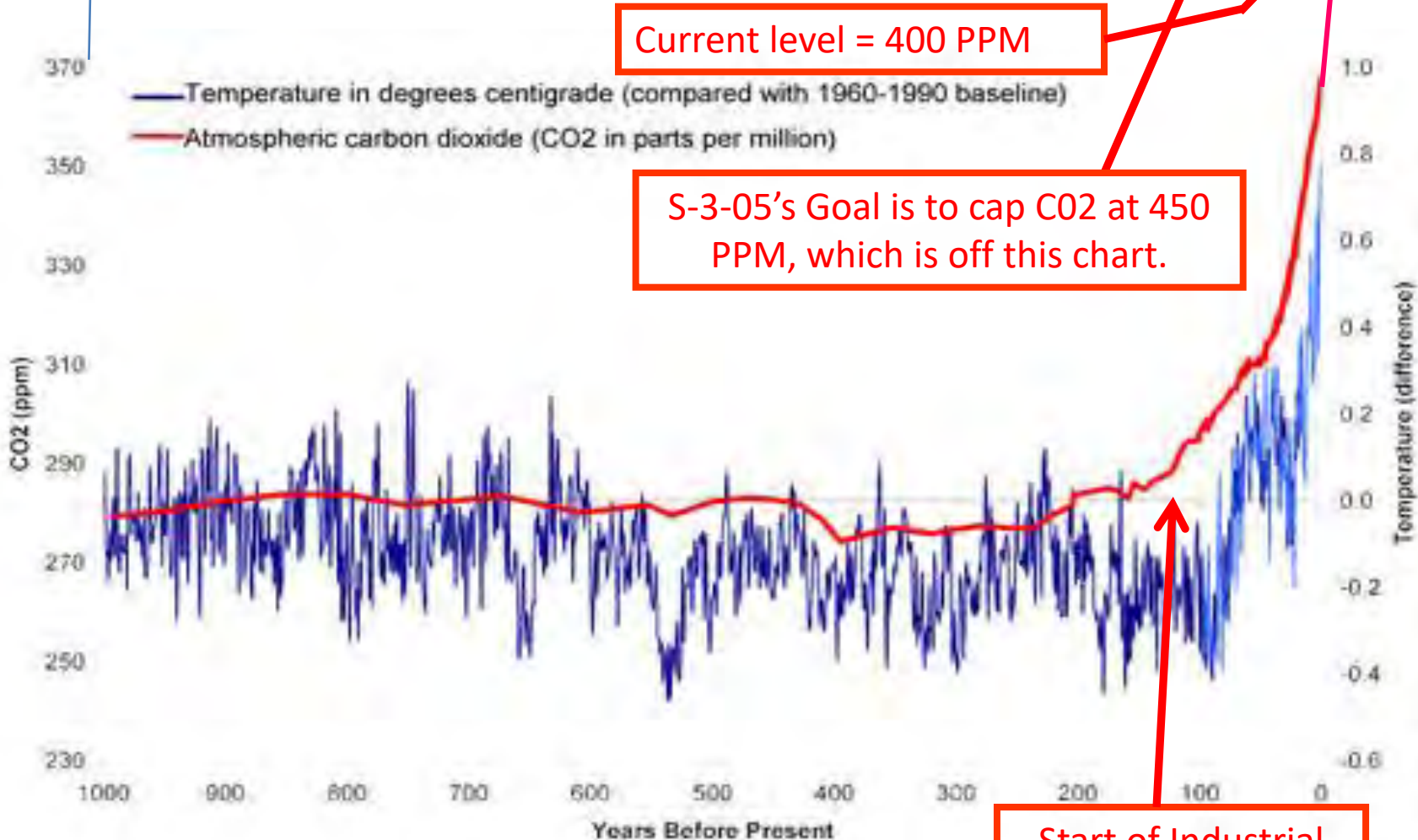
# Our Climate Crisis

- From: [http://en.wikipedia.org/wiki/An\\_Inconvenient\\_Truth#Scientific\\_basis](http://en.wikipedia.org/wiki/An_Inconvenient_Truth#Scientific_basis)



# Our Climate Crisis

- Earth & Space Research (ESR) website:  
[http://www.esr.org/outreach/climate\\_change/mans\\_impact/man1.html](http://www.esr.org/outreach/climate_change/mans_impact/man1.html)



Current level = 400 PPM

S-3-05's Goal is to cap CO2 at 450 PPM, which is off this chart.

Start of Industrial Revolution



# Fixing the Problem

We must *stabilize* the value of the earth's atmospheric  $CO2_e$

$CO2_e$  Emissions

Sequestration  
(Photosynthesis)

$E_N$

+

$E_A$

+

$E_{WFB}$

Natural: rotting, fire, digestion, respiration

Anthropogenic: combustion of fossil fuel, methane, other

Warming Feed Back: such as methane from melting permafrost

$>$  → Positive Slope

$=$  → Zero Slope

$<$  → Negative Slope

$S$

Growth of plants on Earth

The **Warming Feed Back** term is the wild card. It must not become dominant.

If **Anthropogenic emissions** were to be sufficiently low (80% below 1990 levels has been allocated to developed countries), the slope would be zero, thus **capping** the value of the Earth's atmospheric  $CO2_e$

# Motivation for Change

- Fairness to individuals
  - Costs no longer hidden
  - Costs avoided or recovered, by not using parking
- Less driving, to reduce environmental harm
  - Motivates choosing alternative modes
  - Less driving to find parking
- Cost Effective Development
  - Less parking needed reduces land and building costs

# Goals, 1 of 2

- One agency operates all parking
- Nearly all parking is shared
- Parking costs are effectively unbundled
  - From wages and rents
  - From costs of goods and services
- No change to how parking gets built
  - Generally, municipalities require & developers build

# Goals, 2 of 2

- Priced right
  - Value Priced: Base price derived from costs
  - Driver demand determines a congestion price
- No need to search for parking
  - Directions to parking that meets user's needs
  - Accurate price predictions
- Each parking space's use is archived
  - Supports informed decisions
- Privacy and the needs of the disabled are supported

# Definitions and Methods, 1 of 6

- Definition & Examples of ***Parking Beneficiary Group***
  - Owners
    - Private investors or governments operating public parking
  - Those losing money due to provided parking
    - Employees
    - Apartment renters or condominium owners
    - Hotel or restaurant patrons
    - Shoppers
  - Those offered specific parking
    - Driving-age students at a school with parking
    - Driving-age train riders using a station with parking

# Definitions and Methods 2 of 6

- How to Effectively Unbundle the Cost or the Benefit
  - Price charged per minute
    - Base price rate established to cover all costs
    - Congestion price rate
      - Dynamically set as a function of occupancy rate
      - Charge is time average, if rate changes, while car is parked
  - Parking generally available to all drivers
  - Earnings distributed to members of Beneficiary Group
    - Calculation of individual's earnings depends on situation



# Definitions and Methods, 3 of 6

- Calculation of monthly earnings
  - If parking is provided for several groups, each group's portion of the earnings is proportional to its original contribution to cost (Mixed use case)
  - Each beneficiary group's total is divided up among its members
    - Condominium owners: proportional to spaces effectively purchased
    - Renters: proportional to spaces effectively renting
    - Shoppers: proportional to money spent
    - Employees or students of driving age: proportional to time spent at work or school
    - Train riders of driving age: proportional to time spent on round trips

# Definitions and Methods, 4 of 6

- For congestion pricing, *define **Cluster of Parking***
  - 20 to 40 contiguous spaces nearly equal in desirability
  - Assigned the same price
- Pricing
  - Base price
    - Covers all costs  $r_{BaselineHourly} = \frac{(r_{Investment} \times v_{Parking}) + c_{YOPD}}{(n_{HoursPerYear} \times f_{TO})}$
    - Report's Page 13 & 14 provides details
  - Congestion price, for each cluster

$$r_{HourlyRate} = r_{BaselineHourly} \times (B^{(30-V)/5}), \text{ for } V < 30; r_{BaselineHourly}, \text{ otherwise}$$

- $B$  is nominally 2; adjusted to keep vacancy above 15%
- $V$  is the vacancy % rate (Report's Eq. 2, Table 2, Pages 14 & 15)

# Definitions and Methods, 5 of 6

- Pricing predictions
  - For any set of dates, start times, durations, and destinations
  - Availability of predictions
    - Broadcast into navigational units
    - Website or phone
- Help to find desired parking
  - Driver gives times and locations and stipulates . . .
    - Max price, to get space at minimum walk distance
    - Max walk distance, to get space at minimum price
  - Voice-activated navigational system for ease and safety

# Definitions and Methods, 6 of 6

- Monthly statements
  - All parking charges and earnings
    - First, within state
    - Then, within nation
    - Finally, within North and South America
  - Customer selects presentation detail
    - Less detail for ease and more privacy
    - More detail to know and adjust parking decisions
  - Packaged with other statements
    - All utilities, transit use, road use

# Implementation Plan, 1 of 3

- Prototype design
  - Most likely a Climate Action Plan Mitigation Measure
- Requirements document to support request for proposal (RFP)
- Winning proposal leads to design
  - Hardware selection and design
  - Software generation
- Prototype installation
  - Most likely a Climate Action Plan Mitigation Measure
  - Debug
  - Adjustments to satisfy stakeholders

# Implementation Plan, 2 of 3

- Government agency develops and executes full installation strategy
  - To minimize impact on institutions
  - To maximize early success and driving reductions
    - Large employment centers with “free” parking
    - Train stations with large, “free” parking lots
  - Supported by new law that requires cooperation but very little effort, from . . .
    - Private and public institutions
    - Individuals



# Implementation Plan, 3 of 3

- Basis for a new law supporting installations
  - To provide equal protection of the law
    - Government has required parking for 50 years
    - Those driving less than average often lose money
  - Prototype will have demonstrated feasibility
  - Global warming considerations show subsidized parking to be a public nuisance
    - Global warming will likely cause a human catastrophe
    - Short term strategies are critical
    - Electric cars and getting most electricity from renewables will take decades
    - Properly pricing parking is relatively cheap and quick (5 years)

# Unbundle Flow Diagram Definitions

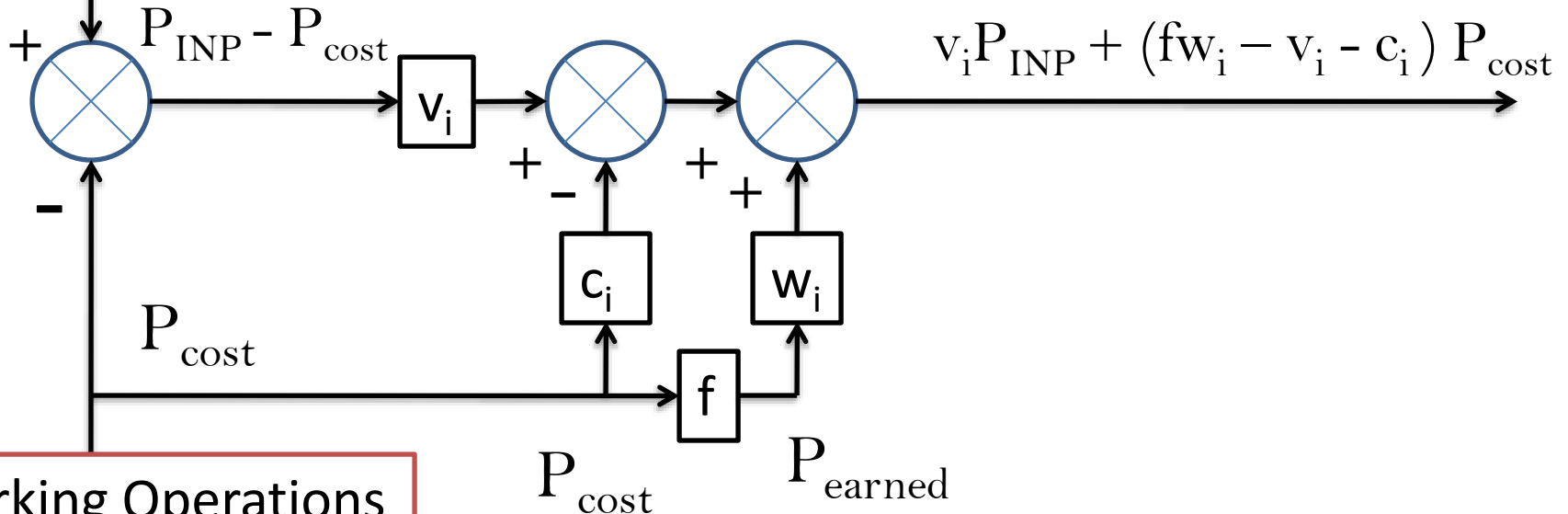
Variable	Definition
$P_{INP}$	Company payroll if there were no parking costs
$P_{cost}$	Total parking cost. Price will be sized to recover this.
$P_{earned}$	Parking earnings equals parking cost minus collection cost
$V_i$	Employee value. Fraction of available pay. For the average employee, $1/n$
$C_i$	Fraction of parking cost paid. Zero, if the employee never parks.
$f$	Parking earnings divided by parking cost. Close to 1 for efficient collection
$w_i$	time worked divided by total time worked of all employees. If average, this is $1/n$ .

# Unbundle Flow Diagram

Company Operations

Payroll,  
If No  
Parking

$P_{\text{INP}}$



Parking Operations

For the average  $i^{\text{th}}$  employee,  $v_i = 1/n$  and  $w_i = 1/n$ . If this employee never parks, their pay is  $(1/n)P_{\text{INP}} - (1/n)P_{\text{cost}}(1-f)$ . If  $f = 1$ , the pay is what it would be with no parking.

# Mike Bullock, 1 of 2

- Personal
  - Married, two daughters, 3 grand daughters, 1 grandson
    - Daughter Laura Bullock White (Berkeley)
    - Heidi Bullock (Oceanside)
  - Moved from Cupertino to Oceanside in April 2007
  - Oceanside home (1800 Bayberry Dr) and 4-plex (506 N. Ditmar)
  - Swims with and competes for Oceanside Swim Masters
- Education
  - BSEE, Lamar University
  - MSE, University of Texas at El Paso
- Professional
  - Lockheed Martin Systems Engineer, 1971 to 2007
    - Last 2 years, Space Based Infrared System (SBIRS, satellite to detect and track missiles)
    - 10 Years previous: Milstar (communication satellite)
      - Verification of antenna pointing accuracy
      - Antenna pointing calibration

# Mike Bullock, 2 of 2

- Most Recent Activities
  - California Democratic Party
    - Delegate, 76<sup>TH</sup> AD
    - Elected member of the San Diego County Central Committee
    - CDP Resolutions and Platform

# ***San Diego County's Climate Action Plan Misadventures***

- The Sierra Club proposed Dividend-Account parking, as a demonstration project for County employees
- The County argued it was infeasible
- Superior Court Judge Taylor ruled that the County failed to show it was infeasible
- The County appealed on a 3-2 vote
- This is the 2<sup>nd</sup> failed CAP for the County. The first was ordered rescinded on the same issue and resulted in a published Appellant Court Ruling



**DRAFT**

**These entities or others may become interested in issuing a Request for Information as described herein**

**City of Encinitas in cooperation with the cities of Oceanside, Carlsbad, Solana Beach, and Del Mar, the United States Marine Corps Base at Camp Pendleton, and North County Transit District**



**REQUEST FOR INFORMATION (RFI)  
OR A REQUEST FOR AN INDICATION  
OF INTEREST (RFIOI) IN RESPONDING  
TO AN RFI**

**Design, Install, and Operate a Dividend-  
Account Car Parking System at Selected  
Work Locations for Employees**

**CM RFI 18-XX**

**Date Issued: Month j, 2018 or 2019  
Questions Due: Month k, 2018, 5:00 PM  
Proposals Due: Month l, 2018, 2:00 PM**

**IF YOU DID NOT DOWNLOAD, OR DIRECTLY RECEIVE THIS DOCUMENT FROM THE XXX WEBSITE AT [WWW.XXX.GOV/BIDS](http://WWW.XXX.GOV/BIDS), YOU ARE NOT LISTED AS AN OFFICIAL DOCUMENT HOLDER FOR THIS SOLICITATION AND WILL NOT BE NOTIFIED BY THE CITY OF ADDENDA ISSUED. YOU MUST ACKNOWLEDGE ANY ADDENDA ISSUED IN YOUR SUBMITTAL OR RISK BEING CONSIDERED NON RESPONSIVE. PLEASE BE SURE TO VISIT THE WEBSITE ABOVE TO REGISTER AS A DOCUMENT HOLDER FOR THIS SOLICITATION.**

City of XXX  
City Manager's Department – Environmental Services  
Attn: YYY

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# I. INTRODUCTION

The City of Encinitas, or one of the other entities shown above, may want, at some future date, to request information that will aid in the selection of a vendor for a possible Dividend-Account Car-Parking System Demonstration pilot on behalf of the themselves and other entities, such as Oceanside, Carlsbad, Encinitas, Solana Beach, and Del Mar, the United States Marine Corps Base at Camp Pendleton, and the North County Transit District (collectively referred to as “Partners”). The Partners may seek to evaluate the benefits, effectiveness, and popularity of a Dividend-Account Car Parking System for employees in the north coastal region of San Diego County through the operation of a temporary pilot program lasting from twelve (12) to thirty-six (36) months. It could become the goal of the Partners to determine whether permanent Dividend-Account Car-Parking systems would be successful in our region based on the outcome of a pilot program. Partners may decide to be actively coordinating with the San Diego Association of Governments (SANDAG), the agency that may be leading regional Dividend-Account Car-Parking Systems coordination around topics including data collection and monitoring, public outreach, policy/regulations. The partners are more likely to want to proceed if there is an identified interest on the part of vendors to respond to an actual RFI. To save time, the rest of this document is written as if one of the Partners has already decided to issue an RFI. However, that is not currently the case. This document, perhaps best described as Request for Indication of Interest has been adapted from a dock-less bike share RFI. Thank you for considering this concept. Please indicate if you would be interested in designing and operating such a system.

Mike Bullock



Oceanside, CA 92054  
760-754-8025; Cell: 760-421-9482

## A. Location

The study area includes the cities of Oceanside, Carlsbad, Encinitas, Solana Beach, and Del Mar, and the United States Marine Corps Base at Camp Pendleton, all of which are located in northern San Diego County along the coast. The region has a mild climate with average temperatures ranging from the mid-60s in the winter to mid-80s in the summer. The terrain is relatively flat along the coast, particularly when traveling in the north-south directions. Each of the cities have dense urban centers of varying sizes with grid street plans and relatively flat terrain. Generally, most of the cities in the study area have more hilly terrain and a suburban layout east of Interstate 5 (I-5). The combined population of the cities is approximately 365,000 and the combined geographical area of the cities is approximately 106 square miles. Highway 101 runs along the coast through each of the cities for a contiguous distance of approximately 20 miles. Highway 101 is one of the most popular bicycling routes in the San Diego region. North County Transit District (NCTD) operates two rail lines and 34 bus routes throughout North County. Thirteen rail and/or bus transit centers are located within the study area. Total annual NCTD ridership is approximately 10.7 million passengers. The Camp Pendleton Marine Corps base is located just north of Oceanside and serves as a major employer for both enlisted and non-enlisted personnel. The southwest corner of the base adjacent to Oceanside Harbor and west of I-5 features relatively flat terrain and could benefit from increased biking connections.

**Table 1: General information about the region**

	Population <sup>1</sup>	Employment <sup>2</sup>	Size (sq. mi.)	Coastline (mi.)
Oceanside	175,948	35,662	42	3.5
Carlsbad	112,930	66,596	39	6.3
Encinitas	61,928	22,443	20	6
Solana Beach	13,494	7,843	3.6	1.5
Del Mar	4,274	3,474	1.8	2.9

<sup>1</sup>SANDAG Current Estimates, 2016

<sup>2</sup>U.S. Census Bureau, 2015

## **B. Background**

The cities in the North County coastal region of San Diego County are increasingly aware of the need to reduce local greenhouse gas (GHG) emissions to limit the effects of climate change

while offering viable transportation alternatives to driving alone. Many of the cities have adopted Climate Action Plans (CAPs) or are in the process of developing CAPs. CAPs establish environmental initiatives by which cities aim to achieve GHG emissions reduction goals and targets. Transportation, especially travel via single occupancy vehicle, is a major source of GHG emissions in North County. Facilitating safe, convenient, and affordable alternative transportation options is often a component of these plans and initiatives. Car parking systems that increase economic fairness and choice, compared to bundled-employee-benefit car parking systems (erroneously called “free parking”) at places of employment will reduce single occupancy vehicle (SOV) commuting and increase the need for first/last mile solutions. For this reason, this RFI will be provided to those firms that would benefit from increasing the demand for first/last mile solutions.

The Marine Corps Mobility Transformation Strategy calls for demonstration projects at installations like Camp Pendleton to meet official business mobility with capabilities that are smarter, more efficient, more accessible, and cheaper.

Partners will seek to coordinate with SANDAG on Dividend-Account Car-Parking Systems data analysis while ensuring the selected Dividend-Account Car-Parking Systems vendor can meet data sharing requirements that assist in quantifying the impacts of Dividend-Account Car-Parking Systems on vehicle miles traveled (VMT), access to transit, economic development, and other benefits.

Offering and promoting programs, like Dividend-Account Car-Parking Systems, that replace vehicle trips with active transportation and/or transit trips, is one of the ways the Partners can help to reduce emissions while offering more efficient and more affordable transportation modes for residents, employees, and visitors. A Dividend-Account Car-Parking System is a system which operates employee car parking for the financial gain of the employees by value-pricing the parking and distributing the earnings, which are the revenue minus a fair cost of operation, among employees. The earnings are provided in proportion to the time an employee spends on the work premises. There may also be an “add in” payment provided by either the employer or from a grant, such as a Greenhouse Gas Reduction Fund (GGRF) grant, sized so that an employee that continues to drive every day will lose no money under the system. This system will in effect pay each employee an additional amount of income for each day they get to work without relying on the single occupancy vehicle (SOV) mode. See Reference 1 for more details on the Dividend-Account Car Parking System. The References are listed at the end of Section II, Request for Information.

### **C. Purpose and Objectives of the RFI**

The purpose of this Request for Information (RFI) is to identify vendors with the resources to pilot a Dividend-Account Car-Parking System program in the Partners’ jurisdictions, in accordance with the objectives set forth in this RFI.

The Partners seek a qualified vendor to design, establish, implement, operate, and maintain an innovative, valuable, and mutually-beneficial Dividend-Account Car-Parking System pilot program. The pilot should enable and encourage residents, employees, and visitors to affordably and conveniently travel by car pool, transit, active transportation or some combination of these modes. The pilot should also facilitate a decrease in vehicular parking demand, vehicular traffic, and (GHG) emissions, while promoting active and healthy transportation options.

Qualified vendors are invited to submit proposals based on the information provided in this RFI.

This RFI is a mechanism for gathering information and does not constitute a binding procurement process, however, selection of goods and/or services may result from information obtained through this RFI process, where deemed appropriate. The Partners, jointly or individually, are not obligated to make an award or issue a Request for Proposal as part of this process. In addition, the Partners, in their sole discretion, may decide to engage in direct question and answer sessions with one or more vendors and may decide to enter into an agreement or issue permits based upon those discussions/interviews or a resulting proposal.

If a single demonstration pilot project or multiple demonstration pilot projects were successful, given the severity of our anthropogenic climate change crisis, it is anticipated that other employers will decide to install Dividend-Account car-parking systems. Since municipal governments are required under CEQA to adopt General Plan Updates (GPUs) that include, perhaps using a Climate Action Plan, a set of enforceable measures that will achieve climate-stabilizing targets, and since cars and light-duty trucks (LDVs) are the largest category of GHG emissions, it is further anticipated that municipal governments will, over time, update their off-street parking ordinances to include requirements for Dividend-Account Car Parking systems. Reference 2 shows that this system is adaptable to all types of parking. A selected vendor would have access to a market of more than 365,000 residents living in the north coastal region, more than 135,000 employees that work in the region, and others that visit the region for leisure.

Potential Dividend-Account Car-Parking Systems program marketing opportunities may include, but are not limited to: being listed as a preferred vendor on the Partners websites, co-branded sustainability campaigns, signage, event sponsorship, press releases, and social media announcements.

#### **D. Obtaining RFI Documents**

The website for this RFI and related documents is: PlanetBids (<http://www.encinitasca.gov/bids>). All correspondence will be posted on the PlanetBids website. It is the responsibility of Proposers to check the website regularly for information updates and RFI clarifications, as well as any RFI addenda. To submit a proposal, a Proposer must be registered with the City of Encinitas as a vendor. To register as a vendor, go to the following link (<http://www.encinitasca.gov/bids>), and then proceed to the “New Vendor Registration” link. All addenda will be available on the PlanetBids website.

#### **E. RFI Contact**

The City of Encinitas will receive questions and information requests on this RFI up to **5:00 p.m. on some TBD Month “n”, 2018**. All questions regarding the RFI documents shall be submitted through PlanetBids. All project correspondence will be posted on the PlanetBids website. It is the responsibility of the Proposers to check the website regularly for information updates, clarifications, and addenda.

## **II. REQUEST FOR INFORMATION or REQUEST FOR INDICATION OF INTEREST**

This section describes the information being requested by the Partners to learn about prospective **Dividend-Account Car-Parking System (“System”)** vendors and optionally to select a vendor to operate in the Partners’ jurisdictions. Interested vendors must include all



information outlined below in a submitted proposal.

**A. Dividend-Account Car-Parking System (“System”) Pilot Program Requirements**

Vendors responding to this RFI must describe their proposed system that is capable of providing the following services and shall describe these services in their submission:

1. System pilot program(s), as described in Reference 1, to include the following installed and maintained capabilities:
2. A capability to establish and maintain a database of System Vehicles, System Members, System Parking and System Accounts. A System Account includes the mailing name and address of a person that has agreed to receive payments and pay bills that are the result of the implementation of the System and the actions taken by the person, or some other person driving the System Vehicle or System Vehicles, as described herein. Such a person is a “System Member.” A “System Vehicle” is one that can be identified when it is parked in the System and one that is associated with a System Account and System Member. A System Member may take responsibility to pay for the cost of parking for multiple System Vehicles.
3. A capability to provide an easy method for Employees and others to become System Members by establishing a System Account with their chosen System Vehicles.
4. A capability to provide signage to designate System Parking areas well enough to prevent nearly all accidental entries by unauthorized vehicles, meaning vehicles that are not System Vehicles.
5. A capability to provide written materials to explain to employees and others that may want to become System Members how the System will work and why it is an important improvement to economic fairness and environmental outcomes, assuming a reasonable level of cooperation with the City and other affected groups, such as City vendors and sub-contractors.
6. A capability to operate the system for an agreed-upon amount of time, with no money exchanges, to establish a pre-install database of commute behavior including using questionnaires to determine how non-drivers say they are getting to work.
7. A capability to identify a System Vehicle within a minute of its being parked in a System Parking space and to store the System Vehicle identifier and the time it was recognized as being parked.
8. A capability to recognize when a System Vehicle exits a System Parking space, within a minute and to store the vehicle identifier and the recognized exit time.
9. A capability to identify vehicles that are NOT System Vehicles when they are in the System Parking area and are therefore trespassing, while they are in the System Parking area.
10. A capability to record the start time and end time of the trespassing vehicle’s trespassing, to within an accuracy of 1 minute, as well as its license plate image, sufficient to support a conviction of trespassing.
11. A capability to send the license plate of the trespassing vehicle and its start time and end time of its trespassing to law enforcement officials with 5 minutes of the recorded start time of the trespass.
12. A capability to provide notice and evidence of this trespassing in real time and as stored

information for law enforcement so that they can then ticket and prosecute the owners of any and all vehicles that have been illegally parked in a System Parking space. It is anticipated that this would include the capture and storage of the license plate numbers of the vehicles that are parked in the System Parking lot whenever it is the case that the vehicle is not a System Vehicle.

13. A capability to compute an instantaneous charge rate (cost per minute) for the case of an application of “congestion pricing”, whereby an agreed-upon base price is increased by an agreed-upon congestion-pricing algorithm, designed to prevent the occupancy rate from exceeding an agreed-upon upper bound value, such as 90% occupied. An example of such an algorithm is in Reference 2.
14. A capability to compute and store the time that the charge rate changes, for the case of an application of a congestion-pricing algorithm. Note that this time is called the Rate Change Time. At these times, the rate could either increase, by the addition of a car being parked in a System Space or the rate could be decreased, by the subtraction of a car in a System Space.
15. A capability to accumulate a total charge for each System Member, where the total charge is the sum of the products of each parked duration time over which a fixed charge rate applies and the length of that time duration, for all the System Vehicles associated with the System Member, over a month. This total charge is called the System Member Monthly Charge (“SMMC”). Note that the Member may or may not be an employee.
16. A capability to compute the total charges, for all System Members over a month for the System. This amount is the Total System Monthly Charge (“TSMC”).
17. A capability to compute a Total System Monthly Earnings (“TSME”), which is the TSMC, reduced by a agree-to amount, such as 5%, where the 5% is taken out of the TSMC to cover the operator’s expenses.
18. A capability to record all the times an employee enters and leaves the work premises. One way to do this is to require employees to have an RFID. There may also be an GPS or a license plate reading solution. Note that a privacy requirement will prevent this information from being shared, with the employer, for example, with the exception of providing it to a law enforcement person, in the event a warrant is signed by a presiding judge.
19. A capability to use the times an employee enters and leaves the work premises to compute the time, over a month, an employee has spent at or within the work premises. This time is known as the Employee Monthly Time (“EMT”).
20. A capability to compute the total time all employees spent at the premises over a month, to be known as the Total Employee Monthly Time (“TEMT”).
21. A capability to compute an Employee’s Monthly System Earnings (“EMSE”) as the Total System Monthly Earnings (“TSME”), multiplied by the employee’s Employee Monthly Time, EMT divided by the TEMT. This is also described in Reference 1.
22. A capability to compute an Employee’s Add-In “EAI”, as follows. If the employee’s System Member Monthly Charge, SMMC, value is greater than the employee’s earnings, TSME; then, for that case, the EAI is equal to the employee’s SMMC minus the employee’s TSME. If the employee’s System Member Monthly Charge, SMMC value is not greater than the employee’s earnings, TSME; then the employee’s EAI is equal to zero. This is also described in Reference 1.
23. A capability to accept Employee’s Add-In, EAI money from the Employer, with the

expectation that the money would originate from a grant funded by, for example, the Greenhouse Gas Reduction Fund (GGRF), or could come from the Employer's budget, as a Climate Action Plan (CAP) or other expense. It could also be generated by converting some "free" parking to be a different Account Parking System Parking (System Parking), thereby generating new money to the City.

24. A capability to compute an employee's monthly payment ("EMP"), as follows: It is equal to the Employee's Monthly System Earnings, EMSE plus the employee's Add-In, EAI minus the System Member Monthly Charge, SMMC. This is also described in Reference 1.
25. A capability to automatically send out monthly statements to all System Members. System Members who are not employees will receive a bill if they have parked in the System parking during the month. The bill will then be for the member's SMMC. Each employee will receive a statement showing SMMC, EMSE, and EAI. If the employee's EAI is zero, then the employee will receive a payment in the form of cashable check for the employee's EMP. This is also explained in Reference 1.
26. A capability to protect employee privacy where privacy means that the employee's data will never be shared, with the sole exception of sharing with law enforcement officials in accordance with a valid court order requesting the data. For example, at no time will the data be shared with other employees, including those working in the management of the employer that is providing the employee parking that is the System Parking.
27. A capability to protect System Member privacy where privacy means that the System Member's data will never be shared, with the sole exception of sharing with law enforcement officials in accordance with a valid court order requesting the data.
28. A capability to allow visitors, vendors, and others, that are identified by the Company management, to be treated as employees. There could also be "visitor" parking that is not associated with the System.
29. A capability to identify System Vehicles that are parked in the visitor parking or other inappropriate parking places, since it is expected that it will required as a part of City Policy that System Vehicles that are associated with employees will be required to be parked in the System Parking. Since employees are earning money from the System Parking, it would be inappropriate for them to not use the System Parking. This information would be shared with City Management, as soon as it is collected.
30. A capability to perform regular inspection, maintenance, and repair of all System Parking facilities and associated capabilities often enough to eliminate nearly all system failures.
31. A capability to perform vendor-managed methods of enforcement.
32. A capability to have demonstrated secured financial backing with the ability to operate at full capacity for the life of the pilot program and beyond with a sustainable business model.
33. A capability to provide close coordination with all Partners, including real-time sharing of System Parking data collected, active promotion of the Dividend-Account Car-Parking Systems program in coordination with each Partner, and timely response to any complaints received or requests made by the Partners and Dividend-Account Car-Parking Systems users. Describe the type of data that is collected and can be provided to the Partners. Promotion and advertisement of the Dividend-Account Car-Parking Systems program must comply with all Partners' municipal codes and ordinances.
34. A capability to offer a Dividend-Account Car-Parking Systems program that can be deployed, operated, managed, and maintained by the vendor at no cost, except for the

possibility of the EAI payments, to the Partners and with minimal oversight needed from the Partners.

35. A capability to establish and operated multiple Dividend-Account Car-Parking Systems programs including for for cases other than employee parking, as described in Reference 2, that can be deployed, operated, managed, and maintained by the vendor at no cost, except for the EAI payment, for employee parking, to the Partners and with minimal oversight needed from the Partners.
36. A capability to conform to contract specifications, including general liability insurance, worker's compensation, automobile liability insurance, indemnification, and termination clauses. Sample contract attached.

## **B. Proposal Elements**

Vendors interested in responding to this RFI must prepare a proposal that includes the following information:

1. Describe how drivers can become System Members.
2. Provide a detailed System maintenance plan.
3. Describe the vendor's capability to provide data and reports to the Partners, including raw and summarized data. Summarized data could include both user data (e.g., demographics, trip purpose, repeat usage, percent of trips starting and ending in close proximity to transit, mode shift, and transit usage) and trip data (e.g., average trip length, average trip time, trip start and end hotspots, trip path, estimated GHG emissions per trip). Ideally, this data should be provided via a publicly accessible API in your suggested General Dividend-Account Car-Parking Systems Feed Specification (GBFS) format. Describe vendor's ability to collect quantitative and qualitative data and report out findings from users (e.g. in-app surveys).
4. Describe how the vendor will employ anti-theft and anti-vandalism measures to ensure Systems do not pose a nuisance to the community.
5. Since the establishment of Dividend-Account Parking systems will increase bike usage, describe how the vendor will address bicycle safety concerns, including helmet use, riding at night and other safety concerns that may or may not be regulated by state vehicle codes.
6. Describe how the Dividend-Account Car-Parking Systems program may operate in conjunction with existing bike rental businesses operating in the Partners' cities.
7. Describe the vendor's plans for future growth and expansion, including possible anticipated increases in demand for good car parking systems as the public becomes more aware of the threat of anthropogenic climate change and how good systems improve economic fairness, etc.
8. Provide an estimated timeline for a twelve-to-twenty-four-month pilot Dividend-Account Car-Parking System program, including any needed permitting, set-up, promotion, advertising, maintenance and servicing, data delivery to Partners, summary and reporting on the outcome of the pilot program and possible continuation of the program.

9. Describe a recommended minimum Dividend-Account Car-Parking Systems size for the North County Coastal operating area.
10. Describe strategies for effectively educating users on proper System Parking use and the reason that society needs to improve the way we pay for the use of car parking.
11. Describe any approach you would recommend to enhance access and fairness for disadvantaged communities.
12. Describe time required to deploy a Dividend-Account Car-Parking Systems pilot program if selected based on System Parking size, etc.
13. Describe an approach to increasing the use of Dividend-Account Parking to include most city car parking, then across City boundaries, and then across County, State, and international boundaries, with the final system being one wherein nearly all System Vehicles have a single, world-wide, System Account.

## References Providing Additional Description

1. ***Eliminating the Harm of Bundled-Cost or Bundled-Benefit Parking***, Presentation to the 2018 Energy Utility Environment Conference (EUEC), Mike Bullock, March 2018
2. ***A Plan to Efficiently and Conveniently Unbundle Car Parking Costs***, paper presented to the Air and Waste Management Association (AWMA) Conference in 2010, Mike Bullock and Jim Stewart, June 2010
3. ***Oceanside Civic Center Garage Space Allocation***, EXCEL Spread Sheet, Bullock, based on a file provided by Oceanside staff, July 2018

## III. INSTRUCTIONS

### A. Proposal Due Date

Proposals must be submitted electronically no later than **5:00 p.m. on TBD Month 2018 or 2019**. Proposals must be submitted electronically via the PlanetBids system used to download the RFI. The maximum file size for submittal is 50 megabytes, and the file type shall be Portable Document Format (PDF). The electronic system will close submissions exactly at the date and time set forth in the RFI or as changed by addenda.

### B. Proposal Acceptance

Respondents are responsible for submitting and having their submittal accepted before the closing time set forth in this RFI or as changed by addenda. NOTE: Pushing the submit button on the electronic system may not be instantaneous; it may take time for the Respondent's documents to upload and transmit before the submittal is accepted. It is the Respondent's sole responsibility to ensure their document(s) are uploaded, transmitted, and arrive in time electronically. The City of Encinitas will have no responsibility for submittals that do not arrive in a timely manner, no matter what the reason.

### **C. Page Limit**

No submissions exceeding twenty-five (25) pages will be accepted (excluding attachments). In addition, attachments may not exceed twenty-five (25) pages. The City of Encinitas discourages “padding” of proposals with brochures, extensive literature, and boilerplate material not applicable to a pilot Dividend-Account Car-Parking Systems program.

### **D. Proposal Format**

Proposals must be organized in the following format and include the following content:

1. Letter of transmittal signed by an individual authorized to bind the proposing entity stating the firm has read and will comply with all terms and conditions of the RFI.
2. General information about the firm, including the size of the organization, location of offices, number of years in business, organizational chart, name of owners and principal parties, number and position titles of staff.
3. Qualifications of principals, project managers and key personnel who would be assigned to this project. Include their position in the firm, and types and amount of relevant experience operating a Dividend-Account Car-Parking Systems program or similar program. Identify the primary contact that will be the overall project manager. Resumes are not required, but may be included as attachments. The selected respondent may not substitute personnel without written authorization from the Partners.
4. A work plan that establishes the Respondent’s understanding of, and ability to satisfy Partners’ objectives. Respondent shall succinctly describe the proposed approach for implementing a Dividend-Account Car-Parking Systems program, outlining the activities, including innovative ideas that would be undertaken in completing the various tasks and specifying who would perform them.
5. A preliminary estimated schedule for deployment of a pilot Dividend-Account Car-Parking Systems program. Show all critical paths, major milestones, and decision points in pilot schedule.
6. A list of the municipal or other government agencies your firm has worked with during the past three years. Provide the following information for at least one operational system that has at least some of the similar components as would a Dividend-Account Car-Parking System program that is managed by the respondent:
  - a) Name, address, and telephone number of the agency;
  - b) Time period for the project;
  - c) Brief description of the scope of the services provided;
  - d) Identify the staff members on the project and their specific responsibilities; and
  - e) Person and contact information for a reference.

## **IV. PROPOSAL EVALUATION**

### **A. Proposal Evaluation**



A review committee comprised of representatives from each of the potential Partner cities will judge the merit of proposals received in accordance with the general criteria defined herein. Failure of proposers to provide in their proposal any information requested in this RFI may result in disqualification of the proposal. The sole objective of the review committee will be to select the proposal that is most responsive to the Partners' needs. The Partners reserve the right to elect to not proceed with a pilot Dividend-Account Car-Parking System program and reject all proposals received through this RFI process.

1. Experience of the vendor and proposed staff. Experience of project staff with similar scope of services. Level of education, training, licensing and certification of staff
2. Approach to the project. Demonstrated understanding of the Partners' needs and solicitation requirements. Approach is well organized and presented in a clear, concise and logical manner.
3. Availability and proposed use of technology and methodologies. Quality control and thoroughness is well defined.
4. Capability to Perform. Ability to complete work within deadlines. Availability and continuity of staff during the course of the project, if selected. Unsatisfactory past performance with the City of Encinitas (or any of the Partner cities) may be considered as determined by the City of Encinitas (or any of the Partner cities) in their sole and absolute discretion.
5. Relevant Experience. Experience in performing similar services for organizations of similar size to the Partner cities. Experience with public agencies. Years of experience with these types of services.
6. Innovation. Innovative ideas on the development, operation, promotion, and sustainability of Dividend-Account Car-Parking System programs.

## **B. Final Negotiation**

As reflected above, vendor selection will be based on a combination of factors as determined to be in the best interest of the Partners. After evaluating the proposals and discussing them further with the finalists, or the tentatively selected vendor, the City of Encinitas reserves the right to further negotiate the proposed program.

# **V. CONDITIONS GOVERNING THIS PROCUREMENT**

## **A. Scope Changes, Additions and Deletions**

All changes in proposal documents shall be through written addendum and furnished to all proposers. Verbal information obtained otherwise will NOT be considered in the evaluation process.

## **B. Rejection of Proposals**

The City of Encinitas reserves the right to reject any or all Proposals and to waive informalities and minor irregularities in Proposals received and to accept any portion of Proposal or all items of Proposal if deemed in the best interest of the City of Encinitas to do so.

### **C. Proprietary Information**

Any restrictions on the use of data contained within a Proposal must be clearly stated in the Proposal itself. Proprietary information submitted in response to this RFI will be handled in accordance with applicable City of Encinitas Procurement Regulations and the California Public Records Act.

### **D. Response Materials Ownership**

All materials submitted regarding this RFI become the property of the City of Encinitas. Responses may be reviewed by any person at Proposal opening time and after final selection has been made. The City of Encinitas has the right to use any or all ideas presented in reply to this request, subject to the limitations outlined in Proprietary Information above. Disqualification of a proposer does not eliminate this right.

### **E. Acceptance of Proposal Content**

The contents of the Proposal of the successful proposer will become contractual obligations if contractual agreements action ensues. Failure of the successful proposer to accept these obligations in a permit to operate, purchase agreement, purchase order, contract, delivery order or similar acquisition instrument may result in cancellation of the award and such proposer may be removed from future solicitations.

### **F. Cost of Proposal Preparation**

The City of Encinitas shall not be liable for any pre-contractual expenses incurred by any submitting vendor. Each submitting vendor shall protect, defend, indemnify, and hold harmless the City of Encinitas from any and all liability, claims or expenses whatsoever incurred by, or on behalf of, the entity participating in the preparation of its response to this RFI. Pre-contractual expenses are defined as expenses incurred by vendors in:

1. Preparing the proposal in response to this RFI;
2. Cost to acquire a permit; and
3. All other expenses incurred by a vendor related to preparation of proposal or establishment of a Dividend-Account Car-Parking System program.

### **G. Interview**

Interviews with the top respondents may be requested. The selection of vendors invited to interview will be solely based on the Partners' discretion. The vendors asked to interview will be notified in advance.

# ATTACHMENT 1

## Sample License Agreement for Dividend-Account Parking Services

This License Agreement for Dividend-Account Car-Parking System Services ("Agreement") is made this day of September 2017, by and between the City of Encinitas ("City") and \_\_\_\_ ("Dividend-Account Car-Parking System Vendor").

### RECITALS

1. A goal of City is to provide safe and affordable multi-modal transportation options to all residents, reduce traffic congestion, and maximize carbon free mobility.
2. Dividend-Account Car-Parking System services are a component to help the City achieve its transportation goals and the City desires to make this System available to residents and those who work or otherwise drive and park in the City.
3. Dividend-Account Car-Parking System Vendor proposes to operate a Dividend-Account Car Parking program within the City at an agreed-to location with an agree-to number of System parking spaces within the designated location or locations. As an example, based on Reference 3, there could be 239 spaces designated as System Parking, out of a total of 284 spaces in the Oceanside Civic Center Parking Garage. Note further, that if there are 259 employees that work for the City and are given parking spaces, there would be a need to establish 20 additional System Parking spaces outside of the Oceanside Civic Center Parking Garage.
4. Dividend-Account Car-Parking System Vendor will abide by all City ordinances and rules governing the use of public space.
5. Dividend-Account Car-Parking System Vendor possesses the technology necessary to install operate, maintain, and expand such a system and multiple systems as demand expands.

### AGREEMENT

1. Initial Term. This Agreement is effective for twelve to eighteen months from the date of execution ("Initial Term, Phase 1"), which will include a duration of installation during which no money is exchanged so as to establish a baseline of modal splits for employee commuting, and then a year of full operation to document the modal split changes and an estimated amount of greenhouse gas (GHG) emissions saved by the program. At the conclusion of the Initial Term Phase 1, the Agreement may be extended by mutual written agreement of the parties for an additional two-year term (Initial Term, Phase 2), subject to any new terms agreed between the parties, unless either party notifies the other party of its intent not to continue with the Agreement no later than 30 days before the expiration of the Initial Term, Phase 1 and Phase 2.
2. Exclusive Operator. During the Initial Term's Phase 1 and Phase 2, the City designates Dividend-Account Car-Parking Systems Vendor as the exclusive provider of the System services within its city limits. This designation is personal to Dividend-Account Car-Parking Systems Vendor and may not be assigned or transferred to any party. This exclusivity provision shall expire and not be renewed past the Initial Term's Phase 1 and Phase 2 unless agreed in writing by the parties.

3. Use of City Property. City authorizes Dividend-Account Car-Parking Systems Vendor to use ("License") City property, including the public right-of-way and System Parking areas that are suitable, solely for the purposes set forth in Section 4 of this Agreement. This authorization is not a lease or an easement, and is not intended and shall not be construed to transfer any real property interest in City Property.
4. Permitted Use. Dividend-Account Car-Parking System's System Members may use City Property solely for parking System Vehicles. The City Property is maintained by the City. Dividend-Account Car-Parking Systems Vendor may operate an agree-to amount of System Parking places on City Property as set forth in Exhibit A. If at any time during the term of the Agreement Dividend-Account Car-Parking Systems Vendor desires to place additional System Parking within the City limits, Dividend-Account Car-Parking Systems Vendor must request and receive authorization from the city to do so in writing. The City may limit the number of System Parking places upon identifying a potential harm to public health or safety. Dividend-Account Car-Parking Systems Vendor shall not place or attach any personal property, fixtures, or structures to City Property without the prior written consent of City.
  - a. Use of City Property and Dividend-Account Car-Parking Systems Vendor's operations within the City, shall, at a minimum: a) not adversely affect City Property or the City's streets, or sidewalks; b) not adversely affect the property of any third parties; c) not inhibit pedestrian or vehicular movement, as applicable, within City Property or along other property or rights-of-way owned or controlled by the City; d) not create conditions which are a threat to public safety and security. Dividend-Account Car-Parking Systems Vendor shall instruct its customers not to park or leave any System Vehicle where they would impede pedestrian or vehicular traffic.
  - b. Upon termination of this Agreement by either party, Dividend-Account Car-Parking Systems Vendor shall, at its sole cost and expense, immediately restore City Property to a condition which is visually and structurally indistinguishable from the immediately surrounding area.
5. System Parking. The City, at its own discretion, may support the System with the installation of signs and painting to further the orderly operation of the System Parking.
6. Condition of City Property
  - a. City makes City Property available to Dividend-Account Car-Parking Systems Vendor in an "as is" condition. City makes no representations or warranties concerning the condition of City Property or its suitability for use by Dividend-Account Car-Parking Systems Vendor or its customers, and assumes no duty to warn either Dividend-Account Car-Parking Systems Vendor or the System Members concerning conditions that exist now or may arise in the future.
  - b. City assumes no liability for loss or damage to Dividend-Account Car-Parking Systems System Members. Dividend-Account Car-Parking Systems Vendor agrees that City is not responsible for providing security at any location where Dividend-Account Car-Parking Systems Vendor's System Vehicles are parked, and Dividend-Account Car-Parking Systems Vendor hereby waives any claim against City in the event Dividend-Account Car-Parking System's System Vehicles or other property are lost, stolen, or damaged.
7. Maintenance and Care of Portion of City Property; Dividend-Account Car-Parking Systems Vendor shall be solely responsible for: (i) maintaining City Property to the City standards applicable for use by the Dividend-Account Car-Parking Systems Vendor as

permitted under Section 3; and (ii) obtaining from the City any applicable permits or approvals required by the City. Dividend-Account Car-Parking Systems Vendor shall exercise due care in the use of City Property and shall be responsible for maintaining City Property in good condition and repair. Dividend-Account Car-Parking Systems Vendor shall not act, or fail to act, in any way that result in excessive wear or damage to City Property. Dividend-Account Car-Parking Systems Vendor expressly agrees to repair, replace or otherwise restore any part or item of real or personal property that is damaged, lost or destroyed as a result of the Dividend-Account Car-Parking Systems Vendor's use of City Property. Should the Dividend-Account Car-Parking Systems Vendor fail to repair, replace or otherwise restore such real or personal property, Dividend-Account Car-Parking Systems Vendor expressly agrees to pay City's costs in making such repairs, replacements or restorations. The obligations under this Section apply to all City facilities, infrastructure, or appurtenances located on City Property.

8. Operations & Maintenance. Dividend-Account Car-Parking Systems Vendor will cover all maintenance costs for the System and maintenance to minimum level of service and reporting outlined in Exhibit A.
9. License Fee. The parties intend to agree to a license fee before the Agreement may be extended beyond the Initial Term.
10. Indemnification. Dividend-Account Car-Parking Systems Vendor shall defend, pay, indemnify and hold harmless City, its officers, officials, employees, agents, invitees, and volunteers (collectively "City Parties") from all claims, suits, actions, damages, demands, costs or expenses of any kind or nature by or in favor of anyone whomsoever and from and against any and all costs and expenses, including without limitation court costs and reasonable attorneys' fees, resulting from or in connection with loss of life, bodily or personal injury or property damage arising directly or indirectly out of or from or on account of:
  - a. Any occurrence upon, at or from City Property or occasioned wholly or in part by the entry, use or presence upon City Property by Dividend-Account Car-Parking Systems Vendor or by anyone making use of City Property at the invitation or sufferance of Dividend-Account Car-Parking Systems Vendor, except such loss or damage which was caused by the sole negligence or willful misconduct of City.
  - b. Use of Dividend-Account Car-Parking Systems Vendor's System Parking by any individual, regardless of whether such use was with or without the permission of Dividend-Account Car-Parking Systems Vendor.
11. Insurance. Dividend-Account Car-Parking Systems Vendor shall procure and maintain for the duration of this agreement insurance against claims for which Dividend-Account Car-Parking Systems Vendor has indemnified the City pursuant to Section 10 of this Agreement. Dividend-Account Car-Parking Systems Vendor shall maintain general liability and automobile liability insurance policies with limits of no less than one million dollars (\$1,000,000.00) per occurrence for bodily injury or death, personal injury and property damage, and two million dollars (\$2,000,000.00) aggregate. Each insurance policy shall name the City as an additional insured and it shall be endorsed to state that:
  - (i) coverage shall not be suspended, voided, or cancelled by either party, or reduced in coverage or in limits except after thirty (30) calendar days prior written notice by certified mail, return receipt requested, has been given to City; and (ii) for any covered claims, the Dividend-Account Car-Parking Systems Vendor's insurance coverage shall be primary insurance as respects the City and any insurance or self-insurance maintained by the City shall be in excess of the Dividend-Account Car-Parking Systems Vendor's

insurance and shall not contribute with it. The insurance required to be provided herein, shall be procured by an insurance company approved by City, which approval shall not be unreasonably withheld. Additionally, before Dividend-Account Car-Parking Systems Vendor shall employ any person or persons in the performance of the Agreement, Dividend-Account Car-Parking Systems Vendor shall procure a policy of workers' compensation insurance as required by the Labor Code of the State of California, or shall obtain a certificate of self-insurance from the Department of Industrial Relations.

12. Compliance with Law. Dividend-Account Car-Parking Systems Vendor at its own cost and expense, shall comply with all statutes, ordinances, regulations, and requirements of all governmental entities applicable to its use of City Property and the operation of its System program, including but not limited to laws governing operation of vehicles. If any license, permit, or other governmental authorization is required for Dividend-Account Car-Parking Systems Vendor's lawful use or occupancy of City Property or any portion thereof, Dividend-Account Car-Parking Systems Vendor shall procure and maintain such license, permit and/or governmental authorization throughout the term of this Agreement. City shall reasonably cooperate with Dividend-Account Car-Parking Systems Vendor, at no additional cost to City, such that Dividend-Account Car-Parking Systems Vendor can properly comply with this Section and be allowed to use City Property as specified in Section 4, above.
13. Business License. Dividend-Account Car-Parking Systems Vendor is required to obtain and maintain a City Business License during the duration of this Agreement.
14. Required Reports. Dividend-Account Car-Parking Systems Vendor shall provide reports to the City concerning utilization of its System Parking not less than monthly, and shall cooperate with the City in the collection and analysis of any aggregated data concerning its operations.
15. No Joint Venture. Nothing herein contained shall be in any way construed as expressing or implying that the parties hereto have joined together in any joint venture or liability company or in any manner have agreed to or are contemplating the sharing of profits and losses among themselves in relation to any matter relating to this Agreement.
16. Termination. This Agreement may be terminated prior to the expiration date set forth in Section 1, above, upon the occurrence of any of the following conditions:
  - a. Upon delivery of written notice from City to the Dividend-Account Car-Parking Systems Vendor terminating this agreement for any reason, or for no reason, by giving at least sixty (60) days' notice to the Dividend-Account Car-Parking Systems Vendor of such termination.
  - b. An attempt to transfer or assign this Agreement.

Dividend-Account Car-Parking Systems Vendor shall not terminate this Agreement without first by giving at least 180 days' written notice of plans for termination.

17. Amendment. This Agreement may be amended by mutual agreement of the parties. Such amendments shall only be effective if incorporated in written amendments to this agreement and executed by duly authorized representatives of the parties.
18. Applicable Law and Venue. The laws of the State of California shall govern the interpretation and enforcement of this Agreement. Any action to interpret or enforce the terms or conditions of this Agreement shall be brought in the Superior Court for the County of San Diego, or in the United States District Court for the Southern District of California. Dividend-Account Car-Parking Systems Vendor hereby waives any right to remove any such action from San Diego County as is otherwise permitted under



California Code of Civil Procedure Section 394.

19. Counterparts. This Agreement may be executed simultaneously or in any number of counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same agreement.

IN WITNESS WHEREOF THE PARTIES HERETO have executed this Agreement on date first above written.

**CITY OF ENCINITAS**

**DIVIDEND-ACCOUNT CAR-PARKING  
SYSTEMS VENDOR**

\_\_\_\_\_

\_\_\_\_\_

Karen Brust, City Manager

[Title]

\_\_\_\_\_

\_\_\_\_\_

Date

Date

**ATTEST:**

\_\_\_\_\_

City Attorney

**Exhibit A**

Description of Dividend-Account Car-Parking Systems Vendor’s Service Level Agreement

The following performance indicators shall be met and reported to help the City measure our success serving its citizens and improving the livability and mobility of Encinitas. Dividend-Account Car-Parking Systems Vendor will maintain it’s System in an excellent state of functionality and repair, with a minimum of error-free operation 95% of the time.

<b>Performance Indicator</b>	<b>Description</b>	<b>Measurement Tool</b>	<b>Minimum Performance Standard</b>	<b>Reporting Frequency</b>
App & customer service support portal: phone and internet. The portal will support the establishment of an account and editing an account	A new account can be entered and audited. It can be edited and an audit can verify the edits. The time and method of the submissions can be retrieved	Tool to audit accounts either by name or unique account number	Accurate 99.5% uptime.	monthly
Ability to set the value price of the parking, a per minute value	The system can accept a “value price” and use the number as described in this report	Tool to audit the fact of and the proper use of the value price	Accurate 99.5% uptime.	monthly
Ability to set the base multiplier, which is used in the congestion pricing algorithm as shown in Table 2 of Reference 2. It is expected to be a number between 1.5 and 2.5. It can be adjusted upwards if the parking is getting too full too often	The system can accept a “base multiplier” and use the number as described in Table 2 of Reference 2.	Tool to audit the fact of and the proper use of the value base multiplier	99.5% of the time	monthly
Ability to report out monthly statements	A feature to display each statement that	Interface to allow a specification of	Statements can be viewed and verified for accuracy with an accuracy of 99.5%	monthly

	was sent out to all employees and all users that are not employees, to verify accuracy	account and month to view the statement that was mailed, for verification		
Ability to accept money into an account and to pay earnings and “add-ins”, out of the account, as described in this report	Most of the money accepted will be car-parking charge but there will also money that is sent in to cover the “Add-in” payments. Most of the money will be via an automated transfere as is done for dockless bike rentals. However, an ability to accept a mailed check will also be required	Transactions will be put into a file that can be audited	Money transfers will occur and be observable with an accuracy of 99.5%	Monthlyt
Ability to report out the percent of employees at their work location that are using their allocated parking over any duration, from specific days to longer specified durations	This tool supports a request for the percent of employees that are at work without using car parking in the employee parking spaces	Software interface that will show the results on a screen and allows for the result file to be stored or printed	Functional 99.5% of the time	monthly

Ability to report out the total amount charged to employees, paid to employees as earnings and, separately, as "add ins", over any duration, from specific days to longer specified durations	This tool supports a request for the described data	Software interface that will show the results on a screen and allows for the result file to be stored or printed	Functional 99.5% of the time	monthly
Parking spot usage rate	The monthly use rate is reported for any single parking place or for a set of parking places	The result can be viewed on screen or in a file that can be stored or printed	Data collection failure would be reported within two (2) hours during business hours between 8am to 8pm Monday through Friday except for State and Federal holidays. Direct 24/7 contact line for true emergencies, either by phone, text, and/or email  Failure outside of business hours reported within two hours (2) of start of business hours	Monthly
System failure detected or reported by a member	Error either automatically reported to the person responsible and their back-ups, as a text on their phones and an email to their computer, to include the error report time	A program collects the time of the data error recognition and the time of the correction	Within two (2) hours during business hours between 8am to 8pm Monday through Friday except for State and Federal holidays. Direct 24/7 contact line for true emergencies, either by phone, text, and/or email  For complaint outside of business hours, within two hours (2) of start of business hours	Monthly

## ***Support for a Road Use Charge (RUC) that Protects Privacy and the Economic Interests of Low-Income Drivers***

**WHEREAS**, (1) greenhouse gas (GHG) emissions must be significantly reduced by 2030; (2) about 40% of California's GHG is emitted by on-road vehicles; and (3) even given the most ambitious estimates for fleet efficiency and fleet electrification, to support climate-stabilization requirements, it will be necessary to reduce per-capita driving; and furthermore,

**WHEREAS**, (1) California's current road-use fees (our gas tax, our toll roads and our bridge-use tolls) do not cover the full cost of operating and maintaining roads; (2) having the full cost of road use hidden from users increases driving, thus adding significantly to air pollution, congestion, sprawl, and GHG emissions; (3) an assessment conducted by the California Transportation Commission (CTC) found that 58 percent of our state's roads are in need of maintenance, 20 percent of our bridges need major or preventive maintenance, and 6 percent of our bridges require replacement; (4) a RUC has been shown to be feasible by the CTC; and (5) construction jobs are needed; and finally,

**WHEREAS**, (1) our gas tax is our most significant road-use fee; (2) state-mandated increases in battery-electric vehicles reduces gas-tax revenue; (3) a gas tax is inherently regressive because low-income drivers tend to drive older cars; and (4) a gas tax does not account for time, place, driver income, vehicle weight, vehicle pollution level, or instantaneous roadway congestion;

**THEREFORE, BE IT RESOLVED**, that the San Diego County Democratic Party supports researching a road-use charge (RUC) pricing and payout system that (1) would cover all road-use costs; (2) would protect the economic interests of low and middle-income drivers by use of a progressive price structure that also recognizes the needs of rural drivers; (3) would protect privacy by requiring a search warrant to obtain location or travel information; (4) would include an instantaneous congestion-pricing algorithm; (5) would ensure that the per-mile price incentive to drive energy-efficient cars would still be sufficient to support necessary fleet electrification; and (6) would send earnings to those losing money under the current system.

**BE IT FURTHER RESOLVED**, that this support be communicated as a co-sponsor for the resolution sent to California Democratic Party (CDP) Resolutions Committee and Platform Committee.

Mike Bullock, 76 AD, 760-754-8025, [mike\\_bullock@earthlink.net](mailto:mike_bullock@earthlink.net)

DEMCCO adopted a similar resolution in 2014 and supports this resolution.

Endorsed by Rob Howard, Oceanside Mayoral Candidate, SD Labor E-Board, Former North County NAACP President; Nora Vargas SDC BOS D1 Candidate; Kyle Krahel-Frolander, NAC Chair and Oceanside Planning Commissioner (Former Chair); Lela Panagides, Carlsbad City Council Candidate D2



# DISCUSSION DRAFT

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## CEQA AND CLIMATE CHANGE ADVISORY



December 2018

# Discussion Draft

## CEQA and Climate Change Advisory

### I. INTRODUCTION

The role of the California Environmental Quality Act (CEQA)<sup>1</sup> in addressing climate change and greenhouse gas (GHG) emissions continues to be the topic of much discussion. That was true in June 2008 when the Governor’s Office of Planning and Research (OPR) first prepared an advisory on greenhouse gas impacts, and it continues to be true today. Since 2008, there have been developments in statutes, regulations, and science, as well as a growing body of case law focused on addressing climate change and greenhouse gas emissions.

This *discussion draft* contains initial thoughts on updates to the 2008 advisory. This document incorporates developments since June 2008, including regulatory changes made to the regulations that implement CEQA (commonly known as the “CEQA Guidelines”<sup>2</sup>) in late 2018 by the California Natural Resources Agency (Agency).<sup>3</sup> Although this document largely focuses on project-level analyses of greenhouse gas impacts, Section IV briefly addresses community-scale greenhouse gas reduction plans as one pathway to streamline CEQA analyses. This discussion draft is intended to address some common issues and topics that arise in greenhouse gas emissions analyses under CEQA, but is not intended to address every single issue and topic.

OPR seeks your input on this discussion draft document. In particular, we seek comments on the following:

1. Are there any important points that we missed that we should address?
2. Do you have any suggestions on how to clarify the topics that we did address?

Since this discussion draft addresses the existing provisions in the CEQA statute and Guidelines as well as case law, OPR encourages commenters to focus their input on those directives.

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<sup>1</sup> The CEQA statute is found at Public Resources Code section 21000 and following.

<sup>2</sup> The CEQA Guidelines are found at the California Code of Regulations, Title 14, section 15000 and following.

<sup>3</sup> The California Office of Administrative Law (OAL) is currently reviewing the Agency’s rulemaking package for the updates to the CEQA Guidelines. OAL is anticipated to complete its review in late December 2018.

Input may be submitted electronically to [comments@opr.ca.gov](mailto:comments@opr.ca.gov). Please submit all comments before **Friday, March 15 at 5:00 pm**.

OPR issues technical assistance on issues that broadly affect the practice of land use planning and CEQA. (Gov. Code, § 65040, subds. (g), (l), (m).) This discussion draft does not alter lead agency discretion in preparing environmental documents subject to CEQA. This document should not be construed as legal advice. OPR is not enforcing or attempting to enforce any part of the recommendations contained in this draft document. (Gov. Code, § 65035 [“It is not the intent of the Legislature to vest in the Office of Planning and Research any direct operating or regulatory powers over land use, public works, or other state, regional, or local projects or programs.”].)

The CEQA Guidelines do not require specific methodologies for determining environmental impacts, prescribe specific thresholds of significance, or require specific mitigation measures. Instead, the CEQA Guidelines acknowledge lead agency discretion in determining the appropriate methodologies, thresholds, and if necessary, mitigation measures that are tailored to the project. Approaches and methodologies for calculating greenhouse gas emissions and addressing the environmental impacts through CEQA review continue to improve and are increasingly available to assist public agencies to prepare their CEQA documents and make informed decisions. Many public agencies—along with academic, business, and community organizations—are striving to determine the appropriate means by which to evaluate and mitigate the impacts of proposed projects on climate change. Once finalized, the purpose of this document will be to provide advice and recommendations, which public agencies and other entities may use at their discretion.

## **II. BACKGROUND**

The impacts of climate change pose an immediate and growing threat to California’s economy, environment, and to public health. Cities and counties will continue to experience the effects of climate change in various ways, including increased likelihood of droughts, flooding, wildfires, heat waves and severe weather. Climate change may result from natural factors, natural processes, and human activities that change the composition of the atmosphere and alter the surface and features of the land. Significant changes in global climate patterns are associated with global warming, an average increase in the temperature of the atmosphere near the Earth’s surface, attributed to accumulation of greenhouse gas emissions in the atmosphere. Greenhouse gases trap heat in the atmosphere, which in turn heats the surface of the Earth. Some greenhouse gas emissions occur naturally and are emitted to the atmosphere through natural processes, while others are created and emitted solely through human activities. The emission of greenhouse gases through the combustion of fossil fuels (i.e., fuels containing carbon) in conjunction with other human activities is the leading cause of climate change.

State law defines greenhouse gases to include the following: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (Health and Safety Code, section 38505(g).) The most common greenhouse gas that results from human activity is carbon dioxide, followed by methane and nitrous oxide. Other contributors to climate change, such as black carbon, may also be appropriate for lead agencies to consider as part of the environmental analysis.

#### A. Regulatory Background, Relevant Statutes, Executive Orders, and Planning Documents

Various legislative mandates and state policies address the reduction of greenhouse gas emissions and establish quantitative emission reduction targets. For example:

- **Executive Order S-3-05** (2005) established a progressive series of targets: by 2010, reduce greenhouse gas emissions to 2000 levels; by 2020, reduce greenhouse gas emissions to 1990 levels; and by 2050, reduced greenhouse gas emissions to 80 percent below 1990 levels.
- **Assembly Bill 32** (2006, Nunez) requires statewide greenhouse gas reductions to 1990 levels by 2020 and continued reductions beyond 2020. The law requires the California Air Resources Board (CARB) to establish a program to track and report greenhouse gas emissions; approve a scoping plan for achieving the maximum technologically feasible and cost effective reductions from sources of greenhouse gas emissions; adopt early reduction measures to begin moving forward; and adopt, implement and enforce regulations to ensure the required reductions occur.
- Pursuant to **Senate Bill 375** (2008, Steinberg), CARB establishes greenhouse gas emissions reduction targets for metropolitan planning organizations (MPOs) to achieve based on land use patterns and transportation systems specified in Regional Transportation Plans and Sustainable Community Strategies. Current targets for the State's largest MPOs call for a 19 percent reduction in greenhouse gas emissions from cars and light trucks from 2005 emissions levels by 2035.<sup>4</sup>
- **Senate Bill 391** (Liu, 2009) requires the [California Transportation Plan](#) to support 80 percent reduction in greenhouse gas emissions below 1990 levels by 2050.
- **Executive Order B-16-12** (2012) specifies a greenhouse gas emissions reduction target of 80 percent below 1990 levels by 2050 specifically for transportation.

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<sup>4</sup> See the California Air Resources Board's February 2018 [Updated Staff Report](https://ww2.arb.ca.gov/our-work/programs/sustainable-communities-program/regional-plan-targets), p. 34, available at <https://ww2.arb.ca.gov/our-work/programs/sustainable-communities-program/regional-plan-targets>.

- **Executive Order B-30-15** (2015) extends the goal of AB 32 and sets a greenhouse gas emissions reduction goal of 40 percent below 1990 levels by 2030. The executive order also addresses the need for climate adaptation and directs state governments to take a number of actions, including factoring climate change in state agencies’ planning and investment decisions.
- **Senate Bill 32** (2016, Pavley) codifies the 2030 emissions reduction goal of Executive Order B-30-15 by requiring a reduction goal of 40 percent below 1990 levels by 2030.
- CARB’s [Mobile Source Strategy](#) (2016) describes California’s strategy for containing air pollutant emissions from vehicles, and quantifies growth in vehicle miles traveled that is compatible with achieving state climate targets.
- CARB’s [2017 Climate Change Scoping Plan](#) (2017 Scoping Plan) describes California’s strategy for achieving the 2030 greenhouse gas emissions reduction target established by SB 32. The Scoping Plan also recognized the critical and complementary role of local governments in achieving the State’s climate goals. (CARB, 2017, Scoping Plan, p. 97; see also Chapter 8 of OPR’s General Plan Guidelines.)
- **Senate Bill 100** (2018, De León) establishes a state goal of 100 percent clean electricity goal by 2045, and advances the Renewables Portfolio Standard to 50 percent by 2025 and 60 percent by 2030.
- **Executive Order B-55-18** (2018) directs the state to achieve carbon neutrality no later than 2045 and achieve and maintain net negative emissions thereafter.

#### B. Requirements of CEQA and CEQA Guidelines Section 15064.4

CEQA is a public disclosure law that requires public agencies to make a good-faith, reasoned effort, based upon available information, to identify the potentially significant direct and indirect environmental impacts—including cumulative impacts—of a proposed project or activity. The CEQA process is intended to inform the public of the potential environmental effects of proposed government decisions and to encourage informed decision-making by public agencies. In addition, CEQA obligates public agencies to consider less environmentally-damaging alternatives and adopt feasible mitigation measures to reduce or avoid a project’s significant impacts.

The lead agency is required to prepare an Environmental Impact Report (EIR), a Mitigated Negative Declaration (MND), or equivalent document, when it determines that the project’s

impacts on the environment are potentially significant. This determination of significance must be based upon substantial evidence in light of all the information before the agency. The lead agency's evaluation of a project's environmental impacts "need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible." (CEQA Guidelines, § 15151.)

Although the CEQA Guidelines, at Appendix G, provide a checklist of suggested issues that should be addressed in an EIR, neither the CEQA statute nor the CEQA Guidelines prescribe thresholds of significance or particular methodologies for performing an impact analysis. This is left to lead agency judgment and discretion, based upon factual data and guidance from regulatory agencies and other sources where available and applicable. A threshold of significance is essentially the level at which a lead agency finds a particular environmental effect of a project to be significant. Compliance with a given threshold means the effect normally will be considered less than significant. Lead agencies are encouraged but not required to adopt thresholds of significance for environmental impacts. (CEQA Guidelines, § 15064.7, subd. (b).) Lead agencies may also use thresholds adopted or recommended by other agencies or recommended by experts, provided the lead agency's decision to use such thresholds is supported by substantial evidence. (*Id.*, subd. (c).) A lead agency may also use thresholds on a case-by-case basis. (*Id.*, subd. (b).) Even in the absence of clearly defined thresholds for greenhouse gas emissions, such emissions must be disclosed and mitigated to the extent feasible whenever the lead agency determines that the project contributes to a significant, cumulative climate change impact.

Through SB 97 (2007, Dutton), the Legislature acknowledged that greenhouse gas emissions and the effects of those emissions are appropriate subjects for CEQA analysis. SB 97 directed OPR to develop amendments to the CEQA Guidelines to address analysis and mitigation of the potential effects of greenhouse gas emissions in CEQA documents and processes. (Pub. Resources Code, § 21083.05.) The Agency adopted those amendments at CEQA Guidelines section 15064.4 in 2009. In late 2018, the Agency adopted further revisions to section 15064.4 that are intended to reflect recent case law and existing practice.

The revised CEQA Guidelines section 15064.4 states:

- (a) The determination of the significance of greenhouse gas emissions calls for a careful judgment by the lead agency consistent with the provisions in section 15064. A lead agency shall make a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate the amount of greenhouse gas emissions resulting from a project. A lead agency shall have discretion to determine, in the context of a particular project, whether to:

- (1) Quantify greenhouse gas emissions resulting from a project; and/or



- (2) Rely on a qualitative analysis or performance based standards.
- (b) In determining the significance of a project's greenhouse gas emissions, the lead agency should focus its analysis on the reasonably foreseeable incremental contribution of the project's emissions to the effects of climate change. A project's incremental contribution may be cumulatively considerable even if it appears relatively small compared to statewide, national or global emissions. The agency's analysis should consider a timeframe that is appropriate for the project. The agency's analysis also must reasonably reflect evolving scientific knowledge and state regulatory schemes. A lead agency should consider the following factors, among others, when determining the significance of impacts from greenhouse gas emissions on the environment:
- (1) The extent to which the project may increase or reduce greenhouse gas emissions as compared to the existing environmental setting;
  - (2) Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project.
  - (3) The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions (see, e.g., section 15183.5(b)). Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of greenhouse gas emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an EIR must be prepared for the project. In determining the significance of impacts, the lead agency may consider a project's consistency with the State's long-term climate goals or strategies, provided that substantial evidence supports the agency's analysis of how those goals or strategies address the project's incremental contribution to climate change and its conclusion that the project's incremental contribution is not cumulatively considerable.
- (c) A lead agency may use a model or methodology to estimate greenhouse gas emissions resulting from a project. The lead agency has discretion to select the model or methodology it considers most appropriate to enable decision makers to intelligently take into account the project's incremental contribution to climate change. The lead agency must support its selection of a model or methodology with

substantial evidence. The lead agency should explain the limitations of the particular model or methodology selected for use.

The CEQA Guidelines generally address greenhouse gas emissions as a cumulative impact due to the global nature of climate change. (Pub. Resources Code, § 21083, subd. (b)(2).) As the California Supreme Court explained, “because of the global scale of climate change, any one project's contribution is unlikely to be significant by itself.” (*Cleveland National Forest Foundation v. San Diego Assn. of Governments* (2017) 3 Cal.5th 497, 512.) A project's significant greenhouse gas impacts must be disclosed and mitigated to the extent feasible whenever the lead agency determines that the project contributes to a significant, cumulative climate change impact. (CEQA Guidelines, §§ 15064.4, subd. (b), 15183.5.) Thus, “[t]he question therefore becomes whether the project's incremental addition of greenhouse gases is ‘cumulatively considerable’ in light of the global problem, and thus significant.” (*Cleveland National Forest Foundation San Diego Assn. of Governments, supra*, 3 Cal.5th at 512, citation omitted.)

### III. POTENTIAL APPROACHES

Each public agency that serves as a CEQA lead agency should develop its own approach to performing a climate change analysis for projects that generate greenhouse gas emissions. A consistent approach should be applied for the analysis of projects, and the analysis must keep pace with scientific knowledge and regulatory schemes. (*Cleveland National Forest Foundation v. San Diego Assn. of Governments, supra*, 3 Cal.5th at 519.) For these projects, compliance with CEQA entails three basic steps: identify and quantify the greenhouse gas emissions; determine the significance of those emissions in the context of climate change; and if the impact is found to be significant, identify alternatives and/or mitigation measures that will reduce the impact below significance.

Lead agencies must use their best efforts to determine whether greenhouse gases may be generated by a proposed project, and if so, quantify or estimate the GHG emissions by type and source. (CEQA Guidelines, § 15064.4, subd. (a).) Second, the lead agency must determine whether the project's incremental contribution is cumulatively considerable. (*Id.*, § 15064.4, subd. (b), 15183.5.) When determining whether a project's effects on climate change are “cumulatively considerable” even though its greenhouse gas contribution may be individually limited, the lead agency must consider the impact of the project when viewed in connection with the effects of past, current, and probable future projects. Finally, if the lead agency determines that the greenhouse gas emissions from the project as proposed are potentially significant, it must investigate and implement ways to avoid, reduce, or otherwise mitigate the impacts of those emissions.

The following discussion includes some general factors, based on existing laws and regulations, for lead agencies consider when analyzing whether a proposed project has the potential to cause a significant climate change impact on the environment.

#### A. Establish an Appropriate Methodology and Identify Greenhouse Gas Emissions

- Lead agencies shall make a good-faith effort, based on available information, to describe, evaluate, calculate, or estimate the amount of CO<sub>2</sub> and other greenhouse gas emissions from a project, including, but not limited to, the emissions associated with vehicle use, energy consumption, water usage and construction activities, and the impact on natural environments that sequester carbon. CEQA defines a “project” broadly to include “whole of an action, which has a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment.” (CEQA Guidelines, § 15378, subd. (a).) Thus, the analysis must consider all phases of the project.
- Lead agencies have the discretion to use a model or methodology to analyze greenhouse gas emissions that is appropriate for the project. (*Center for Biological Diversity v. Department of Fish & Wildlife* (2015) 62 Cal.4th 204, 228; see, e.g., *Eureka Citizens for Responsible Gov’t v. City of Eureka* (2007) 147 Cal.App.4th 357, 371-372) Various models exist that could be used in a greenhouse gases analysis, but not every model will be appropriate for every project. (CEQA Guidelines, § 15204, subd. (a).)
- A lead agency may take either a quantitative or qualitative approach to the environmental analysis. Under either approach, the lead agency’s analysis must demonstrate a good-faith effort to disclose the amount and significance of greenhouse gas emissions resulting from a project, based to the extent possible on scientific and factual data. (CEQA Guidelines, § 15064.4, subd. (a).) In preparing an EIR, a lead agency’s evaluation of project impacts need not be exhaustive, but an EIR’s sufficiency will be viewed in light of what is reasonably feasible. (*Id.*, § 15151.)
- A qualitative analysis may be appropriate in some circumstances. For instance, in some cases, methods do not exist to model project emissions, or the project is small in scale and quantification of emissions may not reveal information that would assist the lead agency in determining the significance of emissions. A lead agency is not required “to conduct every test or perform all research, study, and experimentation recommended or demanded by commentors.” (CEQA Guidelines, § 15204, subd. (a).) That said, a qualitative approach must still be based to the extent possible on scientific and factual data and demonstrate a good-faith effort at disclosure of project impacts. (*Ibid.*)

- Although a lead agency may use a qualitative approach to the impacts analysis, when possible, lead agencies should quantify the project's construction and operational greenhouse gas emissions, using available data and tools, to determine the amount, types, and sources of greenhouse gas emissions resulting from the project. Quantification may allow the lead agency to more accurately evaluate the project's emissions compared to state greenhouse gas reduction targets, which are in turn based on scientific consensus on the greenhouse gas emissions reduction needed to avert the worst effects of climate change. Even where a lead agency does not apply a numeric threshold of significance to a proposed project, quantification may still be useful for lead agencies to determine the significance of the project's greenhouse gas emissions. (See *Berkeley Keep Jets Over the Bay v. Bd. of Port Commissioners* (2001) 91 Cal.App.4th 1344, 1367-1370; but see *Mission Bay Alliance v. Office of Community Investment & Infrastructure* (2016) 6 Cal.App.5th 160, 200-202.) Additionally, quantification may be useful in indicating to the lead agency and the public whether emissions reductions are possible, and if so, from which sources. Thus, if quantification reveals that a substantial portion of a project's emissions result from energy use, a lead agency may consider whether design changes could reduce the project's energy demand.
- Technical resources, including a variety of modeling tools, are available to assist public agencies to quantify greenhouse gas emissions. (See Section IV below.) Emissions models for particular types of projects continue to improve. Lead agencies must make a good-faith effort to describe or calculate a project's greenhouse gas emissions based to the extent possible on available data. (CEQA Guidelines, § 15064.4, subd. (a); see also § 15151 [standards for adequacy of an EIR].) Perfection is not required.
- To determine transportation-generated greenhouse gas emissions in particular, lead agencies may decide it is appropriate to use the same method or methodology used to determine the transportation impacts associated with a project's vehicle miles traveled (VMT). For more information, lead agencies should refer to **Appendices A and B** of this discussion draft, and to OPR's [Technical Advisory on Evaluating Transportation Impacts in CEQA](#), which provides a potential method for connecting the greenhouse gas assessment to thresholds of significance based on state greenhouse gas emissions reduction goals. Using a consistent approach for both the greenhouse gas and transportation analyses can provide efficiency and consistency in the environmental analysis.
- There is no standard format for including the analysis in a CEQA document. A greenhouse gas/climate change analysis can be included in one or more of the typical

sections of an environmental document (e.g., air quality, transportation, energy) or may be provided in a separate section on cumulative impacts or climate change.

- When determining a project’s greenhouse gas emissions, lead agencies must describe the existing environmental conditions or setting, without the project, which normally constitutes the baseline physical conditions for determining whether a project’s impacts are significant. (CEQA Guidelines, § 15125.)

## B. Determine Significance

- As with any environmental impact, lead agencies must determine what constitutes a significant impact on climate change that may be caused by the project’s physical changes. (Pub. Resources Code, § 21002; CEQA Guidelines, § 15064, subd. (d); *Protect the Historic Amador Waterways v. Amador Water Agency* (2003) 116 Cal.App.4th 1099, 1106-07.) Because the issue of climate change is discussed in a cumulative context, an important consideration in selecting and developing significance thresholds is identifying the level at which a project’s individual emissions would be cumulatively considerable. In the absence of regulatory standards for greenhouse gas emissions or other scientific data to clearly define what constitutes a “significant impact”, individual lead agencies may undertake a project by-project analysis, consistent with available guidance and current CEQA practice.
- The potential effects of a project may be individually limited but cumulatively considerable. (CEQA Guidelines, § 15064.4, subd. (b); *Cleveland National Forest Foundation v. San Diego Assn. of Governments, supra*, 3 Cal.5th at p. 515 [“The fact that a regional plan’s contribution to reducing greenhouse gas emissions is likely to be small on a statewide level is not necessarily a basis for concluding that its impact will be insignificant in the context of a statewide goal.”].) Lead agencies should not dismiss a proposed project’s direct and/or indirect climate change impacts without careful consideration, supported by substantial evidence. Documentation of available information and analysis should be provided for any project that may significantly contribute new greenhouse gas emissions, either individually or cumulatively, directly or indirectly (e.g., transportation impacts).
- Although climate change is ultimately a cumulative impact, not every individual project that emits greenhouse gases must necessarily be found to contribute to a significant cumulative impact on the environment.
- A number of models exist to quantify greenhouse gas emissions, and Guidelines section 15064.4, subdivision (b), provides a list of non-exhaustive factors that can be utilized by the lead agency when conducting an impacts analysis. Although the

sufficiency of an EIR is viewed in light of what is reasonably feasible, lead agencies must ensure that greenhouse gas impact analyses “stay in step with evolving scientific knowledge and state regulatory schemes.” (*Cleveland National Forest Foundation v. San Diego Assn. of Governments*, *supra*, 3 Cal.5th at p. 504.) As with the analyses for other environmental impacts under CEQA, the lead agency must support its analysis with substantial evidence.

- CEQA authorizes reliance on previously approved plans and mitigation programs that have adequately analyzed and mitigated greenhouse gas emissions to a less-than-significant level as a means to avoid or substantially reduce the cumulative impact of a project. (See Section D.)

### 1. *Thresholds of Significance*

A lead agency has the discretion to select and develop appropriate thresholds of significance to analyze a project’s environmental impacts, or rely on thresholds developed by other agencies that it deems applies to the project. The CEQA Guidelines define a “threshold of significance” as “an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant.” (CEQA Guidelines, § 15064.7, subd. (a).) The selection and development of thresholds requires a lead agency to “make a policy decision in distinguishing between substantial and insubstantial adverse environmental impacts based, in part, on the setting.” (*North Coast Rivers Alliance v. Marin Municipal Water Dist. Bd. of Directors* (2013) 216 Cal.App.4th 614, 625.) The California Supreme Court further explained that “[a]lthough lead agencies have discretion in designing an EIR, the exercise of that discretion must be ‘based to the extent possible on scientific and factual data.’” (*Cleveland National Forest Foundation v. San Diego Assn. of Governments*, *supra*, 3 Cal.5th at p. 515, quoting CEQA Guidelines, § 15064, subd. (b).)

The following discussion includes *some* of the methods that a lead agency may use in selecting the appropriate threshold below which the lead agency may find an impact is less than significant. The lead agency has the discretion to select the appropriate significance threshold, which may differ among projects depending on the project design, location, and other circumstances. Each case must be analyzed in light of its own facts and circumstances. The discussion below merely provides information on some of the significance thresholds that are currently in practice and have been identified by the courts as acceptable methods.

In the context of analyzing greenhouse gas emissions, the threshold of significance will assist the lead agency in determining whether a project’s incremental contribution of emissions is cumulatively considerable in light of the global issue. A lead agency should be able to



conclude that an impact on climate change is less than significant if, based on substantial evidence, the lead agency determines that a project’s incremental contribution is not cumulatively considerable. That said, a lead agency must evaluate any substantial evidence supporting a fair argument that, despite compliance with thresholds, the project’s impacts are nevertheless significant. (*Protect the Historic Amador Waterways, supra*, 116 Cal.App.4th at pp. 1108-1109.)

A lead agency may choose to review a project’s environmental impacts using more than one threshold of significance. (*Cleveland National Forest Foundation v. San Diego Assn. of Governments, supra*, 3 Cal.5th at p. 507 [EIR proposed three different significance thresholds and applied each to three different years].) Regardless of which threshold or combination of thresholds the lead agency uses, the agency must support its analysis and significance determination with substantial evidence. (CEQA Guidelines, § 15064.7.)

#### a. Significance Threshold Based on Efficiency

A significance threshold that is based on an efficiency metric—rather than an absolute number—would allow lead agencies to compare projects of various types, sizes, and locations equally, and determine whether a project is consistent with the State’s reduction goals. For example, an efficiency metric for a residential project can be expressed on a per-capita basis, and a metric for an office project can be expressed on a per-employee basis. A lead agency may use a threshold that another agency has developed or the lead agency may develop its own. In the context of analyzing greenhouse gas emissions, the California Supreme Court has explained that an efficiency metric is an appropriate method to measure impacts that are global, such as greenhouse gas emissions:

. . . the global scope of climate change and the fact that carbon dioxide and other greenhouse gases, once released into the atmosphere, are not contained in the local area of their emission means that the impacts to be evaluated are also global rather than local. For many air pollutants, the significance of their environmental impact may depend greatly on *where* they are emitted; for greenhouse gases, it does not. For projects, like the present residential and commercial development, which are designed to accommodate long-term growth in California's population and economic activity, this fact gives rise to an argument that a certain amount of greenhouse gas emissions is as inevitable as population growth. Under this view, a significance criterion framed in terms of efficiency is superior to a simple numerical threshold because CEQA is not intended as a population control measure.

(*Center for Biological Diversity v. Department of Fish & Wildlife*, 62 Cal.4th at pp. 219-220.)

A lead agency relying on an efficiency metric derived from statewide data should be careful to support with substantial evidence how the selected metric appropriately applies to the lead agency's impacts analysis for a particular project. Additionally, if relying on consistency with state plans as a basis for determining significance, a lead agency should align its quantitative metrics and locally-appropriate emission reductions goals with the methodology used to derive CARB's statewide per capita targets of no more than six metric tons CO<sub>2</sub>e per capita by 2030 and no more than two metric tons CO<sub>2</sub>e per capita by 2050. (CARB, 2017 Scoping Plan, pp. 98-99.)

#### b. Compliance with State Goals and Percentage Reduction from BAU Emissions

Pursuant to the California Supreme Court's decision in *Center for Biological Diversity v. Department of Fish & Wildlife, supra*, 62 Cal.4th 204, a lead agency may use compliance with state goals as a threshold. The most recently codified goal is contained in SB 32 (2016, Pavley), which codified the 2030 emissions reduction goal of Executive Order B-30-15 by requiring a reduction goal of 40 percent below 1990 levels by 2030. A lead agency may also choose to advance towards the State's goal of carbon neutrality by 2045 established by Executive Order B-55-18. This goal was established following the completion of the 2017 Scoping Plan and reflects the global scientific community's consensus of what is needed to avoid the worst impacts of climate change and maintain a climate of less than 2 degrees Celsius above the 20th century average. For a complete list of state goals, please see pages 3-4 of this document.

Agencies may also look to the state's percentage goal of reducing emissions below the "business as usual" (BAU) scenario discussed in CARB's Scoping Plan as the basis for a project's significance threshold. (*Center for Biological Diversity v. Department of Fish & Wildlife, supra*, 62 Cal.4th at p. 216.) The BAU scenario represents the forecast of greenhouse gas emission levels in the absence of conservation or regulatory efforts beyond what was in place when the forecast was made. (CARB, 2017 Scoping Plan, p. 22.) If a lead agency relies on the BAU scenario, the agency must be careful to support with substantial evidence the identified project-level percentage reduction of greenhouse gas emissions compared to BAU with achieving the statewide goal of percentage reduction from BAU emissions. The lead agency should rely on local or regional inventories of emissions that include land uses relevant to the project at hand. Notably, correlating the project-level percentage reduction with the statewide goals may be difficult to achieve in practice and thus this particular threshold may not be readily implemented.

#### c. Consistency with Relevant Regulations, Plans, Policies, and Regulatory Programs

Relevant regulations, plans, and policies adopted to reduce greenhouse gas emissions can assist in establishing a significance threshold. "Such requirements must be adopted by the

relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of greenhouse gas emissions.” (CEQA Guidelines, § 15064.4, subd. (b).) In *Center for Biological Diversity v. Department of Fish & Wildlife, supra*, the court noted that “[a] significance analysis based on compliance with such statewide regulations, however, only goes to impacts within the area governed by the regulations. That a project is designed to meet high building efficiency and conservation standards, for example, does not establish that its greenhouse gas emissions from transportation activities lack significant impacts.” (*Id.* at p. 229.)

A lead agency may also consider project compliance with community-scale climate action plans or other greenhouse gas emissions reductions plans prepared pursuant to CEQA Guidelines section 15183.5. (See *Center for Biological Diversity v. Department of Fish & Wildlife, supra*, 62 Cal.4th at 230 [discussing climate action plans or greenhouse gas emissions reduction plans as appropriate means to analyze a project’s greenhouse gas impact].) As discussed briefly in Section III.D. below, a lead agency may be able to streamline the environmental analysis if the proposed project is consistent with a greenhouse gas emissions reduction plan that meets the requirements of CEQA Guidelines section 15183.5.

#### d. Absolute Numerical/Quantitative Threshold

A lead agency may establish a numerical threshold of significance for greenhouse gas emissions expressed as an absolute number, or use an existing threshold that another agency has developed that it deems applies to a project, such as a local air district. (CEQA Guidelines, § 15064.4, subd. (b)(2); *Center for Biological Diversity v. Department of Fish & Wildlife, supra*, 62 Cal.4th at p. 230 [“a lead agency may rely on existing numerical thresholds of significance for greenhouse gas emissions, though . . . use of such thresholds is not required.”].) The numerical threshold would be the emissions level below which a project’s incremental contribution to global climate change would be less than “cumulatively considerable.” A lead agency may establish a threshold on a case-by-case basis, or apply a general-use threshold for different land use types and projects that the lead agency adopted pursuant to Guidelines section 15064.7, subdivision (b). (See CARB, 2017 Scoping Plan, p. 102 [“[L]ead agencies have the discretion to develop evidence-based numeric thresholds (mass emissions, per capita, or per service population) consistent with this Scoping Plan, the State’s long-term greenhouse gas goals, and climate change science.”].) A quantitative threshold should be based on compliance with statewide emission reductions targets, and the lead agency would need to ensure that the quantitative project-level threshold was properly correlated to statewide targets.

## 2. Timeframe for the Analysis of Impacts

The CEQA Guidelines acknowledge lead agency discretion in establishing the timeframe for the analysis of project impacts that is appropriate for the proposed project. (CEQA Guidelines, § 15064.4, subd. (b).) CEQA does not prescribe a particular horizon year or years. Lead agencies, however, must consider a project’s direct and indirect significant impacts on the environment, “giving due consideration to both the short-term and long-term effects.” (CEQA Guidelines, § 15126.2, subd. (a).) The Legislature also declared that state policy requires “governmental agencies at all levels to consider . . . long-term benefits and costs, in addition to short-term benefits and costs[.]” (Pub. Resources Code, § 21001, subd. (d).) Thus, a lead agency should be careful to select an appropriate timeframe for the analysis to adequately addresses all potentially significant short-term and long-term effects.

For some projects, a lead agency may determine that a timeframe of a few years is appropriate for the impacts analysis, such as for a project with only short-term impacts. But projects with a longer-term implementation period, such as a long-range planning document, will likely require a longer time horizon for the impacts analysis. For such projects, it would be appropriate for lead agencies to analyze the project’s greenhouse gas impacts for horizon years that are consistent with existing state policy and goals for greenhouse gas emission reductions. In analyzing a project’s impacts, a lead agency may also consider multiple horizon years.

In the past, lead agencies generally have analyzed project consistency with AB 32, which requires statewide greenhouse gas reductions to 1990 levels by 2020. But for longer-term projects, a 2020 time horizon will not be adequate in the near future because we will soon surpass that year. The California Supreme Court explained that for EIRs using a climate goal-consistency approach, “year 2020 goals will become a less definitive guide, especially for long term projects that will not begin operations for several years.” Rather, these EIRs “may in the near future need to consider the project’s effects on meeting longer term emissions reduction targets.” (*Center for Biological Diversity v. Department of Fish & Wildlife, supra*, 62 Cal.4th at p. 223.) The appropriate scope and timeframe for a lead agency’s greenhouse impacts analysis will likely evolve and shift over time. Thus, in developing and preparing evidence-based impact analyses, lead agencies “must ensure that CEQA analysis stays in step with evolving scientific knowledge and state regulatory schemes.” (*Cleveland National Forest Foundation v. San Diego Assn. of Governments, supra*, 3 Cal.5th at p. 519.)

### C. Mitigate Impacts

- The lead agency must impose all mitigation measures that are necessary to reduce greenhouse gas emissions to a less-than-significant level. CEQA does not require mitigation measures that are infeasible for specific legal, economic, technological, or other reasons.

- Mitigation measures will vary with the type of project being contemplated, but may include alternative project designs or locations that conserve energy and water, measures that reduce vehicle miles traveled by fossil-fueled vehicles, measures that contribute to established regional or programmatic mitigation strategies, and measures that sequester carbon to offset the emissions from the project.
- In some cases, greenhouse gas emissions reduction measures will not be feasible or may not be effective at a project level. Rather, it may be more appropriate and more effective to develop and adopt program-level plans, policies and measures that will result in a reduction of greenhouse gas emissions on a community or regional level. Further, it may be more effective to incorporate greenhouse gas-reducing elements into the proposed project, such as using renewable non-emitting energy generated on-site and siting a project near transit.
- If there are not sufficient mitigation measures that the lead agency determines are feasible to achieve a less-than-significant level, the lead agency should adopt those measures that are feasible, and adopt a Statement of Overriding Considerations that explains why further mitigation is not feasible. A Statement of Overriding Considerations must be prepared when the lead agency has determined to approve a project for which certain impacts are unavoidable. These statements should explain the reasons why the impacts cannot be adequately mitigated in sufficient detail and discuss the project benefits that outweigh the unavoidable impacts. This discussion must be based on specific facts, so as not to be conclusory.
- Lead agencies may want to consider the loading order of mitigation measures to reduce or avoid greenhouse gas emissions that may be appropriate for a proposed project. OPR notes, however, that lead agencies have the discretion to determine the precise method of mitigation for their projects. (CEQA Guidelines, § 15126.4, subd. (a)(1)(B).) Additionally, the effectiveness and feasibility of any proposed mitigation measure is within the lead agency’s discretion based on the substantial evidence before it.

As a first level of mitigation, lead agencies may determine it is appropriate to focus on all reasonable and feasible on-site strategies to reduce or avoid greenhouse gas emissions such as on-site design features. As the Scoping Plan recommends, lead agencies should “prioritize on-site design features that reduce emissions, especially from VMT, and direct investments in GHG reductions within the project’s region that contribute potential air quality, health, and economic co-benefits locally.” (CARB, 2017 Scoping Plan, p. 102; see also, OPR’s General Plan Guidelines.) Additionally, there may be practical reasons to prefer on-site mitigation. There may be

circumstances in which requiring on-site mitigation may result in various co-benefits for the project and local community, and that monitoring the implementation of such measures may be easier.

Next, if the project requires further mitigation, lead agencies may consider off-site measures that are additional to on-site measures. A lead agency has the discretion to select off-site mitigation measures that are based locally, regionally, or in-state over investments in out-of-state or international mitigation measures. As with on-site mitigation measures, there may be practical reasons related to prefer local off-site measures over measures farther afield. Examples of off-site mitigation could include funding a local or regional off-site greenhouse gas mitigation project or purchasing verifiable carbon credits. CEQA does not prohibit off-site mitigation measures, but lead agencies must support with substantial evidence in the record their determination that mitigation will be effective and fully enforceable. (CEQA Guidelines, § 15126.4.) To do so, lead agencies may need to require more stringent protocols to verify the effective and enforceability of off-site mitigation measures. (*Id.*, §§ 15126.4, 15364.)

#### D. Streamlining Greenhouse Gas Analyses Using Greenhouse Gas Emissions Reduction Plans

The Legislature has made it clear that lead agencies should tier or streamline their environmental documents whenever feasible, specifically stating that tiering “will promote construction of needed housing and other development projects” by streamlining regulatory procedures and avoiding repetitive analyses. (Pub. Resources Code, § 21093.) The Legislature’s declaration for tiering or streamlining is applicable to greenhouse gas emissions analyses because emissions resulting from individual projects may be best analyzed and mitigated at a programmatic level. To streamline the environmental analysis, a lead agency may consider preparation of a greenhouse gas emission reduction plan, such as a climate action plan, that is compliant with CEQA Guidelines section 15183.5. Later project-specific environmental documents may tier from and/or incorporate by reference the existing programmatic review so long as the plan meets the requirements in section 15183.5. (CEQA Guidelines, 15183.5, subd. (a); *Center for Biological Diversity v. Department of Fish & Wildlife*, *supra*, 62 Cal.4th at p. 230.) More detailed information and guidance on greenhouse gas emission reduction plans is contained in Chapter 8, Climate Change, of OPR’s General Plan Guidelines.

#### IV. GREENHOUSE GAS EMISSIONS TOOLS

Quantification would assist lead agencies in preparing an adequate analysis of greenhouse emissions using currently available data and tools. Quantification is possible using currently available tools for most, if not all, projects.



The following includes a list of some of the more useful climate change tools and resources that a lead agency can use to quantify greenhouse emissions and determine the significance of project impacts to climate change. Not every tool or resource will be appropriate for every project.

- **General Plan Guidelines:** State of California developed guidance on how to develop a general plan, and contains specific information on developing a qualified climate action plan (see Chapter 8, Climate Change), available at <http://www.opr.ca.gov/planning/general-plan/guidelines.html>
- **Cool California website:** State of California supported online resource that hosts links to various tools and case studies, available at <https://coolcalifornia.arb.ca.gov/>. This website also includes the Climate Action Map Portal (CAPMap), an open data tool provided by the California Air Resources Board to help local governments learn more about other climate action plans and climate change policies being implemented across the state.
- **California State Energy Efficiency Collaborative:** Outlines the steps to reduce greenhouse gas emissions and includes templates supported by the State of California, available at <http://californiaseec.org/>
- **California Air Pollution Control Officers Association (CAPCOA) website:** Outlines examples of policies and programs to reduce greenhouse gas emissions, available at <http://www.capcoa.org/>. Also see CAPCOA's white paper, "Quantifying Greenhouse Gas Mitigation Measures," August 2010, available at <http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf>.
- **California Emissions Estimator Model (CalEEMod):** Widely used for project-level greenhouse gas emissions quantification, available at <http://www.caleemod.com>
- **CARB's Emission Factors (EMFAC) Web Database:** Database containing emissions and emission rates data from motor vehicles, available at <https://www.arb.ca.gov/emfac/>

# Appendix A: Analyzing Greenhouse Gas Emissions from Transportation

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To streamline the analysis of transportation-generated greenhouse gas (GHG) emissions, lead agencies may use the same method or methodology used to determine the transportation impacts associated with a project's vehicle miles traveled (VMT). However, lead agencies have the discretion to use a model or methodology to analyze greenhouse gas emissions that is appropriate for the particular project. (*Center for Biological Diversity v. Department of Fish & Wildlife* (2015) 62 Cal.4th 204, 228.)

The following sections provide some guidance summarized from OPR's [Technical Advisory on Evaluating Transportation Impacts in CEQA](#), which may be useful to lead agencies when determining the greenhouse gas impacts associated with transportation. Lead agencies may refer to the technical advisory on transportation impacts for more detailed information on assessing vehicle travel and selecting an appropriate threshold. That technical advisory is non-regulatory and lead agencies may use the advisory at their discretion.

This appendix is a **discussion draft**. OPR invites the public to provide comments on this document.

**Avoid truncating or discounting vehicle trips.** CEQA requires environmental analyses to reflect a "good faith effort at full disclosure." (CEQA Guidelines, § 15151.) Thus, where methodologies exist that can estimate the full extent of vehicle travel from a project and associated greenhouse gas emissions, the lead agency should apply them to do so. Where vehicle miles traveled impacts will grow over time, analyses should consider both a project's short- and long-term effects associated with vehicle miles traveled and greenhouse gas emissions. Lead agencies should also consider all impacts and not truncate analyses because of jurisdictional or other boundaries. For additional details, see the "Consideration for All Projects" section of OPR's technical advisory.

**Approach for Residential and Office Projects.** Tour- and trip-based approaches<sup>5</sup> are sound methods for assessing both vehicle miles traveled and greenhouse gas emissions from residential/office projects. These approaches are also the most straightforward methods for assessing reductions in vehicle miles traveled and greenhouse gas emissions from mitigation measures. For additional details, see the "Technical Considerations in Assessing Vehicle Miles Traveled" section of OPR's technical advisory.

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<sup>5</sup> See OPR's [Technical Advisory on Evaluating Transportation Impacts in CEQA](#), "Appendix 1: Considerations About Which VMT to Count", for a description of these approaches.

**Approach for Retail and Transportation Projects.** Generally, lead agencies should analyze the effects of a retail or transportation project by assessing the greenhouse gas emissions resulting from the change in total vehicle miles traveled<sup>6</sup> because retail projects typically re-route travel from other retail destinations. A retail project might lead to increases or decreases in vehicle miles traveled and associated greenhouse gases, depending on previously existing retail travel patterns. For additional details, see the “Technical Considerations in Assessing Vehicle Miles Traveled” and “Considering the Effects of Transportation Projects on Vehicle Travel” sections and Appendix 2 of OPR’s technical advisory.

**Land Use Plans.** For land use plans, lead agencies should analyze the associated vehicle miles traveled and greenhouse gas emissions across the full area over which the plan may substantively affect travel patterns. This may include looking beyond the boundary of the plan or jurisdiction’s geography. Lead agencies should avoid under-counting the vehicle miles traveled and emissions associated with travel between the project and destinations that are located outside of the boundary of the plan or the jurisdiction’s geography. Lead agencies should count, in full, a project’s vehicle miles traveled and associated greenhouse gas emissions.

Analysis of specific plans may employ the same thresholds as the thresholds used for projects. A general plan, area plan, or community plan may have a significant greenhouse gas emissions impact if the proposed new residential, office, or retail land uses in the plan would exceed, in the aggregate, the respective vehicle miles traveled threshold recommended in OPR’s technical advisory.

Where the lead agency tiers from a general plan environmental impact report pursuant to CEQA Guidelines sections 15152 and 15166, the lead agency generally focuses on the environmental impacts that are specific to the later project and were not analyzed as significant impacts in the prior EIR. (Pub. Resources Code, § 21068.5; Guidelines, § 15152, subd. (a).) Thus, in analyzing the later project, the lead agency should focus on the greenhouse gas impacts that were not adequately addressed in the prior environmental impact report. In the tiered document, the lead agency should continue to apply the thresholds recommended above.

**Using Vehicle Miles Traveled Data to Determine Greenhouse Gas Emissions.** A lead agency may calculate transportation-generated greenhouse gas emissions from a project’s vehicle miles traveled either by using a CO<sub>2</sub> per vehicle miles traveled multiplier, or by using methods that factor in variations in vehicle speed (such as used in the Emission Factors (EMFAC) model).

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<sup>6</sup> See OPR’s [Technical Advisory on Evaluating Transportation Impacts in CEQA](#), “Appendix 1: Considerations About Which VMT to Count” and the “Assessing Change in Total VMT” section, for a description of this approach.

## Appendix B: Potential Streamlining of the Greenhouse Gas Emissions Analysis for Transportation-Efficient Projects and Projects that Reduce Vehicle Miles Traveled

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This appendix is a **discussion draft** of one potential pathway to streamline the project-level CEQA analyses for operational impacts associated with greenhouse gas emissions and vehicle miles traveled. This discussion draft appendix does not address potential streamlining for construction-related impacts. In addition to the main body of the discussion draft advisory, OPR invites the public to provide comments on this discussion draft appendix.

Most greenhouse gas (GHG) emissions that result from land use development in California come from transportation and building energy use.<sup>7</sup> Building in a more transportation-efficient manner, so long as it is in accordance with best practices and building standards focused on building energy conservation, leads to overall energy savings and minimization of greenhouse gas emissions.

A path to streamline the transportation and greenhouse gas analyses may be possible for some projects, depending on the project-specific circumstances. Projects that produce low vehicle miles traveled (VMT) can be expected to have low transportation greenhouse gas emissions. Research shows that low-VMT land uses also tend to produce low levels of emissions associated with building energy.<sup>8</sup> Further, in California, building energy efficiency standards and greenhouse gas emissions are moving toward carbon neutrality.<sup>9</sup> Finally, appliance efficiency programs such as the United States Environmental Protection Agency's Energy Star program can also help reduce energy use.

Therefore, a land use development project that produces low vehicle miles traveled, achieves applicable building energy efficiency standards, uses no natural gas or other fossil fuels, and includes Energy Star appliances where available, may be able to demonstrate a less-than-significant greenhouse gas impact associated with project operation.

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<sup>7</sup> California Air Resources Board, California Greenhouse Gas Emissions Inventory, available at <https://www.arb.ca.gov/cc/inventory/data/data.htm>.

<sup>8</sup> See Kevin Fang and Jamey Volker (Mar. 2017) *Cutting Greenhouse Gas Emissions Is Only the Beginning: A Literature Review of the Co-Benefits of Reducing Vehicle Miles Traveled*, available at [https://ncst.ucdavis.edu/wp-content/uploads/2017/03/NCST-VMT-Co-Benefits-White-Paper\\_Fang\\_March-2017.pdf](https://ncst.ucdavis.edu/wp-content/uploads/2017/03/NCST-VMT-Co-Benefits-White-Paper_Fang_March-2017.pdf); see also Reid Ewing and Fang Rong (2018) *The Impact of Urban Form on U.S. Residential Energy Use*.

<sup>9</sup> See, e.g., Title 24 of the California Code of Regulations, Executive Order B-55-18, and SB 100 (2018, de León).

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## ***Greenhouse Gas Emissions Associated with Transportation***

California policy efforts to reduce transportation greenhouse gas emissions generally can be divided into three broad categories:

1. Addressing vehicle energy efficiency
2. Addressing carbon content of fuels
3. Addressing the amount of vehicle miles traveled

Land use development does not affect vehicle energy efficiency or the carbon content of fuels, but contributes to greenhouse gas emissions by adding vehicle travel or modifying vehicle travel patterns.

Pursuant to SB 743 (Steinberg, 2013), the CEQA Guidelines were amended to establish vehicle miles traveled as the metric of transportation impact statewide, replacing level of service (LOS). To provide technical assistance in implementing this change, OPR provides information that users can use at their discretion in its [Technical Advisory on Evaluating Transportation Impacts in CEQA](#). This technical advisory includes non-regulatory recommended approaches and methods for using the vehicle miles traveled metric for various project types. A lead agency could use the recommended methods and thresholds in OPR's technical advisory on transportation to help correlate the assessment of both vehicle miles traveled and transportation-sector greenhouse gas emissions. The recommendations for thresholds in that technical advisory are based on state climate goals.

For example, to streamline the CEQA analyses of both transportation greenhouse gas emissions and transportation impacts using the vehicle miles traveled metric, a lead agency could consider the following when analyzing the operation of proposed land use development projects:

*Residential.* A residential project that would generate vehicle travel that is 15 or more percent below existing residential vehicle miles traveled per capita, measured against the region or city, may have a less-than-significant impact both for transportation and the greenhouse gas emissions associated with transportation.

*Office.* An office project that would generate vehicle travel that is 15 or more percent below existing office vehicle miles traveled per employee, measured against the region, may have a less-than-significant impact for both transportation and the greenhouse gas emissions associated with transportation.

*Retail.* A retail development that leads to a reduction in vehicle miles traveled may have a less-than-significant impact both for transportation and the greenhouse gas emissions associated with transportation.

These potential suggested thresholds are based on the recommended methodology for calculating vehicle miles traveled in OPR's [Technical Advisory on Evaluating Transportation Impacts in CEQA](#). Because OPR's recommendations are non-binding and non-regulatory, a lead agency may use its discretion to undertake a different approach to analyzing transportation impacts. Accordingly, the potential suggested thresholds may not apply or be appropriate in those cases.

### ***Greenhouse Gas Emissions Associated with Building Energy Use***

The preceding section addressed greenhouse gas emissions from transportation associated with operation of a land use project. This section discusses greenhouse gas emissions associated with energy use associated with operation of project buildings.

Greenhouse gas emissions from buildings in California are generated mostly from the use of electricity and natural gas, mainly from space heating and cooling, water heating, use of lighting and electronics, and refrigeration. Title 24 of the California Code of Regulations, known as the California Building Standards Code or simply "Title 24," addresses the energy efficiency of buildings, while Title 20, known as the Appliance Efficiency Regulations, addresses the energy efficiency of federally and non-federally regulated appliances.

As stated earlier, in California, building energy efficiency standards and greenhouse gas emissions are moving toward carbon neutrality. Therefore, one can expect greater reductions in greenhouse gas emissions associated with electricity use in the future. Still, electricity use is likely to generate greenhouse gas emissions through approximately 2045, so it remains important to consider programs like the United States Environmental Protection Agency's Energy Star program, which certifies appliances that are particularly energy efficient. Meanwhile, appliances powered directly by natural gas or another fossil fuel would continue to emit greenhouse gas emissions.

In conclusion, a building designed to use electricity as its sole energy source (e.g., is not powered by natural gas), follows applicable Title 24 building standards codes, and uses only Energy Star-rated appliances for appliance types that are offered Energy Star ratings, may have a less-than-significant greenhouse gas impact with respect to energy use during building operations.



## ***Greenhouse Gas Emissions Associated with Construction and Other Sources***

In some situations, cumulative greenhouse gas emissions associated with construction from a land use development project may be orders of magnitude lower than the operational emissions from the project, simply because construction emissions are generally short term in duration compared to the project's overall lifetime. But due to differences in projects, it is difficult to make these conclusions in all cases. For example, some projects may have long construction periods (e.g., 20 years) and may result in a large amount of emissions that may be considered significant. Thus, while a lead agency may be able to streamline the greenhouse gas emissions analysis associated with a project's operational emissions, a lead agency should still carefully consider whether a project's construction emissions are cumulatively considerable.

Similarly, operational greenhouse gas emissions associated with water consumption and solid waste disposal are typically nominal in comparison to the operational emissions from transportation and building energy. However, a lead agency should consider whether there are unique circumstances associated with the project that would lead to significant emissions from water consumption and solid waste disposal.

## ***Summary of Vehicle Miles Traveled and Greenhouse Gas Emissions Streamlining for Land Use Development Projects***

In sum, a land use development consisting of residential, office, and/or retail, which meets the following criteria may have less-than-significant operational greenhouse emissions with respect to transportation and building energy:

1. Results in below threshold vehicle miles traveled, either without mitigation or after mitigation;
2. Uses only electricity (no natural gas or other fossil fuels), for energy in all buildings that constitute the project;
3. Uses Energy Star appliances for any appliance category where they are available; and
4. Is in alignment with applicable Title 24 building standards codes in effect at the time the project is constructed.

## ***Transportation Projects***

Generally, transportation projects affect greenhouse gas emissions mostly through their effect on vehicle miles traveled. Therefore, a transportation project that leads to a reduction in vehicle miles traveled, such as a transit or active transportation project, may be able to demonstrate a less-than-significant impact both for transportation and for the greenhouse gas emissions associated with project operations. Transit and active transportation projects

generally reduce vehicle miles traveled and greenhouse gas emissions from transportation operations.

**References provided by the  
Center for Biological Diversity**

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## INVITED REVIEW

# Genetic consequences of habitat fragmentation in plant populations: susceptible signals in plant traits and methodological approaches

RAMIRO AGUILAR,\*† MAURICIO QUESADA,\* LORENA ASHWORTH,† YVONNE HERRERIAS-DIEGO\* and JORGE LOBO‡

\*Centro de Investigaciones en Ecosistemas, Universidad Nacional Autónoma de México, Campus Morelia, Apartado Postal 27-3 (Xangari), Morelia, 58089 Michoacán, México, †Instituto Multidisciplinario de Biología Vegetal, Universidad Nacional de Córdoba – CONICET, CC 495, (5000) Córdoba, Argentina, ‡Universidad de Costa Rica, Escuela de Biología, 2060 San José, Costa Rica

## Abstract

Conservation of genetic diversity, one of the three main forms of biodiversity, is a fundamental concern in conservation biology as it provides the raw material for evolutionary change and thus the potential to adapt to changing environments. By means of meta-analyses, we tested the generality of the hypotheses that habitat fragmentation affects genetic diversity of plant populations and that certain life history and ecological traits of plants can determine differential susceptibility to genetic erosion in fragmented habitats. Additionally, we assessed whether certain methodological approaches used by authors influence the ability to detect fragmentation effects on plant genetic diversity. We found overall large and negative effects of fragmentation on genetic diversity and outcrossing rates but no effects on inbreeding coefficients. Significant increases in inbreeding coefficient in fragmented habitats were only observed in studies analyzing progenies. The mating system and the rarity status of plants explained the highest proportion of variation in the effect sizes among species. The age of the fragment was also decisive in explaining variability among effect sizes: the larger the number of generations elapsed in fragmentation conditions, the larger the negative magnitude of effect sizes on heterozygosity. Our results also suggest that fragmentation is shifting mating patterns towards increased selfing. We conclude that current conservation efforts in fragmented habitats should be focused on common or recently rare species and mainly outcrossing species and outline important issues that need to be addressed in future research on this area.

*Keywords:* conservation genetics, habitat fragmentation, mating systems, meta-analysis, plant genetic diversity, rarity status

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## Introduction

The development of human civilization throughout the last two centuries has resulted in the transformation of vast natural areas into anthropogenic landscapes, resulting in a process of habitat fragmentation that alters the structure, distribution, and functioning of natural ecosystems

(Saunders *et al.* 1991). Immediate consequences of this process include habitat loss, the formation of remnant habitat patches of varied forms and sizes, a reduction of population sizes, and an increase in the degree of isolation of the remaining populations immersed in an anthropogenic matrix (McGarigal & Cushman 2002; Fahrig 2003). These persistent phenomena are well recognized as the main current driving forces of biodiversity loss in terrestrial ecosystems across the planet (Sala *et al.* 2000).

Studies of fragmentation effects in plants have largely concentrated on population demographic processes,

Correspondence: Ramiro Aguilar, C.C. 495 CP 5000, Córdoba, Argentina. Fax: +45-0351-4332104; E-mail: raguilar@imbiv.unc.edu.ar

especially evaluating plant reproductive dynamics in fragmented habitats (Hobbs & Yates 2003; Ghazoul 2005; Honnay *et al.* 2005; Aguilar *et al.* 2006). However, within the last decade there has been an increased interest in assessing the genetic consequences of habitat fragmentation in plants as stated by initial and recent reviews on this subject (Young *et al.* 1996; Lowe *et al.* 2005; Ouborg *et al.* 2006; Honnay & Jacquemyn 2007). The expected genetic consequences of fragmentation, which creates small, discrete, and isolated populations, are based on traditional island biogeography and metapopulation theories (MacArthur & Wilson 1967; Levins 1969). Thus, habitat fragmentation is expected to erode genetic variability and to increase inter-population genetic divergence of plant populations due to increased random genetic drift and inbreeding, and reductions in gene flow (e.g. Young *et al.* 1996; Sork *et al.* 1999; Lowe *et al.* 2005).

The most immediate effects of fragmentation on the genetic composition of plant populations depend on two factors: the effective population size within fragments and the patterns of genetic variability of the original populations previous to fragmentation (Nason *et al.* 1997; Hamrick 2004). Once a continuous forest is cleared and subdivided into small patches, from a metapopulation viewpoint, the distribution of genetic variability within and between the remaining populations in the landscape will depend on the spatial scale of fragmentation relative to the spatial scale of the pre-existent breeding neighbourhood (Nason *et al.* 1997; Hamrick 2004). Some hypotheses have been proposed to address the effects of habitat fragmentation on plant population genetics. As an immediate result, the genetic variation of populations is reduced due to genetic bottlenecks; specifically, a lower proportion of polymorphic loci and a reduction in the number of alleles per locus are expected within the fragments (Nei *et al.* 1975; Ellstrand & Elam 1993; Young *et al.* 1996). If fragmentation conditions persist over successive generations, decreased heterozygosity due to random drift and increased inbreeding are expected resulting in the accumulation of deleterious recessive alleles, lowering the fecundity of individuals, increasing seed/seedling mortality, and reducing the growth rate of individuals, eventually driving populations to extinction (e.g. Lande 1988; Young *et al.* 1996). The loss of genetic variation may reduce a population's ability to respond to future environmental change, such that the probability of extinction is increased or, at best, opportunities for evolution are limited (Caro & Laurenson 1994; Young *et al.* 1996; Nason *et al.* 1997; Booy *et al.* 2000).

The hypotheses concerning the negative impact of fragmentation on genetic diversity are the basis for the conservation genetic paradigm (Ouborg *et al.* 2006). The field of conservation genetics is relatively recent, and one of its main concerns is to develop basic and applied knowledge to create tools and strategies for conserving the

genetic resources and the evolutionary potential of species (Amos & Balmford 2001; Ouborg *et al.* 2006; Pertoldi *et al.* 2007). In order to develop such tools for effective conservation efforts, it is crucial to arrive to generalizations of plant genetic response patterns of plant species to habitat fragmentation.

Nevertheless, the empirical evidence from the literature provides inconsistent results to support these hypotheses, implying that not all fragmentation episodes necessarily result in genetic erosion of plant populations (e.g. Young *et al.* 1996; Collevatti *et al.* 2001; Lowe *et al.* 2005; Kettle *et al.* 2007). In this regard, quantitative statistical approaches are especially useful tools to integrate and synthesize the body of evidence from published literature (Arnqvist & Wooster 1995). Quantitative reviews such as meta-analysis allow us to reach general conclusions about a domain of research despite the apparent contradictory response patterns of individual studies (Gurevitch & Hedges 2001). This is accomplished by treating individual published results as if they were subjected to sampling uncertainty; thus, we are able to obtain not only the magnitude and direction of each effect (regardless of their *P* values), but also the variability of effects among individual studies (Hedges & Olkin 1985; Arnqvist & Wooster 1995; Gurevitch & Hedges 2001). Consequently, we can estimate the average magnitude of the effect across all studies, test whether the effect is significantly different from zero, and examine potentially causative differences in the effects among studies (Gurevitch & Hedges 2001).

Particular life-history traits of plants may confer different vulnerability to fragmentation effects. Because genetic erosion in fragmented habitats should be more pronounced after several generations, it is expected to find stronger negative effects on the adult generation of short-lived species compared to long-lived species (Young *et al.* 1996); or more precisely, in any plant population subjected to fragmentation conditions for several generations. Similarly, the ability of plants to reproduce clonally, via vegetative spread, may also buffer the genetic effects of fragmentation as a result of delaying the time between generations (Honnay & Bossuyt 2005). Also, the ploidy level of plants may influence the effects on genetic diversity due to fragmentation; as theory predicts, autotetraploids are less subject to the loss of genetic diversity by genetic drift than diploids (Bever & Felber 1992; Moody *et al.* 1993). Finally, the mating system of plants determines the spatial distribution of genetic variation within and among populations (Loveless & Hamrick 1984). Outcrossing plants typically show higher genetic variation within populations, whereas in selfing plants most of the genetic variation is found among populations (Loveless & Hamrick 1984; Hamrick & Godt 1989). Sudden decreases in effective population sizes due to habitat fragmentation would then have stronger negative effects on within-population genetic diversity of outcrossing



species. The fewer individuals remaining after fragmentation, the more severe the genetic bottleneck, which will have particularly large effects on the maintenance of rare alleles (Nei *et al.* 1975).

Likewise, some ecological processes, especially pollination and seed dispersal of plants, can shape the level of demographic and genetic connectivity among populations in fragmented habitats (Nason *et al.* 1997; Nathan & Muller-Landau 2000; Tewksbury *et al.* 2002; Hamrick 2004). The ability of vectors to move pollen and seeds through the fragmented landscape will determine the potential of plant species to offset the effects of genetic drift. In animal-pollinated or animal seed-dispersed plants, the level of genetic connectivity among fragments will depend on vector distribution, abundance, composition, and behaviour (Nason *et al.* 1997), attributes of pollinators and seed dispersers that are usually affected by habitat fragmentation (Didham *et al.* 1996; Graham 2001; Aizen & Feinsinger 2003; Griscom *et al.* 2007). Therefore, animal-pollinated and animal seed-dispersed plant species are expected to show decreased genetic connectivity due to habitat fragmentation compared to abiotically pollinated and abiotically seed-dispersed plants (Nathan & Muller-Landau 2000; García *et al.* 2007). The rarity of species can also determine susceptibility to genetic erosion. Naturally rare species, defined by their narrow geographical range, restricted habitat specificity or small local population sizes (*sensu* Rabinowitz 1981) are usually genetically less diverse than more widespread or common species (Karron 1987; Hamrick & Godt 1989; Ellstrand & Elam 1993). Then, common species may be more susceptible to lose genetic variation due to habitat fragmentation compared to rare species. Including rarity in models is problematic because authors do not uniformly assess rarity; species categorized as rare are not always *naturally* rare, but rather *recently* rare as a consequence of anthropogenic disturbance and habitat fragmentation (Gitzendanner & Soltis 2000). Thus, this categorization usually overlaps with the conservation status of the species (i.e. recently rare species are typically threatened or endangered). Once common and now rare species are expected to show stronger effects on genetic diversity than naturally rare species, as the former have suffered recent (i.e. in non-*evolutionary time*) decreases in regional or local abundance of populations (Huenneke 1991; Gitzendanner & Soltis 2000).

Certain characteristics of published studies may also influence the sensibility to find fragmentation effects. The ability to find fragmentation effects on genetic parameters may be different when using allozymes vs. DNA-based genetic markers. Specifically, because DNA-based genetic markers such as microsatellites have higher mutation rates (and consequently higher levels of variation), they may have higher resolution to detect changes in inter- and intra-population genetic variation compared to allozymes. Also,

fragmentation effects on genetic erosion may not be detected on adult individuals of long-lived woody species, but may be detected in their progeny. Thus, in species of long generational time, the type of tissue used by authors to measure genetic diversity (either from adult or progeny) may determine the magnitude of fragmentation effects. Finally, the time elapsed since fragmentation occurred should be an important factor to assess genetic erosion in plants. Effects are expected to be stronger in plant populations subjected to fragmentation conditions for larger periods of time, where a few or several generations have passed.

In this paper, we conduct a quantitative review to assess the overall effects of habitat fragmentation on plant population genetic parameters and test the predictions of the conservation genetic paradigm. Specifically, we determined (i) the overall magnitude and direction of fragmentation effects on the genetic variability of plant populations; (ii) whether longevity, ploidy level, mating system, clonal growth, type of pollen and seed dispersal vector, and rarity status of plants determine differential susceptibility to genetic erosion in fragmented habitats; (iii) whether different methodological approaches used by the authors determine the ability to find fragmentation effects; and (iv) whether there is a relationship between time elapsed in fragmentation conditions and the magnitude of fragmentation effects in genetic parameters.

## Methods

### *Literature search*

We surveyed the literature through different databases using a combination of 'fragment\*' AND 'genet\*' AND 'plant' as keywords. Searches were conducted in the Science Citation Index and Biological Abstracts databases and also in the main editorials (Blackwell Science, Springer-Verlag, and Elsevier) and scientific societies that group the most relevant indexed journals of ecological genetics and conservation biology. We obtained a large number of papers that were examined for suitability in the meta-analyses. Considering that habitat fragmentation produces three main outcomes in the landscape (namely habitat loss, decreased population sizes, and increased isolation among populations), we included studies using any of these measures of fragmentation, which were statistically compared to assess whether any one of them had particularly stronger effects on genetic parameters. Thus, we included studies conducted in real habitat fragments, in natural plant populations of different sizes and/or degrees of isolation. We also considered a few studies evaluating the effects of fragmentation due to selective logging on genetic parameters. This type of disturbance introduces changes in population density of adult trees, a measure of population size (Kunin 1997; Lowe

*et al.* 2005), without necessarily creating habitat fragments. We excluded articles that exclusively analysed correlations among population size and genetic variability without any explicit mention to the effects of habitat fragmentation (see Leimu *et al.* 2006). We included only studies that correlated genetic variability with population size as an indirect assessment of habitat fragmentation effects.

As measures of genetic variability, we considered expected heterozygosity ( $H_E$ ), percent polymorphic loci ( $P$ ), number of alleles ( $A$ ), and inbreeding coefficient ( $F_{IS}$ ). In cases where heterozygosity was not given (typically in studies using random amplified polymorphic DNA or amplified fragment length polymorphism), we used molecular variance or gene diversity and analysed these parameters together with expected heterozygosity. These four genetic parameters were not necessarily evaluated all together in each study, thus sample sizes for each meta-analysis differed. In several studies, we were able to calculate inbreeding coefficients from observed and expected heterozygosity values ( $F_{IS} = H_E - H_O/H_E$ ). Whenever available, we also included measures of outcrossing rate ( $OR$ ) in fragmented habitats.

For each plant species studied, we gathered information on several life-history traits and ecological aspects as well as on the methodology used by the authors of each study as potential predictors of the genetic responses to habitat fragmentation. We determined: (i) the longevity associated to the different life forms (woody long lived, herbaceous perennial or herbaceous short lived); (ii) whether vegetative reproduction occurred; (iii) the ploidy level (polyploid or diploid); (iv) the mating system, whether a species was mainly outcrossing (which included strictly self-incompatible species, as well as self-compatible species with a predominant outcrossing mating system) or selfing (including species with predominant selfing mating system and some self-compatible species with mixed mating system with clear capability of selfing) as explicitly declared by the authors; (v) pollen dispersal vector (biotic or wind); (vi) seed dispersal vector (biotic or abiotic); (vii) rarity (common, naturally rare or recently rare). We also evaluated the type of genetic marker (allozyme or DNA based) and the plant tissue used for each study (either from adult individuals or progenies). We further searched in each paper for information regarding the time elapsed in fragmentation conditions; this included rough estimates given by authors (expressed as *a few decades or centuries, more than or between* certain amount of time) and also more precise dates or time periods elapsed. With this information, we created three categories (less than 50 years, between 50 and 100 years, and more than 100 years) to compare the magnitude of effect sizes. Furthermore, within the group of publications where authors gave a more precise date of when fragmentation started, we searched for the approximate lifespan of each species. We found information on lifespans in the same or different

publications for 35 out of 47 species. For some species, we used genus-level lifespan information. For the remaining 12 species, we conservatively assigned a tabulated lifespan for woody and non-woody perennials following Ehrlén & Lehtilä (2002). For these species, we calculated the number of generations under fragmentation conditions by dividing the time period of fragmentation by the lifespan of the species, and ran correlation analyses between the number of generations and the effect sizes for  $H_E$  and  $F_{IS}$ . Based on theoretical grounds, these two genetic parameters are expected to be correlated with the number of generations under fragmentation conditions, showing stronger negative effects as more generations pass by. All the species' information was obtained from the same article, from other publications on the same species, or by contacting the authors. However, not every species' characteristic was available, thus predictor variables within a meta-analysis do not necessarily share the same sample size.

Seven articles evaluated the effects of fragmentation on genetic parameters in two species simultaneously and we included each of these species in the same analysis. Because the magnitude and sometimes direction of the responses of each species to habitat fragmentation within the same study were quite different, it is reasonable to assume that the effects are independent for each species (Gurevitch & Hedges 2001).

#### Data analysis

We used a categorical meta-analytical approach due to the large majority of studies evaluating population genetic parameters of plants in contrasting conditions (i.e. fragmented vs. non-fragmented). We obtained the mean value ( $\bar{X}$ ) and standard deviations (SD) of each genetic parameter ( $H_E$ ,  $A$ ,  $P$ ,  $OR$ , and  $F_{IS}$ ) from plant populations ( $n$ ) in each of the two conditions (fragmented and continuous habitats) in each published study. These data were taken either from text, tables or graphs (data from graphs were scanned using Datathief II software available online).<sup>1</sup> For each study, the magnitude of the effect of fragmentation on each of the genetic parameters ( $d_i$ ) was estimated as the unbiased standardized mean difference (Hedge's  $d$ ) between the mean value of the genetic parameter in fragmented and continuous habitats:

$$d_i = \frac{\bar{x}^F - \bar{x}^C}{SD^{FC}} J$$

where  $\bar{X}^F$  is the mean value of a given genetic parameter in fragmented habitats,  $\bar{X}^C$  is the mean value of the same genetic parameter in continuous habitats,  $SD^{FC}$  is the pooled standard deviation, of both groups and  $J$  is a term

<sup>1</sup> <http://www.nikhef.nl/~keeshu/datathief/>

that corrects for bias due to small sample size (see Gurevitch & Hedges 2001). The effect size  $d$  can be interpreted as the difference between the genetic diversity of plants in fragmented habitats and continuous conditions, measured in units of standard deviations. Thus, large differences and low variability generate the largest effect sizes (Gurevitch & Hedges 2001). For each genetic parameter, the overall weighted mean effect size estimate ( $d_{++}^*$ ) was calculated as:

$$d_{++}^* = \frac{\sum_{i=1}^n w_i d_i}{\sum_{i=1}^n w_i}$$

where  $d_i$  is the effect size of the  $i^{\text{th}}$  study and  $w_i$  is the weight (reciprocal of the sampling variance) of the  $i^{\text{th}}$  study.

Positive values of the effect size ( $d$ ) for  $H_E$ ,  $A$ ,  $P$ , and  $OR$ , imply positive effects of habitat fragmentation on these parameters whereas negative  $d$  values imply negative effects of fragmentation on these parameters. The interpretation of effect sizes for inbreeding coefficients is exactly the opposite: positive values of  $d$  imply negative effects of habitat fragmentation (i.e. higher inbreeding) whereas negative  $d$  values imply positive effects of fragmentation (i.e. lower inbreeding). For studies using correlational approaches to evaluate fragmentation effects (typically using population size as the independent variable), we calculated the mean value, standard deviation and sample size by pooling the data points for the lower-half (used as fragmented condition values) and higher-half values (used as non-fragmented condition values) of the continuous independent variable.

We used MetaWin 2.0 (Rosenberg *et al.* 2000) to run the analyses and bootstrap re-sampling procedures as described in Adams *et al.* (1997) to calculate confidence intervals of effect sizes. An effect of habitat fragmentation was considered significant if the 95% biased-corrected bootstrap confidence intervals (CI) of the effect size ( $d$ ) did not overlap zero (Rosenberg *et al.* 2000). Confidence intervals based on bootstrapping methods are generally wider than standard CI, which implies that re-sampling estimates of CI are more conservative (Adams *et al.* 1997). Data were analysed using random-effect models (Raudenbush 1994). This model assumes that differences among studies are due to both sampling error and random variation, which is usually the rule in ecological data (Gurevitch & Hedges 2001). The heterogeneity among effect sizes was assessed with  $Q$  statistics. Specifically, we examined the  $P$  values associated with  $Q_{\text{between}}$  statistics, which describe the variation in effect sizes that can be ascribed to differences between the categories of each predictor variable (i.e. species' life history and ecological traits, and studies' methodologies). We also used these statistics to compare the effect sizes between studies that used different factors of

analyses (e.g. fragment size, logging, population size) to evaluate habitat fragmentation. Within the species used for the meta-analyses, we found few congeneric species (Table S1, Supporting information). We re-ran analyses using data pooled by congeneric species and found no difference in magnitude or direction of effects compared to the analyses performed using all the species as independent data points. We also tested for potential interactions among predictor variables by measuring their pairwise level of dependence with chi-squared tests.

Quantitative reviews of published studies have the intrinsic problem of potential publication bias. That is, studies showing significant results may have a greater probability of publication than those showing non-significant results. We explored this possibility graphically (weighted histograms and funnel plots), and by calculating weighted fail-safe numbers. If the fail-safe number is larger than  $5n + 10$ , where  $n$  is the number of studies, then publication bias may be safely ignored (i.e. results are robust regardless of publication bias; Rosenberg 2005).

## Results

### Sample of studies

From the literature search, we obtained 101 publications from 28 international indexed journals throughout the period of 1989–2008 that evaluated the effects of habitat fragmentation on plant population genetic parameters (Appendix S1, Supporting information). These studies measured at least one parameter of genetic variability on 102 unique plant species to conduct the meta-analyses, which yielded 101 data points for expected heterozygosity ( $H_E$ ), 77 data points for number of alleles ( $A$ ), 57 data points for percent polymorphic loci ( $P$ ), 18 data points for outcrossing rate ( $OR$ ), and 62 data points for inbreeding coefficients ( $F_{IS}$ ). Although the species included in this review comprise a wide sample of plants with different biological and ecological attributes, there is some bias in these characteristics and also in the approaches used by authors to study genetic consequences of habitat fragmentation. Herbaceous perennial and woody long lived (shrubs and trees) represent 53% and 40% of the studied species, respectively, while herbaceous short-lived species comprised only 7% of the studied species. There are larger proportions of insect pollinated species (72%) and abiotically seed-dispersed species (77%). Diploid species are also a majority (84%). Although self-compatible (54%) and self-incompatible (46%) plants are approximately equally represented in the sample, within self-compatible plants there is a high number of mainly outcrossing plants as declared by the authors. Hence, there is a higher proportion of mainly outcrossing species (75%) compared with selfing plants (25%). Species without the capability of vegetative reproduction are slightly

more represented (61%). Common species represent 48%, whereas naturally and recently rare species represent 25% and 27% of the sample, respectively. We found no significant pairwise associations among any of these predictor variables (not shown), which indicate they can be considered statistically independent. Most of the studies evaluate the effects of habitat fragmentation on the genetic variability of adult individuals (72%), using mainly allozymes (60%) as genetic markers.

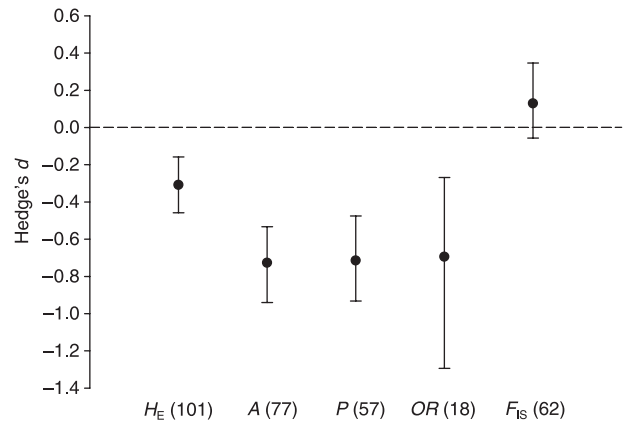
A comparison of the different factors of analysis used by the authors as measures of habitat fragmentation showed no significant differences in the effect sizes for  $H_E$  ( $Q_{\text{between}} = 1.35$ ;  $P = 0.493$ ),  $A$  ( $Q_{\text{between}} = 1.68$ ;  $P = 0.441$ ),  $P$  ( $Q_{\text{between}} = 2.05$ ;  $P = 0.162$ ), and  $F_{IS}$  ( $Q_{\text{between}} = 0.76$ ;  $P = 0.652$ ). That is, fragmentation effects on each of these genetic parameters are comparable whether considering fragment size, degree of isolation, habitat loss, population size, or density of conspecifics (i.e. logging) as factors of analysis.

Weighted histograms showed unimodal distributions with the highest frequency around zero (not shown) and funnel plots of effect sizes vs. sample sizes showed no skewness (not shown), which indicates no bias in reporting results (cf. Aguilar *et al.* 2006 for details of interpretation). Similarly, the calculated weighted fail-safe numbers for each meta-analysis were larger than  $5n + 10$  [ $H_E$ :  $2249.4 > (5 * 101) + 10 = 515$ ;  $A$ :  $2805.4 > (5 * 78) + 10 = 400$ ;  $P$ :  $1444.2 > (5 * 57) + 10 = 295$ ;  $OR$ :  $168.3 > (5 * 18) + 10 = 100$ ;  $F_{IS}$ :  $1306.6 > (5 * 62) + 10 = 320$ ], reinforcing the robustness of these results.

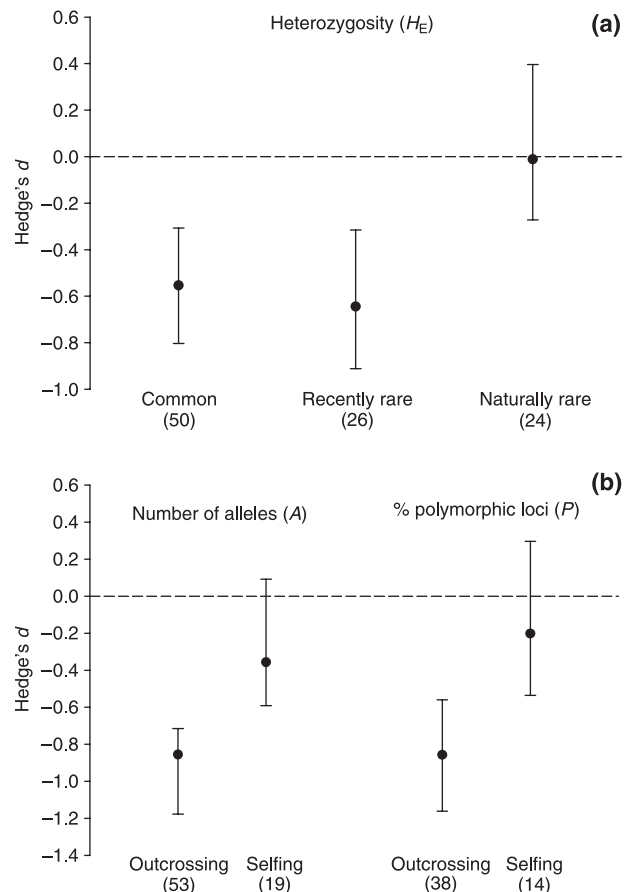
#### Habitat fragmentation and genetic variability

Overall weighted-mean effect sizes of habitat fragmentation on  $H_E$ ,  $A$ , and  $P$  were negative and significantly different from zero (Fig. 1). The  $OR$ , which was only consistently assessed in 18 studies, also showed an overall negative weighted-mean effect size (Fig. 1). Habitat fragmentation showed non-significant overall effects on  $F_{IS}$  (Fig. 1), despite the small positive value implying a slight trend of increasing inbreeding due to habitat fragmentation.

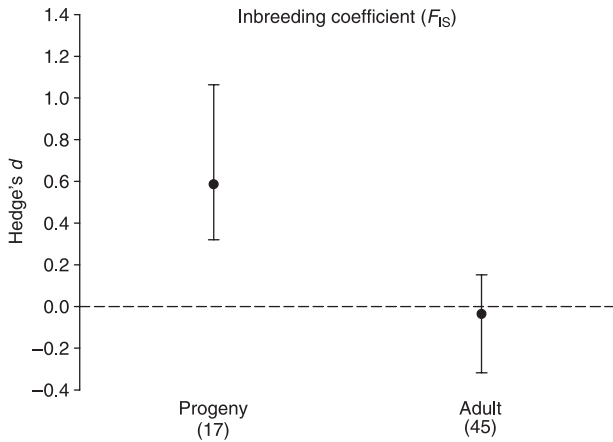
From the evaluation of all predictor variables associated with the species' life history and ecological attributes for each of the genetic parameters, we present only the results that showed significant ( $P < 0.05$ ) values of  $Q_{\text{between}}$  statistics in text and figures. We found that fragmentation effects were significantly different for  $H_E$  between common, naturally rare and recently rare species ( $Q_{\text{between}} = 23.18$ ;  $P < 0.001$ ). On average, common and recently rare species showed strong, negative and significant effects of fragmentation on  $H_E$ , whereas naturally rare species showed non-significant effects on  $H_E$  (Fig. 2a). The same trend was found for  $A$  and  $P$ , although the heterogeneity among effect sizes was only marginally significant (for  $A$ :  $Q_{\text{between}}$



**Fig. 1** Overall weighted-mean effect sizes and 95% bias-corrected confidence intervals of habitat fragmentation on expected heterozygosity ( $H_E$ ), number of alleles ( $A$ ), percent polymorphic loci ( $P$ ), outcrossing rate ( $OR$ ), and inbreeding coefficient ( $F_{IS}$ ). Sample sizes for each meta-analysis are shown in parenthesis; dotted line indicates Hedge's  $d = 0$ .



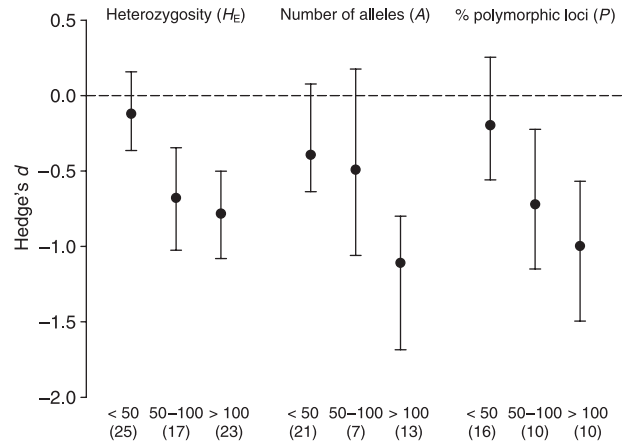
**Fig. 2** Weighted-mean effect sizes and 95% bias-corrected confidence intervals of habitat fragmentation on (a)  $H_E$  of plant species with different categories of rarity (common, recently rare, and naturally rare) and on (b)  $A$  and  $P$  of plants with different mating systems (outcrossing and non-outcrossing) showing statistically significant heterogeneity ( $Q_{\text{between}}$ ). Sample sizes of each category are given in parentheses. Dotted line shows Hedge's  $d = 0$ .



**Fig. 3** Weighted-mean effect sizes and 95% bias-corrected confidence intervals of habitat fragmentation on inbreeding coefficient ( $F_{IS}$ ) of studies evaluating adult and progeny tissues. Sample sizes of each category are given in parentheses. Dotted line shows Hedge's  $d = 0$ .

= 4.72;  $P = 0.094$ ; for  $P$ :  $Q_{\text{between}} = 5.01$ ;  $P = 0.081$ ). Furthermore, for  $A$  and  $P$ , there were significant differences in mean effect sizes between outcrossing and selfing species ( $Q_{\text{between}} = 14.96$ ;  $P = 0.028$  and  $Q_{\text{between}} = 9.17$ ;  $P = 0.05$  for  $A$  and  $P$ , respectively). Outcrossing species showed stronger negative effects of fragmentation on  $A$  and  $P$  compared to selfing species (Fig. 2b). A similar but marginally significant trend was observed for  $H_E$ , [ $d_{\text{outcrossing}} (n=69) = -0.57$ ,  $d_{\text{selfing}} (n=24) = -0.22$ ;  $Q_{\text{between}} = 3.24$ ;  $P = 0.071$ ]. In the case of inbreeding coefficients, none of these predictor variables showed significant heterogeneity, implying that fragmentation not only does not have an overall effect on inbreeding, but also no particular life-history trait is showing susceptibility to fragmentation (not shown). Surprisingly, fragmentation effects on inbreeding were only studied in one short-lived species, which precluded the formal comparison between short- and long-lived species. None of the other life history (life form, vegetative growth capability, and ploidy level) and ecological traits (pollination and seed dispersal vector types) evaluated as predictor variables showed significant heterogeneity in effect sizes of fragmentation on these genetic parameters (not shown).

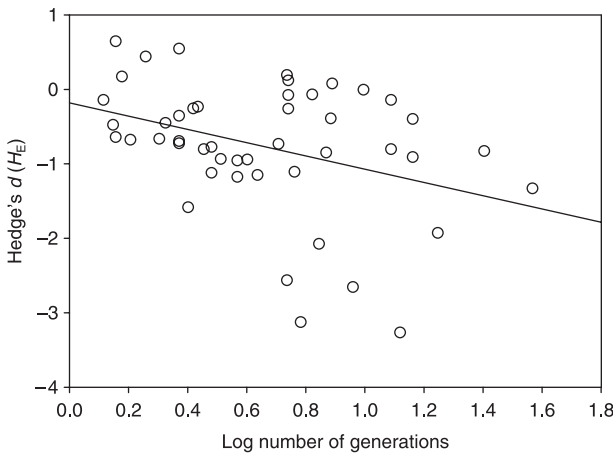
The use of different genetic markers (allozymes vs. DNA based) did not significantly alter the magnitude of effect sizes for each of the genetic parameters evaluated in fragmented habitats (not shown). Furthermore, effect sizes of fragmentation on  $H_E$ ,  $A$ , and  $P$  were also homogeneous among studies sampling adult or progeny tissues (not shown). For inbreeding coefficients, on the contrary, there was a significant difference in mean effect sizes between studies evaluating adult and progeny tissues ( $Q_{\text{between}} = 16.80$ ;  $P = 0.012$ ; Fig. 3): progenies showed a significant positive overall mean effect size value while adults showed a non-significant mean effect size (Fig. 3). This result implies



**Fig. 4** Weighted-mean effect sizes and 95% bias-corrected confidence intervals of habitat fragmentation on  $H_E$ ,  $A$ , and  $P$  of plant populations subjected to different time periods in fragmentation conditions: less than 50 years (< 50), between 50–100 years (50–100), and more than 100 years (> 100). Sample sizes of each category are given in parentheses. Dotted line shows Hedge's  $d = 0$ .

that progenies generated in fragmented habitats (which comprised mostly non-established seeds) presented higher inbreeding coefficients than progenies produced in continuous habitats; whereas for adult individuals no difference in mean  $F_{IS}$  values were observed between fragmented and continuous habitats. Depending on the parameter evaluated, between 53% and 64% of the studies gave at least rough information on the time elapsed in fragmentation condition. Overall, species subjected for more than 100 years in fragmentation conditions had significantly stronger effects on  $H_E$  ( $Q_{\text{between}} = 17.72$ ;  $P = 0.009$ ),  $A$  ( $Q_{\text{between}} = 6.68$ ;  $P = 0.05$ ), and  $P$  ( $Q_{\text{between}} = 15.57$ ;  $P = 0.018$ ; Fig. 4) compared to species evaluated in fragmented systems of less than 50 years, which showed non-significant mean effect sizes on these three genetic parameters (i.e. CI's overlapping zero value; Fig. 4).

Finally, we were able to estimate the number of generations elapsed in fragmentation conditions for 47 and 35 case studies evaluating  $H_E$  and  $F_{IS}$ , respectively. We log-transformed the number of generations and ran correlations with the effect sizes of fragmentation on these two parameters. We found a significant negative correlation between the number of generations elapsed and the species' effect sizes for  $H_E$  ( $r = -0.36$ ,  $P = 0.012$ , Fig. 5). That is, the more generations elapsed in fragmentation conditions for any given plant population, the stronger negative magnitude of effect sizes on  $H_E$ . In the case of fragmentation effects on inbreeding coefficient, we found a non-significant positive correlation with the number of generations ( $r = 0.29$ ,  $P = 0.102$ ,  $n = 35$ ), suggesting a trend of higher inbreeding as more generations pass by in fragmentation conditions.



**Fig. 5** Correlation between the log-transformed number of generations of plant populations in fragmented habitats and the effect sizes of fragmentation on  $H_E$  for 47 plant species. Correlation coefficient  $r = -0.36$ ,  $P = 0.012$ .

## Discussion

Anthropogenic habitat fragmentation is a recent phenomenon in evolutionary time but a pervasive feature of modern landscapes (Fahrig 2003). Plant populations that remain in habitat fragments are confronted with modified environments of reduced area, increased isolation, and new ecological boundaries, potentially affecting their biotic and abiotic interactions (e.g. Fahrig 2003; Ewers & Didham 2006). The genetic consequences of fragmentation on plant populations have been studied for over two decades and no clear response patterns have emerged from the literature. Recently, two reviews have focused on the relationship between genetic diversity and population size (Leimu *et al.* 2006; Honnay & Jacquemyn 2007), one of the immediate possible demographic consequences of habitat fragmentation. Nevertheless, fragmentation is a complex process that involves several different factors simultaneously (McGarigal & Cushman 2002; Fahrig 2003; Ezard & Travis 2006; Leblois *et al.* 2006; Ouborg *et al.* 2006); thus analyzing solely reductions of population size may not fully reflect what is happening in real fragmented scenarios. Population size per se may not be very important for animal pollinators and seed dispersers, whereas the degree of population isolation or the matrix characteristics surrounding the fragments may have more influence on their foraging behaviour (Kunin 1997; Ricketts 2001), affecting their ability to maintain gene flow among fragmented populations. These different factors, which often interact in diverse ways, are difficult to separate in observational or non-experimental designs, the rule in fragmentation studies. Authors tend to focus on one factor and do not usually control for the others (Leblois *et al.* 2006;

Ouborg *et al.* 2006; but see e.g. Prober & Brown 1994; Honnay *et al.* 2007). Thus, the cause of reduced genetic diversity in fragmented habitats should not be adjudicated to one single factor, but rather to the interacting effects of, at least, population size, degree of isolation and matrix characteristics (Ezard & Travis 2006).

In this review, we explicitly focused on fragmentation studies and arrived at a conclusive generalization: habitat fragmentation decreases the genetic diversity of plant populations. The vast majority of studies were conducted on adult populations of long-lived species in relatively recently fragmented systems, which indicates the effects observed on genetic diversity, especially on  $A$  and  $P$ , are probably mainly the result of genetic bottlenecks, the most immediate consequence of fragmentation (e.g. Young *et al.* 1996; Nason *et al.* 1997; Oostermeijer *et al.* 2003; Lowe *et al.* 2005). These species and studies' characteristics may also be the reason for the absence of overall significant effects on inbreeding coefficients (i.e. most sampled adults have probably established before fragmentation took place) and the comparatively smaller mean effect size observed on  $H_E$ , which may be mostly due to the overall reduction in number and frequency of alleles (Barret & Kohn 1991; Nason *et al.* 1997). In a closer examination of the subset of studies that provided dates of fragmentation events, it was clearly observed that time and, more precisely, the number of generations elapsed under fragmentation conditions, are crucial in determining stronger genetic diversity reductions in plant populations, especially in heterozygosity, which may take a number of generations to become apparent (Young *et al.* 1996; Lowe *et al.* 2004, 2005). Studies conducted in more than 100-year-old fragmented systems presented significantly stronger negative effects on genetic diversity (Fig. 4). This notion was more specifically supported by the significant correlation between the estimated number of generations for a subset of species and the magnitude of negative fragmentation effects on  $H_E$  (Fig. 5), primarily as a result of random genetic drift (e.g. Young *et al.* 1996; Young & Clarke 2000; Lowe *et al.* 2004).

## Gene flow and mating patterns in fragmented habitats

The amount of gene flow among remnant populations is a key element that will ultimately determine the genetic consequences of habitat fragmentation (Sork *et al.* 1999; Frankham *et al.* 2002; Hamrick 2004; Sork & Smouse 2006). Moderate or even relatively low levels of gene flow via pollen or seeds between fragmented populations can significantly alleviate the loss of genetic diversity by preventing the effects of genetic drift (e.g. Sork *et al.* 1999; Couvet 2002). In this regard, we found no evidence of any particular pollinator or seed dispersal vector type (either biotic or abiotic) to confer differential susceptibility to the loss of genetic diversity. Although this result does not give



us information about the patterns of gene flow per se in fragmented habitats, it does indicate there is no obvious type of vector able to conduct consistently extensive gene flow between fragments within the studies analysed.

In the present review, we were not able to evaluate contemporary gene flow due to the current paucity of this kind of study and the difficulty of generating effect size measures from gene flow parameters. However, the results observed for outcrossing rates and inbreeding coefficients may indirectly support the possibility of disrupted gene flow and/or changes in mating patterns of fragmented plant populations. Outcrossing rates in fragmented populations showed a significant overall decrease compared to populations in continuous habitats (Fig. 1), suggesting that fragmented plant populations are suffering changes in mating patterns towards increased selfing. Moreover, inbreeding coefficients will increase immediately in the first generation of progenies if mating patterns are biased towards higher selfing or mating among related individuals (e.g. Young *et al.* 1996; Lowe *et al.* 2005; Kettle *et al.* 2007). Precisely, we found that progenies in fragmented habitats presented significant mean higher inbreeding coefficients than progenies in non-fragmented habitats (Fig. 3), indicating adult individuals in fragmented populations are mating more frequently among related individuals and/or through autogamous pollination.

In addition to reduced heterozygosity due to random genetic drift in populations that remain fragmented for several generations, heterozygosity erosion is more severe when inbreeding accompanies fragmentation (e.g. Young *et al.* 1996; Nason *et al.* 1997; Young & Clarke 2000). The few species subjected to fragmentation conditions for many generations presented quite strong negative effect sizes on  $H_E$  (Fig. 5), probably as a result of both drift and increased inbreeding. In the hypothetical scenario of anthropogenic fragmentation ceasing and landscapes remaining as they are today, the effects on genetic diversity of plants will still be much stronger in the future than we have estimated here if mating patterns continue shifting towards selfing.

### *Mating systems*

Self-incompatible (SI) and mainly outcrossing self-compatible species, which contain most of their genetic variability within populations, suffered greater losses of alleles and polymorphic loci than non-outcrossing self-compatible and selfing species. For self-incompatible species in particular, this may result in the loss of low-frequency self-incompatibility alleles (S) (Wright 1965; Nei *et al.* 1975). In genetically controlled self-incompatibility systems, sharing of even a single S allele can prevent mating between individuals (De Nettancourt 2001). Thus, SI plants surviving in small, isolated populations may experience mate limitation due to reduced S allele diversity

so that the effective population size is further reduced (Byers & Meagher 1992; Glémin *et al.* 2008). Such synergism between genetic and demographic processes has great potential to influence population viability of these species (Young & Clarke 2000; Glémin *et al.* 2008). In fact, animal-pollinated SI species are also strongly negatively affected in terms of effective pollination service and seed production by habitat fragmentation (Aguilar *et al.* 2006), thus these species are exceptionally vulnerable to fragmentation as a consequence of both, ecological and genetic mechanisms. These results represent a clear example of how genetic erosion can have short-term impacts on individual fitness and population viability (e.g. Cascante *et al.* 2002; Fuchs *et al.* 2003).

### *Rarity status*

Our results support the initial hypothesis regarding the rarity status of plants: because common species have comparatively higher levels of genetic variability than naturally rare species, they are expected to lose more diversity due to recent fragmentation processes. Whether rarity is a cause or a consequence of evolutionary and ecological processes is still an open question (Rabinowitz 1981; Gitzendanner & Soltis 2000). In this regard, naturally and recently rare species may represent different timescales and origins of disturbance, which affect the genetic characteristics they possess in the present (Karron 1987; Ellstrand & Elam 1993; Gitzendanner & Soltis 2000; Oostermeijer *et al.* 2003). If this is true, it would be important to distinguish in the system under study whether habitat fragmentation is a consequence of natural phenomena, and thus occurred through evolutionary time, or whether is the result of anthropogenic activity, occurring in recent ecological times. While evolutionary fragmentation may be a more gradual and slower process that may also 'have an end', ongoing ecological fragmentation is a much faster increasing, non-random process (Saunders *et al.* 1991; McGarigal & Cushman 2002; Fahrig 2003). Given the ubiquitous nature of anthropogenic habitat fragmentation in today's landscapes, the results presented here are important and of interest to conservation biology as they situate common species in potential risk of genetic erosion, which is counterintuitive to current conservation principles that almost exclusively emphasize efforts on rare or threatened species (Honnay & Jacquemyn 2007; Gaston & Fuller 2008).

### *Conservation implications and future directions*

Conservation of genetic diversity within populations has direct implications not only for ecosystem functioning but also for providing resilience in the face of environmental change (Luck *et al.* 2003; Reusch & Hughes 2006). The

controversy about whether ecological and demographic factors are more important than genetic factors in driving species to extinction (Lande 1988; Frankham *et al.* 2002) has been recently quantitatively assessed: most taxa are not driven to extinction before genetic factors affect them adversely (Spielman *et al.* 2004), an assertion also supported by further research on plants in fragmented habitats (e.g. Endels *et al.* 2007). Thus, revealing which plant traits are more susceptible to suffer genetic erosion in fragmented habitats is crucial to detect lowered evolutionary potential, compromised reproductive fitness, and elevated extinction risks of wild populations, which should help generate criteria to prioritize conservation efforts (Young *et al.* 1996; Young & Clarke 2000; Amos & Balmford 2001; Lowe *et al.* 2005). Our results indicate that such efforts should be directed to common or recently rare species and mainly outcrossing species. Strictly self-incompatible, animal-pollinated species are at even greater risk due to their additional reproductive impairment in fragmented habitats (Aguilar *et al.* 2006).

Despite these unequivocal signals of susceptibility in plants, there is a clear gap in the literature of plant population genetics in fragmented habitats that precluded us making further generalizations. Such is the case of the poor representation of short-lived species as study targets and the dearth of studies evaluating contemporary gene flow via pollen and seeds on plant species with different life forms coupled with ecological information on the biotic dispersal vectors. Also, special attention should be given to the study of established progenies (seedlings and saplings) in fragmented habitats. Most of the progeny tissue evaluated up to now comes from non-established seeds (personal observation) and their genetic composition may differ markedly from that of the progeny that is actually being recruited in fragmentation conditions if they are subjected to selective pressures shaped by seed predators and herbivores (e.g. Cascante *et al.* 2002) and/or if they come from seed banks of previous reproductive episodes (Mandák *et al.* 2006; Honnay *et al.* 2008). Increasing these types of studies may allow us to determine whether gene flow mediated by animals is in fact changing and how changes in mating patterns will affect the genetic diversity of future generations of plant populations. Including precise measures and information on the history and characteristics of fragmented systems is particularly important, not only to determine timescales of fragmentation but also to test for possible fragmentation thresholds below which genetic variation is lost (e.g. Prober & Brown 1994; Ezard & Travis 2006). These approaches imply the merging of population genetics, plant-animal interaction ecology, and landscape ecology, a multidisciplinary endeavor that will provide knowledge-based tools for conserving the evolutionary potential of species and for managing ongoing anthropogenic modified landscapes.

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The authors share research interests in the ecology, evolution and genetics of plant reproductive dynamics. They have been evaluating the effects of forest fragmentation and other anthropogenic disturbances on pollinators, sexual reproduction and the genetic structure of flowering plants. They are interested in generating basic and applied knowledge in ecology and conservation biology of plant-animal interactions and their role in preserving the genetic diversity of plant populations in human-altered landscapes. Other research interests involve the study of hybridization processes between genetically modified plants with native relatives, the role of pollinators as ecological service providers for human well-being, and the conservation of tropical and subtropical dry forests.

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## Supporting Information

Additional supporting information may be found in the online version of this article:

**Table S1** List of 102 unique plant species included in the meta-analyses. For each species, we provide the botanical family, the genetic parameters evaluated in the study, the molecular marker used, the compatibility system, mating system, pollination vector, seed dispersal vector, ploidy level, vegetative growth capability, life form, type of rarity, studied tissue, time elapsed in fragmentation conditions and the source publication where information was obtained.

**Appendix S1** List of complete references of the studies included in the analyses.

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## Systematic review

# The impacts of roads and other infrastructure on mammal and bird populations: A meta-analysis

Ana Benítez-López<sup>a,\*</sup>, Rob Alkemade<sup>a,1</sup>, Pita A. Verweij<sup>b</sup>

<sup>a</sup> Netherlands Environmental Assessment Agency, PO Box 303, 3720 AH Bilthoven, The Netherlands

<sup>b</sup> Copernicus Institute, Utrecht University, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands

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## ABSTRACT

Biodiversity is being lost at an increased rate as a result of human activities. One of the major threats to biodiversity is infrastructural development. We used meta-analyses to study the effects of infrastructure proximity on mammal and bird populations. Data were gathered from 49 studies on 234 mammal and bird species. The main response by mammals and birds in the vicinity of infrastructure was either avoidance or a reduced population density. The mean species abundance, relative to non-disturbed distances (MSA), was used as the effect size measure. The impact of infrastructure distance on MSA was studied using meta-analyses. Possible sources of heterogeneity in the results of the meta-analysis were explored with meta-regression.

Mammal and bird population densities declined with their proximity to infrastructure. The effect of infrastructure on bird populations extended over distances up to about 1 km, and for mammal populations up to about 5 km. Mammals and birds seemed to avoid infrastructure in open areas over larger distances compared to forested areas, which could be related to the reduced visibility of the infrastructure in forested areas. We did not find a significant effect of traffic intensity on the MSA of birds. Species varied in their response to infrastructure. Raptors were found to be more abundant in the proximity of infrastructure whereas other bird taxa tended to avoid it. Abundances were affected at variable distances from infrastructure: within a few meters for small-sized mammals and up to several hundred meters for large-sized mammals.

Our findings show the importance of minimizing infrastructure development for wildlife conservation in relatively undisturbed areas. By combining actual species distributions with the effect distance functions we developed, regions sensitive to infrastructure development may be identified. Additionally, the effect distance functions can be used in models in support of decision making on infrastructure planning.

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## 1. Introduction

Global biodiversity is changing at an unprecedented rate as a result of several human-induced changes in the global environment (Vitousek, 1994; Pimm et al., 1995; Sala et al., 2000; MEA, 2005). Biodiversity loss at the species level tends to result in the so-called homogenisation process (Lockwood and McKinney, 2001). This process is generally characterised by a decrease in the abundance of many species, culminating into an increase in the number of threatened species and the extinction of others, in combination with a simultaneous increase in the abundance of a few species.

The main drivers of biodiversity change are land-use and land-cover change, climate change, pollution, fragmentation and infrastructure development (UNEP, 2001; Sala et al., 2000; Sanderson et al., 2002; Alkemade et al., 2009).

The ubiquity of road networks and the growing body of evidence of the negative impacts that roads and other linear infrastructure have on wildlife and ecosystems suggest that infrastructure represents a major driving factor of biodiversity loss. The most commonly reported impacts from roads and utility corridors include habitat loss, intrusion of edge effects in natural areas, isolation of populations, barrier effects, road mortality and increased human access (Andrews, 1990; Forman and Alexander, 1998; Spellerberg, 1998; Trombulak and Frissell, 2000; Forman et al., 2003). Road construction leads to habitat destruction and creates open spaces in otherwise closed forests (Gullison and Hardner, 1993; Reed et al., 1996; Santos and Tabarelli, 2002). The open spaces may fragment populations (barrier effect), attract light-demanding species and may be avoided by others (edge effect)

\* Corresponding author. Present address: Instituto de Investigación en Recursos Cinegéticos, IREC (CSIC-UCLM-JCCM), Ronda de Toledo s/n, E-13071 Ciudad Real, Spain. Tel.: +34 926 295 450x3392; fax: +34 926 295 451.

E-mail addresses: [ana.benitez@uclm.es](mailto:ana.benitez@uclm.es) (A. Benítez-López), [rob.alkemade@pbl.nl](mailto:rob.alkemade@pbl.nl) (R. Alkemade), [p.a.verweij@uu.nl](mailto:p.a.verweij@uu.nl) (P.A. Verweij).

<sup>1</sup> Tel.: +31 30 2743298; fax: +31 30 2744445.

(Kroodsmma, 1984; Vos and Chardon, 1998; Bolger et al., 1997; Ortega and Capen, 1999). Additionally, the use of infrastructure by cars or trains increases the risk of collisions with wildlife and the stress on (breeding) individuals (due to noise and visual stimuli), both of these risks affecting animal populations (Van der Zande et al., 1980; Reijnen et al., 1996; Romin and Bissonette, 1996; Boorman and Sasaki, 2005; Parris and Schneider, 2009).

Besides roads, other types of infrastructure, such as railways, powerlines, pipelines, hydroelectric developments, oil wells, seismic lines and wind parks, have an impact on wildlife populations (Dunthorn and Errington, 1964; McLellan and Shackleton, 1989; Cameron et al., 1992; Van Dyke and Klein, 1996; Mahoney and Schaefer, 2002; Nellemann et al., 2003a; Barrios and Rodriguez, 2004). All these impacts may influence the long-term viability of populations and, eventually, biodiversity.

Qualitative reviews provide a broad understanding of the ecological effects of infrastructure that affect a range of taxa and ecosystems, but lack quantitative evidence (Trombulak and Frissell, 2000; Forman et al., 2003). However, the few attempts to quantify the effects of infrastructure (UNEP, 2001; Nellemann et al., 2003b; Fahrig and Rytwinski, 2009), or to model the vulnerability of animal populations to road effects (Jaeger et al., 2005), are not based on meta-analysis, which is the statistical procedure for combining the results of independent studies in a quantitative way (Arnqvist and Wooster, 1995). In this study, we aim at estimating the decline of animal populations in relation to proximity to infrastructure by using a meta-analytical approach.

Among all animal taxa, mammal and bird populations were chosen for our analysis since both have been widely reported to be declining in relation to their distance from infrastructure. However, large differences in disturbance sensitivity seem to exist between and within these groups. Bird populations seem to be affected within a few hundred metres from infrastructure, whereas a reduction in mammal populations has been found at distances of a few hundred metres up to several kilometres from infrastructure (McLellan and Shackleton, 1989; Cameron et al., 1992; Ortega and Capen, 1999; Nellemann et al., 2003a). Additionally, traffic intensity seems to play a role in the decline of both bird and mammal populations close to roads (Van der Zande et al., 1980; Reijnen et al., 1995, 1996; Dyer et al., 2001; Rheindt, 2003; Gagnon et al., 2007).

To quantify the patterns of reduced population densities in relation to infrastructural development, we searched the scientific and non-scientific literature for quantitative data on mammal and bird populations at varying distances from infrastructure. As the metric of effect size, we calculated the ratio between the species abundance at varying distances to infrastructure (Disturbance or Effect distance) relative to the species abundance at the largest (control) distance reported in the study. This ratio is a form of the biodiversity indicator mean species abundance (MSA) which represents the mean abundance of (remaining) original species in an area related to an undisturbed situation (Alkemade et al., 2009). Meta-analysis was used to combine the effect sizes (MSA values) across all studies for several distance intervals and test their level of significance. Furthermore, meta-regression was applied to model the relationship between distance to infrastructure and MSA for birds ( $MSA_B$ ) and mammals ( $MSA_M$ ) (infrastructure–distance effect), and to examine sources of heterogeneity in this relationship.

## 2. Methods

### 2.1. Search and selection of published studies on infrastructural effects

Relevant studies were searched by using the following electronic databases: Ebsco, ISI Web of Knowledge, JSTOR, Omega (Utrecht University Digital Publications Search Machine), Science Direct, Scopus,

Springer Link and Wiley InterScience. The search terms were: road\* AND impact\* AND biodiversity OR mammal, bird; infrastructure AND impact\* AND biodiversity OR mammal, bird; road\* AND distance AND biodiversity OR mammal, bird; road-effect zone AND mammal abundance, bird abundance; road\* AND disturbance\* AND biodiversity OR mammal, bird; powerline AND impact AND biodiversity OR mammal, bird; wind park AND biodiversity OR mammal, bird; road traffic\* AND impact\* AND biodiversity\* OR mammal, bird; infrastructure AND disturbance AND biodiversity OR mammal, bird. An Internet search was also performed using the meta-search engine Google scholar. Bibliographies of articles viewed at full text were searched for relevant secondary articles. Authors and recognized experts in the field of infrastructure development, road establishment and effects on biodiversity (Christian Nellemann, UNEP-Grid Arendal, and Rien Reijnen, Alterra) were also contacted for further recommendations, and for provision of any unpublished material or missing data that may be relevant (grey literature). Foreign language searches were undertaken by using cross-reference.

### 2.2. Study inclusion criteria

From this bulk of literature we selected those studies of which title and keywords were associated to the objective of this review. Subsequently, information contained in the abstracts was examined to further narrow down the selection to those studies that met the following criteria:

- Relevant study objects: Populations of any mammal or bird species. Studies were included irrespective of habitat or spatial scale.
- Types of intervention: Disturbance distances or distances close to infrastructure at which mammal and bird populations might be reduced compared to larger distances or control distances (see Types of comparator).
- Types of outcome: Species abundance (density and/or counts) at varying distances to infrastructure.
- Types of comparator: Control distances or distances at which mammal and bird populations are unaffected by infrastructure and roads.

### 2.3. Data extraction

Finally, 49 studies met the selection criteria for data extraction, from which 90 datasets were extracted and stored in a database, resulting in 2107 data points. The data included the mean abundance at disturbance distances close to infrastructure and at a larger control distance; furthermore we recorded the sample size, the variance, and standard deviation or standard error, depending on the study. These data were used to estimate an effect size and its variance as required in meta-analysis (Osenberg et al., 1999). Additionally, we stored data on location, habitat, infrastructure type, taxon (order) and traffic intensity to explore sources of heterogeneity (see Table 2 in Supplementary material, available at <http://www.environmentalevidence.org/SR68.html>). These variables are considered biologically meaningful and could affect the way different taxa respond to infrastructure. Thus, we expected that different taxa would respond differently to different infrastructure types (linear and clustered) and in different habitat types according to varying visibility of infrastructure, while traffic intensity could affect the response due to the influence of noise and visual stimuli.

### 2.4. Effect size calculation: Mean Species Abundance (MSA)

For each study, individual effect sizes were calculated as the ratio between the abundance of each species close to the infrastructure



(Disturbance distance) and the abundance of the same species at the largest (control) distance, as reported in the study. Individual effect sizes were aggregated for each study and distance, resulting in an estimate of the mean species abundance (MSA), which is the metric of effect size for the meta-analysis (see Eq. (1))

$$MSA_{sd} = \frac{\sum_i R_{isd}}{N_s}; \quad (1)$$

where  $MSA_{sd}$  is the relative mean species abundance estimated in study  $s$  at a distance  $d$ ;  $R_{isd}$  is the ratio between the abundance or density of species  $i$  at distance  $d$  and the abundance or density of species  $i$  at the control distance, calculated as:  $A_{isd}/A_{isc}$  for  $A_{isc} > 0$ .  $N_s$  is the number of species considered in study  $s$ . MSA values ranged from 0 to 1 and declined at shorter distances from infrastructure. For species with higher densities at short distances from infrastructure compared to the control distance, the MSA value was truncated to 1; therefore, if  $A_{isd} > A_{isc}$ , then  $R_{isd} = 1$ .

### 2.5. Estimation of variation in MSA values

The variance of the MSA value for each distance and study was estimated by calculating the variance of the external error (2), and of the internal error (3), which are both forms of the variance of a sample mean (Mood et al., 1973). The largest variance was used in the meta-analysis, thus taking into account the largest error associated with each data point (DerSimonian and Laird, 1986). For single species' studies, only the variance of the internal error could be calculated.

The variance of the external error was calculated as:

$$\sigma_{ext}^2 = \frac{\sum (MSA_{sd} - R_{isd})^2}{N_s(N_s - 1)} \quad (2)$$

The variance of the internal error was calculated as:

$$\sigma_{int}^2 = \frac{\sum \sigma_{R_{isd}}^2}{N_s^2}; \quad (3)$$

where  $\sigma_{R_{isd}}^2$  is the individual variance for each ratio, which was calculated by using the Delta Method (4), a first-order approximation of the variance of a ratio of two random variables (Oehlert, 1992; Winzer, 2000).

$$\sigma_{R_{isd}}^2 = \frac{A_{isd}^2}{A_{isc}^2} \left[ \frac{A_{isd}^2}{\sigma_{A_{isd}}^2} + \frac{A_{isc}^2}{\sigma_{A_{isc}}^2} - \frac{2\rho \cdot \sigma_{A_{isd}} \cdot \sigma_{A_{isc}}}{A_{isd} \cdot A_{isc}} \right] \quad (4)$$

In this equation  $\sigma_{A_{isd}}^2$  and  $\sigma_{A_{isc}}^2$  are the variances of  $A_{isd}$  and  $A_{isc}$ , respectively, and  $\rho$  their correlation coefficient. We assume  $A_{isd}$  and  $A_{isc}$  to be independent and, therefore, the correlation coefficient  $\rho$  to be zero. Variances of  $A_{isd}$  and  $A_{isc}$  were obtained from studies, when available; where this was not the case, the data was assumed to follow a Poisson distribution, in which  $\mu = \sigma^2$  and, therefore,  $A_{isd} = \sigma_{A_{isd}}^2$ , and  $A_{isc} = \sigma_{A_{isc}}^2$  (Sokal and Rohlf, 1981).

Finally, as some species had a density of zero at the disturbance distance ( $A_{isd} = 0$ ), a continuity correction factor ( $k = 1/2$ ) was added to the numerator and denominator of the ratio of all species, resulting in slightly higher variance estimates (Cox, 1970; Sweeting et al., 2004).

### 2.6. Study quality assessment

Study characteristics were summarized and experimental design (control and treatment plots) and data availability for extraction (means, standard errors and sample sizes) were used as criteria for determining study quality (low; medium-low; medium; medium-high; high) (Supplementary material available at <http://www.environmentalevidence.org/SR68.html>). A sensitivity

analysis was done by removing studies scoring “medium–low” or “low”.

### 2.7. Data analyses

Meta-analyses were performed separately for mammal and bird studies by using the package “metafor” in R 2.9.1 software (Viechtbauer, 2009). A random effects meta-analysis was done to derive a pooled effect size for all datasets allowing pseudoreplication. Additionally, meta-analyses were done per distance interval containing non-duplicated independent datasets.

Heterogeneity was assessed by inspection of Forest plots and formal tests of heterogeneity  $Q$  and  $I^2$  (Thompson and Sharp, 1999). Publication bias was also assessed using Funnel plots of asymmetry along with formal tests (Egger et al., 1997; Supplementary material available at <http://www.environmentalevidence.org/SR68.html>).

To explore factors introducing heterogeneity we built several Generalized Linear Mixed Models (GLMM), accounting for several alternative nested ecological hypotheses that included the following a priori selected explanatory variables: distance to infrastructure (DIST or LOGDIST when log-transformed), presence of forest cover (FOR), infrastructure type (INFITYP) and traffic intensity (TRAF). All GLMM were built in S-Plus 7.0 and fit by restricted penalised quasi-likelihood (Pinheiro and Bates, 2000). Each MSA value was weighed by its variance. Study was introduced as random effect since we expected similar but not identical effects of infrastructure across studies.

Models were compared and selected by means of information theoretic criteria, including Akaike's Information Criterion corrected for sample size (AICc) and Akaike weights. AIC corrected for overdispersion (QAIC) was not needed since the random effects of the GLMM accommodate any possible overdispersion in the data. This was *ad hoc* checked by calculating a scale parameter (sigma) for our models using package “lme4” in R 2.9.1. (Bates and Maechler, 2009). The model selected was that minimizing the loss of Kullback–Leibler information.

Additionally data was disaggregated and GLMM were built to examine differences in the relationship between MSA and distance for different habitats, for forested and non-forested habitats, for different infrastructure types (linear and clustered) and for different taxa.

## 3. Results

### 3.1. Data availability and selected studies: review statistics

More than 600 studies contained relevant titles and abstracts. Of these, 50 studies corresponded to the selected criteria for data extraction. Two studies referred to the same data and were treated as one (Noel et al., 2004; Joly et al., 2006), resulting in 49 studies used for the meta-analysis. Some geographical bias was found since most of the studies were from either North America (21) or Europe (23), while a few studies from Africa (3) and Oceania (2) were found.

Twenty-seven studies included 201 bird species, and 49 independent datasets were extracted for the meta-analysis. The other 22 studies included 33 mammal species, and 41 independent datasets were extracted. Some species were repeated more than once (Appendix 3, Supplementary material available at <http://www.environmentalevidence.org/SR68.html>). Of the 49 datasets for birds, 10 contained relevant information on traffic intensities. Of the 41 datasets for mammals, five included information on traffic intensity, which was considered insufficient for the inclusion of this variable in the analysis (Supplementary material available at <http://www.environmentalevidence.org/SR68.html>).

Bird datasets frequently included a large number of species (mean = 9.1 (1–54)), compared to mammal datasets, which (with some exceptions, e.g. Newmark et al., 1996; Goosem and Marsh, 1997; Yost and Wright, 2001) usually focused on a single species (mean = 3.7 (1–11)). The most represented habitat types within the bird datasets were grasslands and agricultural lands (each of them in 15 datasets), and the least represented was boreal forests (1 dataset). The most represented habitat type in the mammal datasets was arctic tundra (12 times) and the least represented habitat types were grasslands and semi-arid habitats (1 time each).

The most represented bird taxon was Passeriformes (21 datasets) and the least represented bird taxa were Coraciiformes, Psittaciformes and Trochiliformes (1 dataset each). The most represented mammal taxon was Artiodactyla (25 datasets) and the least represented mammal taxa were Lagomorpha and Perissodactyla (1 dataset each).

Reported distances in bird datasets were in the range of 0–2580 m whereas data points for mammals were obtained within a range of 0–17,000 m.

### 3.2. Meta-analysis

#### 3.2.1. Combination of all distances with pseudoreplication

The pooled effect size derived from an all-encompassing meta-analysis of MSA values for birds indicated that bird abundance declined within ca. 2600 m from infrastructure ( $MSA_B = 0.678$ ; 95% CI 0.636–0.720,  $P < 0.0001$ ; Table 1). Likewise for mammals,  $MSA_M$  decreased within 17,000 m from infrastructure ( $MSA_M = 0.675$ ; 95% CI 0.608–0.742,  $P < 0.0001$ ). However, for both meta-analyses

there was large heterogeneity and publication bias within the datasets ( $Q_B = 16938.28$ ,  $P < 0.0001$ ; Egger test<sub>B</sub> = 5.785,  $P < 0.0001$ ;  $Q_M = 3466.80$ ,  $P < 0.0001$ ; Egger test<sub>M</sub> = 3.684,  $P < 0.0001$ ; Tables 1 and 2). Fail-safe numbers indicated that a large number of studies reporting neutral or positive effects of the proximity of infrastructure on species abundance would be needed to overturn these results and so even with some publication bias, the results for mammals and birds can be considered a reliable estimate of the true effect (Rosenthal, 1979).

Sensitivity analyses were performed and the results remained similar after removing studies that scored “medium–low” in the study quality assessment. The pooled effect size for bird data increased slightly, heterogeneity was lower but still statistically significant and there was evidence of publication bias ( $MSA_B = 0.683$ ; 95% CI 0.627–0.740,  $P < 0.0001$ ;  $Q = 2653.70$ ,  $P < 0.0001$ ; Egger test = 4.699,  $P < 0.0001$ ; Appendix 4, Supplementary material available at <http://www.environmentalevidence.org/SR68.html>). For mammals the pooled effect size was similar, heterogeneity decreased slightly and there was publication bias ( $MSA_M = 0.678$ ; 95% CI 0.6086–0.7472,  $P < 0.0001$ ;  $Q = 3401.70$ ,  $P < 0.0001$ ; Egger test = 4.006,  $P < 0.0001$ ; Appendix 4, Supplementary material available at <http://www.environmentalevidence.org/SR68.html>).

#### 3.2.2. Effect size per distance interval

Pooled effect sizes calculated per distance interval for independent datasets were significant for mammal and bird data, but considerable heterogeneity and publication bias existed for most of the intervals. Lower MSA values were obtained at shorter distance intervals to infrastructure for both mammals and birds.

**Table 1**  
Results of the meta-analysis for bird species at different distance intervals.

Distance (m)	n	Effect size (MSA)	SE	CI (lb)	CI (ub)	P (e.size)	Q	P(Q)	I <sup>2</sup> (%)	Egger's test intercept	P(t) Egger	Fail-safe N
0–2580	288 <sup>a</sup>	0.6777	0.0215	0.6355	0.7200	<0.0001	16938.28	<0.0001	96.6	5.785	<0.0001	11,23,452
<10	10	0.3983	0.1290	0.1455	0.6512	0.002	62.7322	<0.0001	94.4	2.625	0.0026	245
15–35	18	0.4855	0.0893	0.3105	0.6605	<0.0001	223.89	<0.0001	93.3	4.336	<0.0001	2233
38–65	20	0.5339	0.0905	0.3566	0.7112	<0.0001	370.28	<0.0001	95.2	3.639	<0.0001	1939
70–80	16	0.5923	0.0896	0.4165	0.7680	<0.0001	33.19	0.007	54.5	2.561	0.0002	689
90–100	16	0.6218	0.0722	0.4802	0.7634	<0.0001	38.42	0.0004	68.4	3.993	0.0003	1494
110–125	13	0.6673	0.1022	0.4671	0.8676	<0.0001	40.99	<0.0001	65.7	3.072	0.0001	577
130–140	5	0.7070	0.1592	0.3950	1.0190	<0.0001	45.79	<0.0001	85	4.981	0.0222	225
150–160	16	0.5978	0.0788	0.4434	0.7522	<0.0001	79.12	<0.0001	83.8	4.874	0.0002	1946
170–180	10	Fisher scoring algorithm did not converge										
190–200	13	0.6292	0.0908	0.4512	0.8072	<0.0001	301.50	<0.0001	95.7	6.786	0.0015	2864
210–240	12	0.6734	0.1281	0.4223	0.9246	<0.0001	428.83	<0.0001	95.3	5.434	0.0124	1560
250–280	17	0.6676	0.0963	0.4789	0.8563	<0.0001	331.47	<0.0001	96.5	9.347	0.0122	9320
300–320	15	0.7454	0.1062	0.5374	0.9535	<0.0001	8769.78	<0.0001	99.4	15.540	0.202	20,053
340–375	10	0.6432	0.0943	0.4583	0.8281	<0.0001	34.74	0.0001	75.2	4.828	0.0161	851
380–480	16	0.7495	0.0888	0.5755	0.9236	<0.0001	1052.78	<0.0001	96.9	8.952	0.0003	7820
490–550	14	0.6946	0.1004	0.4978	0.8914	<0.0001	86.19	<0.0001	87	5.331	0.0073	2013
565–645	9	0.7182	0.0929	0.5361	0.9003	<0.0001	27.72	0.0005	75.8	6.594	0.0436	1294
650–785	11	0.7564	0.1203	0.5206	0.9921	<0.0001	581.18	<0.0001	94.1	5.980	0.0451	1588
800–860	3	0.6869	0.1968	0.3011	1.0728	<0.0001	12.75	<0.0001	81.1	4.640	0.0124	69
900–915	4	0.9152	0.1043	0.7108	1.1196	<0.0001	0.2687	0.9658	0	4.1168	0.0189	97
1000–1075	11	0.8363	0.0791	0.6812	0.9913	<0.0001	17.23	0.0695	46.7	4.585	0.0050	930
1100–1175	3	0.9696	0.1275	0.7198	1.2195	<0.0001	0.0722	0.9645	0	4.052	0.0780	52
1200–1290	4	0.8308	0.1097	0.6158	1.0459	<0.0001	5.011	0.171	47	5.426	0.0344	171
1300	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1400	2	0.9098	0.0515	0.8090	1.0107	<0.0001	0.0398	0.842	0	10.941	0.321	176
1500–1505	7	0.8511	0.0677	0.7183	0.9838	<0.0001	13.894	0.0308	71.7	10.572	0.0516	2018
1600	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1700–1750	4	0.9294	0.0992	0.7349	1.1239	<0.0001	0.5252	0.9133	0	4.4439	0.0148	113
1800–2000	4	1.0000	0.0483	0.9053	1.0947	0.0000	0	1.0000	0	7.868	0.136	362
2150	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2365	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2580	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

<sup>a</sup> Total number of MSA values included in the meta-analysis for bird species. The total number of studies is 27, from which 49 datasets were extracted containing 288 MSA calculated values for different distances.

**Table 2**  
Results of the meta-analysis for mammal species at different distance intervals.

Distance (m)	n	Effect size (MSA)	SE	CI (lb)	CI (ub)	P (e.size)	Q	P(Q)	I <sup>2</sup> (%)	Egger's test intercept	P(t) Egger	Fail-safe N
0–17,000	151 <sup>a</sup>	0.6746	0.0342	0.6076	0.7415	<0.0001	3466.80	<0.0001	90.7	3.6843	<0.0001	114,151
1	6	0.1528	0.1005	-0.0442	0.3498	>0.1	12.74	0.0259	71.9	1.0862	0.0937	10
10–25	11	0.7110	0.0451	0.6227	0.7993	<0.0001	4.38	0.9284	0	4.300	<0.0001	816
30–50	16	0.5651	0.0726	0.4229	0.7073	<0.0001	28.65	0.0178	55.8	2.9972	<0.0001	834
75–100	7	0.3957	0.1831	0.0369	0.7545	<0.05	10.87	0.0925	47.7	1.4193	0.0016	362
110–180	16	0.8374	0.0520	0.7354	0.9394	<0.0001	7.42	0.9448	0	3.4069	<0.0001	1083
200	2	0.6104	0.2382	0.1435	1.0774	0.0104	0.02	0.878	0	1.464	0.402	2
250–300	9	0.8470	0.0627	0.7241	0.9698	<0.0001	7.78	0.4557	7.8	4.059	0.0037	485
350–600	19	0.6222	0.1115	0.4035	0.8408	<0.0001	206.68	<0.0001	91.9	3.3561	<0.0001	1485
750–1000	6	0.8669	0.1052	0.6608	1.0731	<0.0001	9.23	0.1002	50.2	4.8430	0.0036	307
1050–2200	20	0.5786	0.0806	0.4207	0.7366	<0.0001	75.49	<0.0001	74.1	3.0049	<0.0001	1316
2500	8	0.8233	0.2098	0.4121	1.2345	<0.0001	0.9453	0.9957	0	1.2516	0.0020	30
3500–4000	7	0.9807	0.1276	0.7307	1.2308	<0.0001	0.2907	0.9995	0	1.9095	0.0775	60
4500–5000	8	0.8666	0.1099	0.6512	1.0820	<0.0001	6.06	0.5323	30.8	3.395	0.0255	265
5500–7000	8	0.8049	0.1983	0.4163	1.1936	<0.0001	0.8083	0.9974	0	1.2467	0.0039	29
7500	2	0.8730	0.0118	0.8498	0.8962	<0.0001	0.0084	0.9272	0	37.35	0.494	2047
8500	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
9500–11,000	4	1.0000	0.0131	0.9744	1.0256	<0.0001	0	1	0	76.122	<0.0001	2527
17,000	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

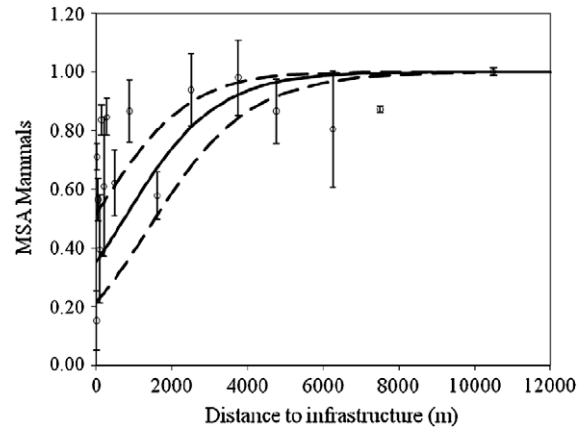
<sup>a</sup> Total number of observations points or MSA values included in the meta-analysis for mammal species. The total number of studies is 22, from which 41 datasets were extracted containing 151 MSA calculated values for different distances.

The number of datasets per distance interval decreased as the distance from infrastructure increased (Tables 1 and 2).

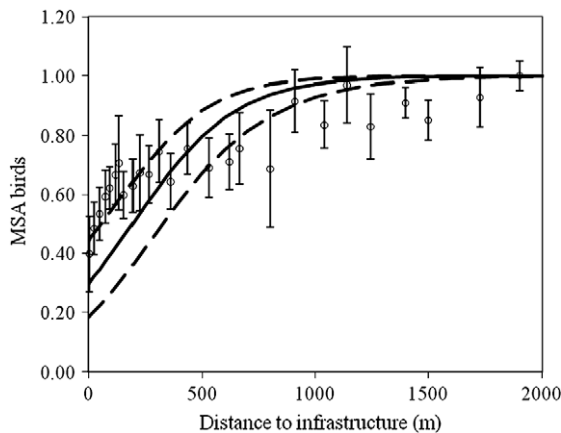
Sensitivity analyses for mammal and bird data resulted in similar MSA values per distance interval with the exception of the distance intervals 300–320, 340–375 and 380–490 m for the bird data, which had larger MSA values (Appendix 4, Supplementary material available at <http://www.environmentalevidence.org/SR68.html>). Heterogeneity was not statistically significant in these intervals, but there was publication bias.

3.2.3. Exploration of reasons for heterogeneity: meta-regression

The relationship between MSA and distance to infrastructure was positive for both mammals and birds (Fig. 1 and 2). When the data was subgrouped per habitat, all relationships were also positive except for temperate forests in the case of mammal species, and Mediterranean forests in the case of bird species (Tables 6 and 7). In forests both bird and mammal species abundances were affected in the proximity of infrastructure whereas in non-forested areas the effect extended over a larger distance (Tables



**Fig. 2.** Logistic regression between mean species abundance of mammals and distance from infrastructure. Open dots represent the pooled results of the meta-analysis per distance interval ± S.E. The black line denotes the estimated curve for the decline of MSA, related to distance. Dashed lines are the 95% upper and lower limits of the confidence bands of the curve.



**Fig. 1.** Logistic regression between mean species abundance of birds and distance from infrastructure. Open dots represent the pooled results of the meta-analysis per distance interval ± S.E. The black line denotes the estimated curve for the decline of MSA, related to distance. Dashed lines are the 95% upper and lower limits of the confidence bands of the curve.

6 and 7). All relationships had lower AICc when “LOGDIST” was chosen as explanatory variable, except for Tundra.

There existed also differences in the relationship between MSA and distance to infrastructure for different taxa. Accitriformes and Falconiformes were the only bird taxa which were unaffected or positively affected by the presence of infrastructure, whereas for other bird taxa proximity to infrastructure seemed to exert a negative effect on species abundance, or the magnitude of the effect was unknown due to low sample size (Supplementary material available at <http://www.environmentalevidence.org/SR68.html>). From all mammal taxa, a positive relationship between MSA and distance to infrastructure could only be found for Artiodactyla and Rodentia, but abundances of the latter were only reduced at short distances from infrastructure while this effect extended over a large distance for the former.

Several *ad hoc* models were built to explore the high heterogeneity between effect sizes. We worked on several biological hypotheses to explain the variability in the relationship between MSA and distance to infrastructure. For bird species the most parsimonious model was that containing only the explanatory variable “LOGDIST” (Akaike weight: 0.78, Table 3). For mammal

**Table 3**  
Models expressing different biological hypotheses on the influence of infrastructure distance, infrastructure type and infrastructure visibility (forest) on the mean species abundance of birds. The selected model appears in bold.

Model (birds)	AICc	K	n	$\Delta_i$ AICc	$w_i$
LOGDIST + FOR + INFITYP + LOGDIST * INFITYP + LOGDIST * FOR + FOR * INFITYP + LOGDIST * INFITYP * FOR	No model convergence				
LOGDIST + FOR + LOGDIST * FOR	1630.78	6	288	3.04	0.17
LOGDIST + INFITYP + LOGDIST * INFITYP	1636.04	6	288	8.30	0.01
LOGDIST + FOR	1633.96	5	288	6.21	0.03
LOGDIST + INFITYP	1637.29	5	288	9.54	0.01
LOGDIST	<b>1627.75</b>	<b>4</b>	<b>288</b>	<b>0.00</b>	<b>0.78</b>
FOR	1647.18	4	288	19.43	<0.01
INFITYP	1646.40	4	288	18.65	<0.01
DIST + FOR + DIST * FOR	1762.19	6	288	134.45	<0.01
DIST + FOR	1744.61	5	288	116.86	<0.01
DIST	1739.98	4	288	112.23	<0.01

AICc = Akaike Information Criterion corrected for sample size;

K = No. of estimable parameters: Intercept, log (effect distance), effect distance, forest, infra type, interaction term, study and error term;

n = No. of data points;

$\Delta_i$ AICc = Delta AICc value;

$w_i$  = Akaike weight.

**Table 4**  
Models expressing different biological hypotheses on the influence of infrastructure distance, infrastructure type and infrastructure visibility (forest) on the mean species abundance of mammals. The selected model appears in bold. See Table 3 for explanation of coefficients.

Model (mammals)	AICc	K	n	$\Delta_i$ AICc	$w_i$
LOGDIST + FOR + INFITYP + LOGDIST * INFITYP + LOGDIST * FOR + FOR * INFITYP + LOGDIST * INFITYP * FOR	889.18	10	151	3.59	0.14
LOGDIST + INFITYP + LOGDIST * INFITYP	963.06	6	151	77.50	<0.01
LOGDIST + FOR + LOGDIST * FOR	900.02	6	151	14.46	<0.01
LOGDIST + LOGDIST	919.67	5	151	34.12	<0.01
LOGDIST + FOR	911.34	5	151	25.79	<0.01
LOGDIST	923.42	4	151	37.87	<0.01
INFITYP	896.93	4	151	11.38	<0.01
FOR	899.30	4	151	13.75	<0.01
DIST + FOR + INFITYP + DIST * INFITYP + DIST * FOR + FOR * INFITYP + DIST * INFITYP * FOR	1081.87	10	151	196.28	<0.01
DIST + FOR + DIST * FOR	964.56	6	151	79.01	<0.01
DIST + INFITYP	893.28	5	151	7.73	0.02
DIST + FOR	<b>885.54</b>	<b>5</b>	<b>151</b>	<b>0.00</b>	<b>0.84</b>
DIST	897.99	4	151	12.45	<0.01

**Table 5**  
Models expressing different biological hypotheses on the influence of infrastructure distance, traffic intensity (noise) and infrastructure visibility (forest) on the mean species abundance of birds. The selected model appears in bold. See Table 3 for explanation of coefficients.

Model (birds)	AICc	K	n	$\Delta_i$ AICc	$w_i$
LOGDIST + FOR + TRAF + LOGDIST * TRAF + LOGDIST * FOR + FOR * TRAF + LOGDIST * TRAF * FOR	583.52	10	87	10.87	<0.01
LOGDIST + TRAF + LOGDIST * TRAF	512.30	6	87	31.65	<0.01
LOGDIST + TRAF	503.06	5	87	22.40	<0.01
TRAF	537.10	4	87	56.44	<0.01
LOGDIST	<b>480.66</b>	<b>4</b>	<b>87</b>	<b>0.00</b>	<b>0.99</b>

species the most parsimonious model was that including the explanatory variables “DIST” and “FOR” (Akaike weight: 0.84, Table 4).

The most parsimonious model for the subset of bird data containing information on traffic intensity was that including only “LOGDIST” as explanatory variable (Akaike weight: 0.99, Table 5).

## 4. Discussion

### 4.1. Effect of distance from infrastructure on bird and mammal species abundance

Our analyses suggest that infrastructure can have a negative impact on bird and mammal abundance and that this impact is more evident in the proximity of the infrastructure. Pooled results for pseudoreplicated data indicated a decline in species abundance

of 28–36% and 25–38% for birds and mammals within 2.6 km and 17 km from infrastructure, respectively. Pooled results per distance interval showed that MSA of birds and of mammals became higher for distance intervals far away from infrastructure. The meta-regression also indicated a positive relationship between MSA of birds and mammals and distance to infrastructure. A second conclusion that can be obtained from these results is that bird populations are likely to be more affected at short distances from infrastructure while the effect on mammal populations seems to extend over larger distances. These results confirm the effect distances reported in other studies, which were larger for mammals (Cameron et al., 1992; Newmark et al., 1996; Nellemann et al., 2003a; Joly et al., 2006) than for birds (Van der Zande et al., 1980; Madsen, 1985; Reijnen et al., 1996; Rheindt, 2003). However, considerable heterogeneity was found in our results, especially for birds, and also publication bias, both limiting the robustness of these conclusions.

**Table 6**

Univariate meta-regression coefficients for the relationship between MSA and distance for bird species in different habitats. Models with log-transformed distance as explanatory variable are more parsimonious than without transformation for all habitats.

Bird species							
Explanatory variable	Habitat	<i>b</i>	Intercept	<i>k</i>	<i>n</i>	<i>K</i>	AICc
LOGDIST	Agricultural lands	1.523	−7.933	15	109	4	626.29
	Temperate forests	0.761	−2.868	8	35	4	192.57
	Boreal forests	No model convergence		1	2		
	Mediterranean forests	27.020	−136.950	2	4	4	−12.28
	Grasslands	1.014	−5.193	15	97	4	417.24
	Scrublands	1.174	−4.853	5	35	4	200.84
	Tropical forests	18.834	−61.705	3	6	4	80.13
	All forests	0.826	−2.770	14	47	4	263.04
	Non-forested habitats	1.333	−6.712	35	241	4	1361.75
DIST	Agricultural lands	0.005	−1.777	15	109	4	779.75
	Temperate forests	No model convergence		8	35	4	
	Boreal forests	No model convergence		1	2		
	Mediterranean forests	0.046	3.222	2	4	4	0.45
	Grasslands	0.002	−0.759	15	97	4	488.01
	Scrublands	No model convergence		5	35	4	
	Tropical forests	0.522	−17.254	3	6	4	97.57
	Forests	0.011	−0.894	14	47	4	301.93
	Non-forested habitats	0.004	−1.218	35	241	4	1478.68

**Table 7**

Univariate meta-regression coefficients for the relationship between MSA and distance for mammal species in different habitats. Models with log-transformed distance as explanatory variable are more parsimonious than without transformation for all habitats except for tundra.

Mammal species							
Explanatory variable	Habitat	<i>b</i>	Intercept	<i>k</i>	<i>n</i>	<i>K</i>	AICc
LOGDIST	Agricultural lands	No model convergence		2	9		
	Temperate forests	0.260	0.103	4	15	4	67.99
	Boreal forests	1.526	−7.742	9	34	4	162.23
	Grasslands	Only 1 dataset		1	5		
	Scrublands	2.133	−6.773	3	11	4	59.19
	Tropical forests	0.681	−1.136	5	22	4	81.39
	Semi-arid lands	Only 1 dataset		1	8		
	Arctic tundra	2.854	−21.429	12	52	4	364.50
	All except for Tundra	0.978	−3.670	25	104	4	528.05
	Forests	0.860	−3.151	18	71	4	313.90
	Non-forested habitats	1.142	−7.089	19	85	4	548.28
	DIST	Agricultural lands	No model convergence		2	9	
Temperate forests		0.002	0.850	4	15	4	75.91
Boreal forests		No model convergence					
Grasslands		Only 1 dataset		1	5		
Scrublands		No model convergence		4			
Tropical forests		0.003	0.592	5	22	4	107.21
Semi-arid lands		Only 1 dataset		1	8		
Arctic tundra		0.001	−1.832	12	52	4	332.68
All except for Tundra		0.004	−0.478	25	104	4	614.09
Forests		0.003	−0.026	18	71	4	397.21
Non-forested habitats		0.001	−1.659	19	85	4	561.76

The sensitivity analyses resulted in a slightly (but not statistically significant) larger pooled effect size for pseudoreplicated data in the case of bird species. Sensitivity analyses per distance interval showed similar results to the full meta-analyses except for the distance intervals between 300 and 480 m from infrastructure, with larger effect sizes. Yet, fail-safe numbers indicate that a large number of non-significant studies would be needed to overturn the pooled effect sizes calculated for these distance intervals. Thus, we decided to maintain these studies in the meta-regression following Wolf and Guevara (2001), who advocate for the use of all available data when doing meta-analysis.

The high heterogeneity underlying the results of our meta-analysis indicates that infrastructure development can have negative impacts on bird and mammal abundance within a certain distance depending on a number of factors which we further explore in Section 4.2.

#### 4.2. Exploration of sources of heterogeneity

Meta-regression helped us to elucidate that “LOGDIST” was the main explanatory variable for the decline in abundance of bird populations due to infrastructure. For mammals, “DIST” was the main variable but the variable “FOR” seemed to add important information to the model. Meta-regression on subgroups divided by habitat type and taxa indicated that in open habitats, both mammal and bird populations seem to avoid infrastructure over larger distances, compared to those in forested biomes, which could probably be related to reduced visibility of infrastructure. Forman and Deblinger (2000) showed similar results for breeding birds in open grasslands and in woodlands (data adapted from Reijnen et al. (1995, 1996)).

For the subset of bird data including information on traffic intensity, the most parsimonious model was that which contained



only “LOGDIST” as explanatory variable. Therefore it seems that traffic intensity has no effect on the reduction of bird populations nearby roads. These results are contrary to the findings of a number of authors that have highlighted the pernicious effects of traffic intensity and noise on bird populations (Reijnen and Foppen, 1994; Reijnen et al., 1995, 1996, 1997; Forman et al., 2002; Rheindt, 2003). However, there are other studies which found a decline in bird populations near roads with low traffic intensity (Räty, 1979; Madsen, 1985; Develey and Stouffer, 2001) and others which found no clear relationship (Peris and Pescador, 2004). Finally, some authors claim that there exists a trade-off between traffic intensity and velocity, with low traffic intensity being related to higher velocities (Martínez-Abraín, 1994; Drews, 1995). Yet, traffic velocity seems to be related to bird mortality, which occurs on the road itself. To the best of our knowledge, studies that deal with this topic usually do not report on bird densities at increasing distances from roads (or include a control distance for comparison). As none of the studies included in our analysis contained data on traffic velocity, the influence of this variable could not be evaluated.

Not all species showed a decline in abundance nearby infrastructure: species abundance of Accipitriformes and Falconiformes was larger in the proximity of infrastructure. This was not a surprising outcome since other studies have reported the presence of raptors nearby roads searching roadkill carrion (Forman and Alexander, 1998; Lambertucci et al., 2009) and hunting (Dónazar et al., 1993; Fajardo et al., 1998; Dean and Milton, 2003), with some exceptions during the breeding season (Martínez-Abraín et al., 2008).

In the case of mammals, we could detect that Rodentia populations were slightly affected within few meters from infrastructure. By contrast, Artiodactyla species were affected up to distances of several hundred meters. Within Artiodactyla wild reindeer (*Rangifer tarandus*) was one of the most studied and sensitive species, with their population abundance being reduced up to several kilometres from infrastructure (Nellemann and Cameron, 1996; Nellemann et al., 2001, 2003a,b). These outcomes are consistent with the fact that small-sized mammals usually have smaller home ranges and migration distances compared to medium- and large-sized mammals, the latter being more sensitive to infrastructure development and habitat fragmentation (Harestad and Bunnell, 1979; Buskirk, 2009).

#### 4.3. Review limitations

Only some of the included studies used Before-After-Control-Impact (BACI) experimental designs, so we decided to use the largest reported distance in the study as control distance. Although the sensitivity analyses allowed us to remove some of the studies of lower quality and indeed the results did not vary in most of the cases, we acknowledge that our conclusions are restricted by the lack of proper comparators in some of the studies.

The identified publication bias is another of the weaknesses of our review. A few studies did not find negative effects of infrastructure on bird and mammal populations and were not included due to lack of proper data on the selected variables (e.g. Adams, 1984; Evans and Gates, 1997; Ballard et al., 2000); and there may exist many others that were never published due to non-significant results or that we were unable to obtain (grey literature). However, fail-safe numbers indicated that our results are sufficiently robust.

Many of the studies initially considered in our systematic review lacked suitable data for extraction and had to be left out of the analysis. Therefore we may have excluded potentially relevant studies and included lower quality studies due to availability of data on the selected variables.

The scope of the study was intended to be global and covered different types of biomes and habitats; nevertheless there is a geo-

graphical bias in the studies included in our review. Most studies were done in Europe and North America and therefore the applicability of the results to other geographic areas remains unknown.

#### 4.4. Conclusions and management implications

Changes in wildlife populations in the proximity of infrastructure have been reported for decades in a number of studies (see Table 2 in Supplementary material, available at <http://www.environmentalevidence.org/SR68.html>), and have been pointed out in relevant authors' reviews (Spellerberg, 1998; Trombulak and Frissell, 2000; Forman et al., 2003). Additionally, there have been previous attempts to quantify wildlife population decline in relation to distance from infrastructure, either locally (Forman and Deblinger, 2000) or at the global scale (UNEP, 2001; Nellemann et al., 2003b; Fahrig and Rytwinski, 2009), but none of them followed the guidelines for systematic reviews (Pullin and Stewart, 2006) or summarized the information by means of a meta-analysis. Our study represents a step forward within the field of road ecology research that may contribute to the understanding of the magnitude of the pernicious effects of infrastructure development on animal populations. Reported effects for most bird populations extend over distances up to about 1 km, and for most mammal populations up to about 5 km, with variation according to taxa and habitat type (Fig. 1 and 2). However, the evidence shown by our results is somewhat hampered by the limitations mentioned in Section 4.3. We therefore encourage researchers to perform BACI studies whenever possible and make their data available for researchers pursuing a systematic review. Should new studies that include these recommendations be released in the future, the review can be updated by including the new available evidence.

Although the patterns found in our analysis are clear, we would like to emphasise that these only represent a partial estimate of the actual effect of infrastructure on wildlife. Therefore, we highlight the importance of broadening the analysis to other taxonomic groups, such as herpetofauna, plants and invertebrates (e.g. Przybylski, 1979; Angold, 1997; Auerbach et al., 1997; Haskell, 2000; Shine et al., 2004; Barrows et al., 2006). Further research on these taxonomic groups would add up to the current models presented in this study, contributing to eventually produce a model that would provide an accurate estimate of the effects of infrastructure development on biodiversity.

The results of our meta-analysis will be implemented in the next version of the GLOBIO3 model, which is used to estimate the biodiversity loss at global, regional and national level at current state and for possible future scenarios and policy options (Alkemada et al., 2009). The results of the GLOBIO3 model have been reported in global assessments such as the second Global Biodiversity Outlook and the fourth Global environmental Outlook and are aimed to support policy makers on the elaboration of biodiversity conservation policies (sCBD and MNP, 2007; UNEP, 2007). The method is also used at the regional level (Verboom et al., 2007) and at the country level (e.g. in Viet Nam, Ecuador and Nicaragua).

Our study shows the importance of minimizing infrastructure development for wildlife conservation in relatively undisturbed areas. By combining actual species distributions with the effect distance functions we developed as a form of dose-effect relationship, regions sensitive to infrastructure development may be identified. More specifically, the effect distance functions can be used in models in support of decision making on infrastructure planning. This would mean a substantial improvement of the current situation in which, in most cases, results of previous studies on ecological impacts are barely taken into account (OECD, 2002; Roedenbeck et al., 2007).



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## Supplementary material

Supplementary material available at <http://www.environmental-evidence.org/SR68.html>. Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.biocon.2010.02.009.

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RESEARCH ARTICLE

# Individual and Population Level Resource Selection Patterns of Mountain Lions Preying on Mule Deer along an Urban-Wildland Gradient

John F. Benson<sup>1,2\*</sup>, Jeff A. Sikich<sup>2</sup>, Seth P. D. Riley<sup>1,2</sup>

**1** La Kretz Center for California Conservation Science, Institute of the Environment and Sustainability, University of California Los Angeles, Los Angeles, California, United States of America, **2** National Park Service, Santa Monica Mountains National Recreation Area, Thousand Oaks, California, United States of America

\* [benson.johnf@gmail.com](mailto:benson.johnf@gmail.com)



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**Data Availability Statement:** Data are owned by the National Park Service and data sufficient to reproduce the authors' analyses will be available upon request. However, given that mountain lions are a specially protected species in California, specific animal location data will not be made available. Requests for data may be directed to: Seth P.D. Riley, National Park Service Santa Monica Mountains National Recreation Area 401 W. Hillcrest Dr. Thousand Oaks, CA 91360 (805) 370-2358; ([seth\\_riley@nps.gov](mailto:seth_riley@nps.gov))

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## Abstract

Understanding population and individual-level behavioral responses of large carnivores to human disturbance is important for conserving top predators in fragmented landscapes. However, previous research has not investigated resource selection at predation sites of mountain lions in highly urbanized areas. We quantified selection of natural and anthropogenic landscape features by mountain lions at sites where they consumed their primary prey, mule deer (*Odocoileus hemionus*), in and adjacent to urban, suburban, and rural areas in greater Los Angeles. We documented intersexual and individual-level variation in the environmental conditions present at mule deer feeding sites relative to their availability across home ranges. Males selected riparian woodlands and areas closer to water more than females, whereas females selected developed areas marginally more than males. Females fed on mule deer closer to developed areas and farther from riparian woodlands than expected based on the availability of these features across their home ranges. We suggest that mortality risk for females and their offspring associated with encounters with males may have influenced the different resource selection patterns between sexes. Males appeared to select mule deer feeding sites mainly in response to natural landscape features, while females may have made kills closer to developed areas in part because these are alternative sites where deer are abundant. Individual mountain lions of both sexes selected developed areas more strongly within home ranges where development occurred less frequently. Thus, areas near development may represent a trade-off for mountain lions such that they may benefit from foraging near development because of abundant prey, but as the landscape becomes highly urbanized these benefits may be outweighed by human disturbance.

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## Introduction

Identifying environmental conditions associated with specific activities that influence fitness of animals, such as foraging, is a fundamental pursuit in ecology and conservation biology [1, 2]. Understanding extrinsic influences on the acquisition of food resources is especially critical for the management of small populations in human-altered landscapes because suitable habitat may be limited, and fluctuations in demography due to environmental stochasticity can have serious, rapid consequences for extinction risk [3–5]. Thus, quantifying habitat and landscape features associated with successful foraging provides valuable information regarding the spatial ecology and habitat requirements of populations of conservation concern.

Large carnivores, such as mountain lions (*Puma concolor*), are sensitive to habitat fragmentation because they occupy large home ranges within which they must acquire sufficient large prey [6]. However, mountain lion populations are able to persist within urbanized landscapes in some situations, especially where protected lands exist within or adjacent to developed areas [7–9]. In these situations, it becomes imperative to understand predator-prey interactions and how they may be influenced by development and other landscape features encountered by mountain lions while foraging for preferred prey along urban-wildland gradients. Despite considerable interest in maintaining populations of mountain lions in ecosystems altered by anthropogenic activities (e.g., [7, 10, 11]), there is little information about predator-prey interactions and resource selection of mountain lions at predation sites within and adjacent to highly urbanized landscapes.

Ecologists are increasingly recognizing the importance of considering individual-level variation in resource selection studies [12]. A common source of variation for mountain lions are sexual differences, as males and females often use space and select resources differently [13–14]. However, most studies of resource selection specifically at foraging sites of mountain lions have not investigated sex-specific patterns [15–18], but see [14]. Another common source of individual variation in resource selection stems from spatial variation in the distribution and abundance of resources. For instance, selection of a resource may vary as a function of its availability on the landscape, often referred to as a functional response in resource selection [19]. Several studies have found that large carnivores exhibit functional responses to anthropogenic landscape features or activity, which may represent trade-offs between mortality risk and foraging success (e.g., [13, 20]). Knopff et al. [20] suggested that mountain lions in Alberta, Canada benefited from human-altered landscapes primarily through prey acquisition and found that mountain lions selected some anthropogenic features more strongly in areas where these features were more prevalent. Recently, Smith et al. [21] found that male and female mountain lions responded differently to increasing development in terms of kill rates and handling time of prey. Thus, both intrinsic (sex) and extrinsic (resource availability) sources of individual-level behavioral variation may influence mountain lion-prey interactions and resource selection in human-altered landscapes. Investigating mountain lion predation in more highly urbanized landscapes than previous studies, such as in areas within and adjacent to major metropolitan areas, may identify novel behavioral responses of these top predators to human disturbance.

We quantified selection of natural and anthropogenic landscape features at sites where mountain lions consumed mule deer (*Odocoileus hemionus*) across home ranges in and adjacent to the city of Los Angeles. Specifically, we addressed several questions. 1) What natural and anthropogenic landscape features were selected and avoided by mountain lions at foraging sites? 2) Were there differences in resource selection patterns between males and females? 3) Was there substantial additional individual-level variation in the responses of mountain lions to anthropogenic land-uses due to spatial variation in the level of human disturbance? Our



results are important because they provide novel information about environmental conditions that facilitate successful predation by mountain lions in a highly urbanized landscape. This information will be valuable for managers attempting to conserve healthy populations of mountain lions, and naturally-functioning ecosystems, along urban-wildland gradients surrounding metropolitan areas.

## Methods

### Ethics statement

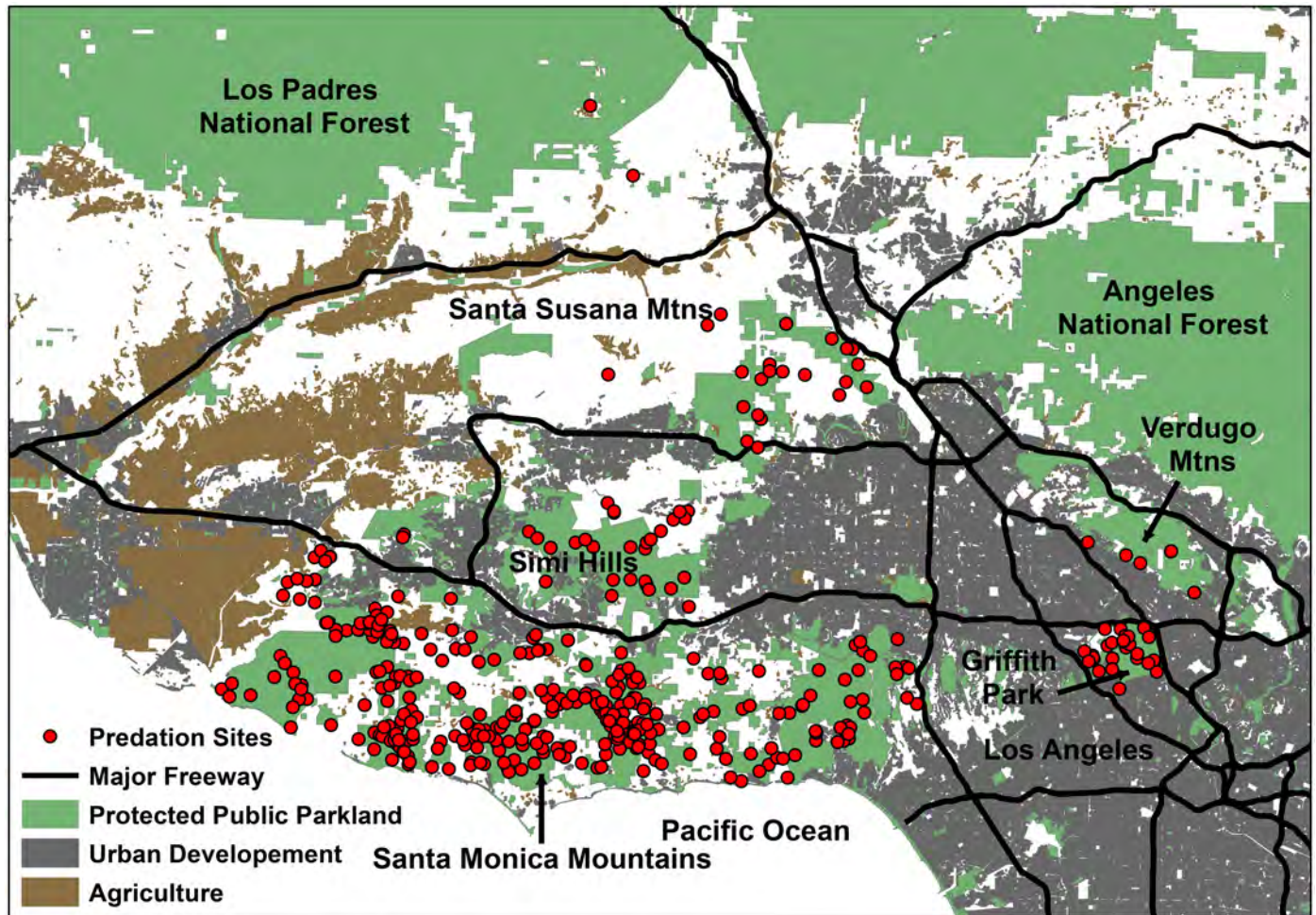
Animal capture and handling protocols were approved by the National Park Service Institutional Animal Care and Use Committee. We conducted research according to the conditions of animal capture and handling protocol PWR\_SAMO\_Riley\_Mt.Lion\_2014.A3. Mountain lions are not an endangered species in California. However, they are a specially protected species that cannot be legally killed in California except under specific circumstances with a state approved permit.

### Study area

We conducted research in and adjacent to the city of Los Angeles in Los Angeles and Ventura Counties, California (Fig 1). The study was focused on the Santa Monica Mountains National Recreation Area (SMMNRA; 34°05'N, 118°46'W), a unit of the National Park Service, and surrounding areas. Most research was carried out on public lands managed by the National Park Service who granted us access to the properties. When access was needed to private land this was obtained from private landowners in advance. The SMMNRA encompassed 600 km<sup>2</sup> and included an assemblage of federal, state, and privately-owned lands largely in the Santa Monica Mountains. The Santa Monica Mountains were bordered by the Pacific Ocean to the south; by US 101, an 8–10 lane freeway, and various urban and suburban communities to the north; by the highly urbanized Los Angeles basin to the east; and by agricultural and developed areas in Ventura County to the west. Additionally, we studied mountain lions in areas north and east of the Santa Monica Mountains in the Simi Hills, the Santa Susana Mountains, Griffith Park, and the Verdugo Mountains (Fig 1). Griffith Park was a municipal park lying within the city of Los Angeles in the western portion of the Santa Monica Mountain range (Fig 1). The Verdugo Mountains were a small, rugged mountain range spanning several cities adjacent to Los Angeles including Glendale and Burbank (Fig 1). All patches of natural habitat in the study area were bordered by major freeways, urbanization, or agricultural development. The study area was characterized by a Mediterranean climate, with cool, wet winters and hot, dry summers. There were multiple land uses throughout the area including federal, state, and local parklands, urban and suburban areas with commercial and residential (both high and low density) development, and agricultural areas (Fig 1). Natural vegetation consisted of mixed chaparral, coastal sage scrub, oak woodlands and savannas, riparian woodlands, and non-native annual grasslands. Bobcats (*Lynx rufus*) and coyotes (*Canis latrans*) occurred throughout most of the study area and the only wild, large ungulates were mule deer.

### Capture and telemetry

We captured mountain lions using Aldrich foot-snares or cable-restraints, baited cage-traps, or by treeing them with trained hounds during 2002–2015. We immobilized mountain lions with ketamine hydrochloride combined with either xylazine hydrochloride or medetomidine hydrochloride administered intramuscularly. Animals were monitored for the duration of the time they were immobilized. We deployed global positioning system (GPS) collars (Followit AB,



**Fig 1. Greater Los Angeles area in southern California where we studied mountain lion predation on mule deer.** Shown are sites where mountain lions fed on mule deer (Predation Sites), major freeways, protected parklands, areas of urban development, and agricultural areas.

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Simplex and Tellus models, Stockholm, Sweden; North Star Science and Technology LLC, Globalstar Tracker model, King George, Virginia, USA; or Vectronic Aerospace, GPS Plus model, Berlin, Germany) equipped with VHF beacons on adults. Fix schedules of GPS collars varied but we programmed most collars to obtain 1–2 day locations and 5–7 night locations per 24-hour period. Additional details of our capture, handling, and tracking of mountain lions are available elsewhere [8].

### Feeding site investigations

We found carcasses of prey eaten by mountain lions by visiting clusters of GPS or VHF telemetry locations ( $n = 520$ ) and searching the area for prey remains. When we found prey remains ( $n = 473$ ) we identified the species, sex, and age of the prey when possible. We obtained coordinates at the prey remains with a handheld GPS unit. Previous research has indicated that clusters of mountain lion locations with locations from  $>1$  night had a high probability of containing a kill, and that increasing numbers and the proportion of night locations in GPS clusters were strong predictors of sites where mountain lions fed on kills [18, 21, 22, 23]. Our protocol for finding prey remains was to visit clusters of telemetry locations that contained  $\geq 2$



night (sunset-sunrise) locations within  $\leq 50$  meters of each other and spanning periods  $\geq 24$  hours. We found prey remains at 91% of the clusters we visited. We reduced the likelihood of bias in the location of these carcasses with respect to landscape features because we visited clusters of locations regardless of the topography or their proximity to habitat features or roads.

A previous study of mountain lions in southern California found that large prey are generally dragged 0–80 m from the kill site [24]. Thus, we recognize that most of the locations where we found carcasses were probably not the exact locations where the deer were killed. However, our distance-based analysis was robust to location error [25] which ensured that our results should provide reliable inferences regarding areas where deer were killed and consumed. Nonetheless, we refer to the locations where we found carcasses as feeding sites to reflect that the deer were not necessarily killed exactly at these sites.

## Resource use and availability

We investigated resource selection with an approach similar to Johnson's (1980) 3<sup>rd</sup> order of selection by comparing locations used by mountain lions at feeding sites to those available within their annual home ranges. The use-available design for resource selection models estimates the relative probability of use of resource variables (i.e. relative to their availability). For the used locations, we identified 30 m pixels (30 x 30m) on the landscape within which we found carcasses of mule deer preyed upon by mountain lions. We also occasionally found carcasses of smaller prey species ( $n = 54$ , 11% of kill sites) but we chose to focus our analysis on deer because they comprised the majority of carcasses and because mountain lions rely on large ungulates to survive and reproduce [13]. We had small sample sizes for smaller prey species ( $n \leq 33$  for each individual prey species smaller than deer). Additionally, given that mountain lions likely spent considerably less time at sites where smaller prey items were consumed, we assumed we missed more of the smaller prey.

To estimate availability, we estimated adaptive local convex hull home ranges in R version 2.15.1 with the package 'adehabitat' using GPS telemetry data for each mountain lion included in our analysis. We set the 'a' parameter as the maximum distance between any 2 points in each dataset [26]. In total, we estimated 49 home ranges for 26 mountain lions with telemetry data (mean number of locations = 1814, range = 166–5507) collected across 1–12 months (mean number of monitoring days = 247, range = 30–365). In most (90%) cases we estimated home ranges with data specific to a single calendar year that matched the year of the feeding sites identified for that mountain lion. In the remaining cases (10%) we combined continuous data from 2 consecutive calendar years (if  $< 40$  days of data were available within a single year) to provide a better estimate of space use for that individual. We used calendar year as our temporal unit rather than season because seasonal variation in climate and conditions was relatively subtle in our southern California study area.

We systematically sampled 30 m pixels separated by 150 m throughout each annual home range resulting in 44 pixels/ km<sup>2</sup> to estimate resources available to each mountain lion [27]. We calculated distances to habitat types, land use designations, and roads from the centroid of all 30 m pixels used by (feeding sites) and available to (systematic locations across each individual's home range) mountain lions while preying on deer. Additionally, we classified the slope and elevation values associated with used and available pixels. We modified 2 existing habitat/vegetation layers (Santa Monica Mountains National Recreation Area Vegetation Layer, 2007 and the CALVEG—South Coast Layer [CALVEG, USDA-Forest Service, Pacific Southwest Region, 2013]) by combining similar habitat types to produce a layer with 6 broad habitat classes: chaparral, coastal sage scrub, prairie/meadow, upland woodland, riparian woodland, and water (Table 1). For areas where natural habitat was developed or otherwise altered for

**Table 1. Resource variables included in resource selection function models for feeding sites used by mountain lions preying on mule deer in southern California, 2002–2015.**

Resource variable	Type	Range (units)	Description
Slope	Continuous	0–70 (%)	Inclination of terrain from horizontal
Elevation	Continuous	0–2432 (m)	Vertical distance above sea level
Chaparral	Continuous	0–3027 (m)	Dense, drought and fire-adapted evergreen shrubs
Riparian woodland	Continuous	0–8645 (m)	Diverse riparian forest and shrubs along canyon bottoms and drainages
Upland woodland	Continuous	0–8008 (m)	Oak, walnut, and other woodlands on slopes, shaded ravines, and canyons
Prairie/Meadow	Continuous	0–5396 (m)	Open grasslands
Water	Continuous	0–9817 (m)	Lakes, ponds, creeks, reservoirs
Trail	Continuous	0–7878 (m)	Unpaved roads and trails
Developed areas	Continuous	0–11545 (m)	Residential and commercial development
Altered-open areas	Continuous	0–5858 (m)	Areas modified by humans but less so than developed areas
Male	Categorical	0–1	Female (0) or male (1)

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anthropogenic activities, we generalized a digital land-use map for 2 classes of anthropogenic land use: developed areas (3% of mountain lion home ranges) and altered-open areas (9% of home ranges). Developed areas included commercial and residential areas with  $\geq 1$  house/acre. Altered-open areas were modified by humans to a lesser extent than developed areas and included golf courses, schools, landscaped areas such as city parks, low-density residential areas ( $< 1$  house/acre), cemeteries, horse ranches, and other moderately developed areas. We calculated distances from the centroid of all used and available pixels to the closest pixel of the 6 habitat classes and 2 land-use classes using the ‘Euclidean Distance’ tool in the Spatial Analyst toolbox in ArcGIS 10.2.2 (ESRI, Redlands, CA, USA) using Geographic Information System (GIS) methods described by Benson [27]. We also estimated distances from used and available locations to 3 classes of paved roads, as well as a single class of unpaved roads and trails (hereafter referred to as trails). Additionally, we estimated slope and elevation from digital elevation models (DEM) in ArcGIS (Table 1). DEM data were estimated at 9.5 m resolution, but we averaged these data across 30 m used and available pixels for our analyses. These distance and classification based values allowed us to compare resources used by and available to lions while preying on deer.

Distance-based variables are effective for assessing habitat selection [28] and using continuous, distance-based variables for habitat classes (rather than categorical variables) also eliminated the need to base inference on subjectively chosen reference categories in our regression models [29]. Distance-based approaches for habitat selection analysis are also robust to error in location data [26] and mitigate GIS error. Thus, even though mountain lions likely dragged carcasses short distances from the actual kill sites, our distance-based analysis should capture selection of areas where lions killed and consumed deer. Distance-based analyses are especially effective for assessing resource-selection at individual sites on the landscape, such as feeding sites, because the proximity to specific resource variables (e.g., water or developed areas) is quantified even if the sites of interest rarely or never actually fell within the habitat types or land-use types being considered.

### Resource-selection models

We modeled resource selection at feeding sites with generalized linear mixed models (GLMMs) implemented in the R (version 3.1.1) package ‘lme4’ with a binary (0 = available, 1 = used) response variable. We included random intercepts for individual and year in each model, with year nested in individual. Including random intercepts for individuals mitigated

the effects of the unbalanced feeding site data across individuals (range 1–77) and the lack of independence between used locations from the same individual [30]. The random intercept of year accounted for correlation between sites used within a given year by a given individual and paired the year-specific used and available data appropriately within our models. We did not include the paved road classes in our resource selection models because of 1) the infrequency of major highways (primary roads) within mountain lion home ranges, and 2) correlation of intermediate-sized paved roads (secondary roads) and smaller paved roads (tertiary roads) with developed ( $r = 0.53$ ) and altered-open ( $r = 0.57$ ) areas, respectively. Secondary and tertiary roads were also correlated with each other ( $r = 0.55$ ). Finally, we excluded the coastal sage-scrub habitat class because it was correlated ( $r = 0.63$ ) with elevation. We were more interested in investigating and accounting for the general influence of elevation on selection of feeding sites than the influence of the specific habitat-type of coastal sage-scrub. Correlation between other predictor variables was modest or low ( $r < 0.44$ ) so we included all remaining variables in our global model (Table 1). Prior to modeling, we rescaled values for all continuous variables by subtracting their mean and dividing by 2 standard deviations following Gelman [31].

The terms “selection” and “preference” have sometimes been used synonymously or inconsistently in the resource selection literature [29, 32]. To avoid confusion, we use the term selection throughout to indicate 1) that used locations (feeding sites) were significantly closer to distance-based resource variables (habitat types, land-use types, trails) than were available locations, or 2) that values of classification-based resource variables (elevation and slope) were significantly greater at used locations relative to available locations. Specifically, we inferred selection or avoidance of resource variables when 95% or 90% confidence intervals of fixed-effect beta coefficients did not overlap 0.

We investigated potential sex-specific patterns in resource selection at feeding sites by including a dummy-coded ‘male’ variable (0 = female, 1 = male) and fitting interactions between ‘male’ and each resource variable. We compared the fit of the null model, the global model with all resource variables, a model with interactions between ‘male’ and each resource variable, and a reduced interactions model retaining only interactions that indicated or approached significance (i.e. when 85% confidence interval did not overlap 0) using Akaike’s Information Criteria (AIC; [33]). This allowed us to evaluate support for models of varying complexity by calculating differences ( $\Delta$ ) in AIC values (lower values indicate better fit). We concluded there was strong empirical support for more complex models if  $\Delta\text{AIC} > 5$ . We investigated the significance and marginal significance of fixed effects and interactions in strongly supported models with 95% and 90% confidence intervals, respectively.

We tested the predictive ability of our models using k-fold cross validation implemented in ‘lme4’ as described by Boyce et al. [34]. Specifically, we used 80% of the data (training data) to build a model that was then used to predict the relative probability of use of the remaining 20% (test data). This procedure was repeated 5 times until all data had been used as both training and test data. We ran Spearman rank correlations to assess relationships between the frequency of cross-validated feeding site locations and 10 probability bins of equal size representing the range of predicted values. A model with good predictive ability is expected to show a strong correlation with higher numbers of locations falling into higher probability bins [34].

## Functional responses to human disturbance

We also explored additional individual variation in selection of areas modified by humans. Specifically, we hypothesized that distance of mule deer feeding sites to developed or altered-open areas might vary as a function of the availability of these areas, consistent with a functional response in resource selection as defined by Mysterud and Ims [19]. To test these

hypotheses, we constructed resource-selection proportions by dividing the mean distance at used locations by the sum of the mean used and available locations (mean used distance / [mean used + mean available]). Proportions of 0.5 represented no difference between used and available, proportions  $< 0.5$  indicated mountain lions were closer to the feature than expected, and proportions  $> 0.5$  indicated mountain lions were farther from the feature than expected. We averaged selection proportions and availability values across years for individuals with feeding sites documented in multiple years. We only constructed these proportions for mountain lions for which we documented  $\geq 5$  feeding sites ( $n = 19$ ). We explored potential functional responses by modeling these resource-selection proportions (response variable) as a function of distance-based resource availability of the same resource (predictor variable, i.e. mean distance to the feature of interest across home ranges) using beta regression models with a 'probit' link which is appropriate for conducting regression on a proportional response variable. We fit 2 separate models for developed and altered-open areas using generalized additive models (GAMs) in the R package 'mgcv' version 1.8-0. We specified predictor variables as non-parametric smooth functions (splines) in the GAMs to allow for the possibility of non-linear relationships, which are often observed with functional responses [12]. However, if the relationship between the response and predictor variables was better modeled as linear (i.e. estimated degrees of freedom [edf] = 1) then predictor terms were included as parametric fixed effects [35]. Thus, because semi-parametric GAMs do not assume a linear response, they allowed us to evaluate whether selection of anthropogenic resources by individual mountain lions varied as a linear or non-linear function of availability. Small samples precluded testing for differences in functional responses between sexes. However, we visually inspected plots of the raw data to ensure that pooling sexes was not disguising obvious differences and that these relationships were qualitatively similar between sexes.

## Results

### Feeding sites

We included the locations of 420 mule deer killed by 26 mountain lions (16 males, 10 females) in our analysis. We found 229 mule deer killed by mountain lions in chaparral (55%), 91 in coastal sage-scrub (22%), 52 in upland forest (12%), 14 in prairie-meadow (3%), 8 in riparian-woodland (2%), 8 in disturbed areas (2%), 8 in altered-open areas (2%), 5 in exotic vegetation (1%), 2 in rocky outcrops ( $< 1\%$ ), 2 in developed areas ( $< 1\%$ ), and 1 in water ( $< 1\%$ ). In reality, the 1 kill classified as being in water was located close to (rather than in) water. This kill was  $< 5\text{m}$  from the edge of a water patch in our habitat layer and was classified as water because it fell within the boundary of a pixel classified as water.

### Population-level and sex-specific resource selection

Model fit for models with resource variables was considerably better than for the null model, indicating that the resource variables provided substantial information regarding resource selection at mule deer feeding sites (Table 2). There was also support for considering differences in resource selection at feeding sites between male and female mountain lions (Table 2). Model fit was best with the reduced interactions model which accounted for sex-specific differences in selection of riparian woodland, water, and developed areas (Table 2). Males selected riparian woodland and water more than females, whereas females selected developed areas marginally more than males (Table 3, Figs 2 and 3). Main effects for the resource variables fit with interactions indicated that females significantly selected developed areas, whereas they avoided riparian woodlands (Table 3). Females did not select or avoid water (Table 3). There were not significant sex-specific differences for other resource variables. Mountain lions

**Table 2. Comparison of model fit between models of varying complexity.** Shown are Akaike's Information Criteria (AIC) and differences between best model and competing models ( $\Delta$ AIC).

Model	AIC	$\Delta$ AIC
3 resource $\times$ sex interactions*	5927.7	0
All resource variables, no interactions	5934.4	6.7
All possible resource $\times$ sex interactions	5937.2	9.5
Null model	6014.1	86.4

\* Riparian woodland  $\times$  male, water  $\times$  male, developed areas  $\times$  male

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avoided higher elevations, whereas they selected steeper slopes, chaparral, and upland forests at mule deer feeding sites (Table 3). Mountain lions also marginally selected trails at mule deer feeding sites (Table 3). Sex-specific maps of the relative probability of use of mule deer feeding sites by males and females are shown in Figs 2 and 3. The best resource-selection model, with 3 sex-specific interactions, had good predictive ability as the frequency of cross-validated locations within probability bins were highly correlated with bin ranks ( $r_s = 0.85$ ).

### Functional response modeling

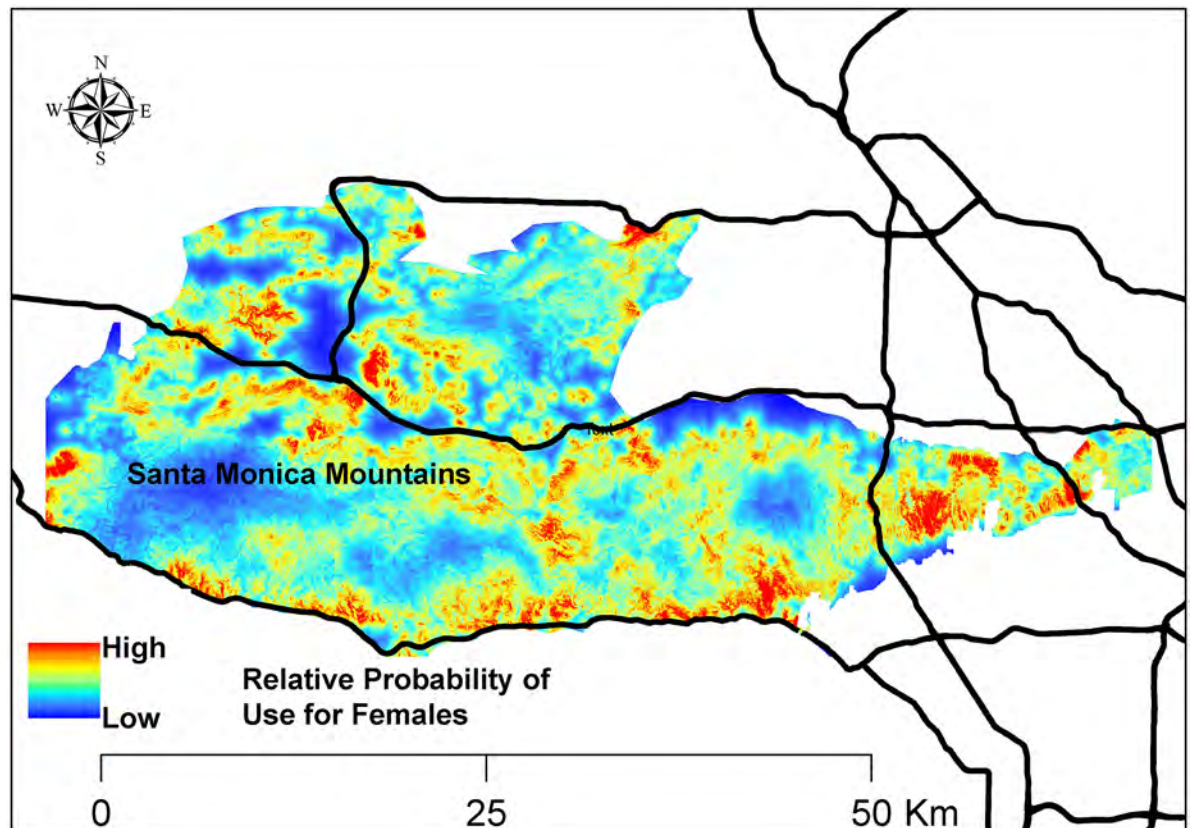
Mountain lions exhibited a functional response to developed areas at feeding sites as there was a significant, negative relationship between selection of developed areas and mean distance to developed areas within individual home ranges ( $\chi^2 = 7.89, P = 0.005$ , Deviance explained = 32.7%,  $n = 19$ ) which did not differ from a linear trend (edf = 1.0; Fig 4). In general, mountain lions selected developed areas at mule deer feeding sites more within home ranges where developed areas were less common (Fig 4). Mountain lions did not select altered-open areas as a function of their availability ( $\chi^2 = 1.0, P = 0.541$ , edf = 1.6,  $n = 19$ ).

**Table 3. Results of mixed-effect resource selection models for mountain lions at mule deer feeding sites in and adjacent to Los Angeles in southern California, 2002–2015.** Shown are  $\beta$  coefficients and 95% and 90% confidence intervals. Significant and marginally significant fixed effects, based on 95% and 90% confidence intervals, respectively, shown in bold. Note that for classification-based variables (elevation and slope) positive  $\beta$  indicate selection, negative  $\beta$  indicate avoidance. All other variables are distance-based, so negative  $\beta$  indicate selection, positive  $\beta$  indicate avoidance. Also shown are the mean values at mule deer feeding sites used by mountain lions.

	$\beta$	95% LCL	95% UCL	90% LCL	90% UCL	Mean used value
Intercept	-6.84	-7.71	-5.98	-7.57	-6.10	—
Male	-0.76	-1.88	0.36	-1.70	0.18	—
Elevation	<b>-0.93</b>	<b>-1.28</b>	<b>-0.58</b>	<b>-1.22</b>	<b>-0.63</b>	372 (m)
Slope	<b>0.23</b>	<b>0.03</b>	<b>0.44</b>	<b>0.06</b>	<b>0.41</b>	24 (%)
Water	-0.04	-0.45	0.38	-0.39	0.30	2523 (m)
Riparian woodland	<b>0.74</b>	<b>0.09</b>	<b>1.39</b>	<b>0.19</b>	<b>1.28</b>	808 (m)
Chaparral	<b>-0.97</b>	<b>-1.46</b>	<b>-0.37</b>	<b>-1.43</b>	<b>-0.51</b>	54 (m)
Prairie-meadow	-0.02	-0.26	0.23	-0.22	0.19	578 (m)
Upland woodland	<b>-0.58</b>	<b>-0.97</b>	<b>-0.18</b>	<b>-0.91</b>	<b>-0.4</b>	273 (m)
Altered open	0.06	-0.23	0.34	-0.18	0.30	651 (m)
Developed	<b>-1.05</b>	<b>-1.61</b>	<b>-0.48</b>	<b>-1.52</b>	<b>-0.58</b>	1325 (m)
Trails	<b>-0.43</b>	-0.80	0.06	<b>-0.74</b>	<b>-0.12</b>	459 (m)
Riparian woodland $\times$ male	<b>-1.06</b>	<b>-1.84</b>	<b>-0.28</b>	<b>-1.71</b>	<b>-0.40</b>	—
Water $\times$ male	<b>-0.62</b>	<b>-1.15</b>	<b>-0.09</b>	<b>-1.06</b>	<b>-0.18</b>	—
Developed $\times$ male	<b>0.66</b>	-0.04	1.37	<b>0.07</b>	<b>1.26</b>	—

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**Fig 2. Relative probability of use of mule deer feeding sites by female mountain lions in the Santa Monica Mountains and Simi Hills, southern California, 2002–2015.** Relative probability of use predicted by generalized linear mixed model of resource selection.

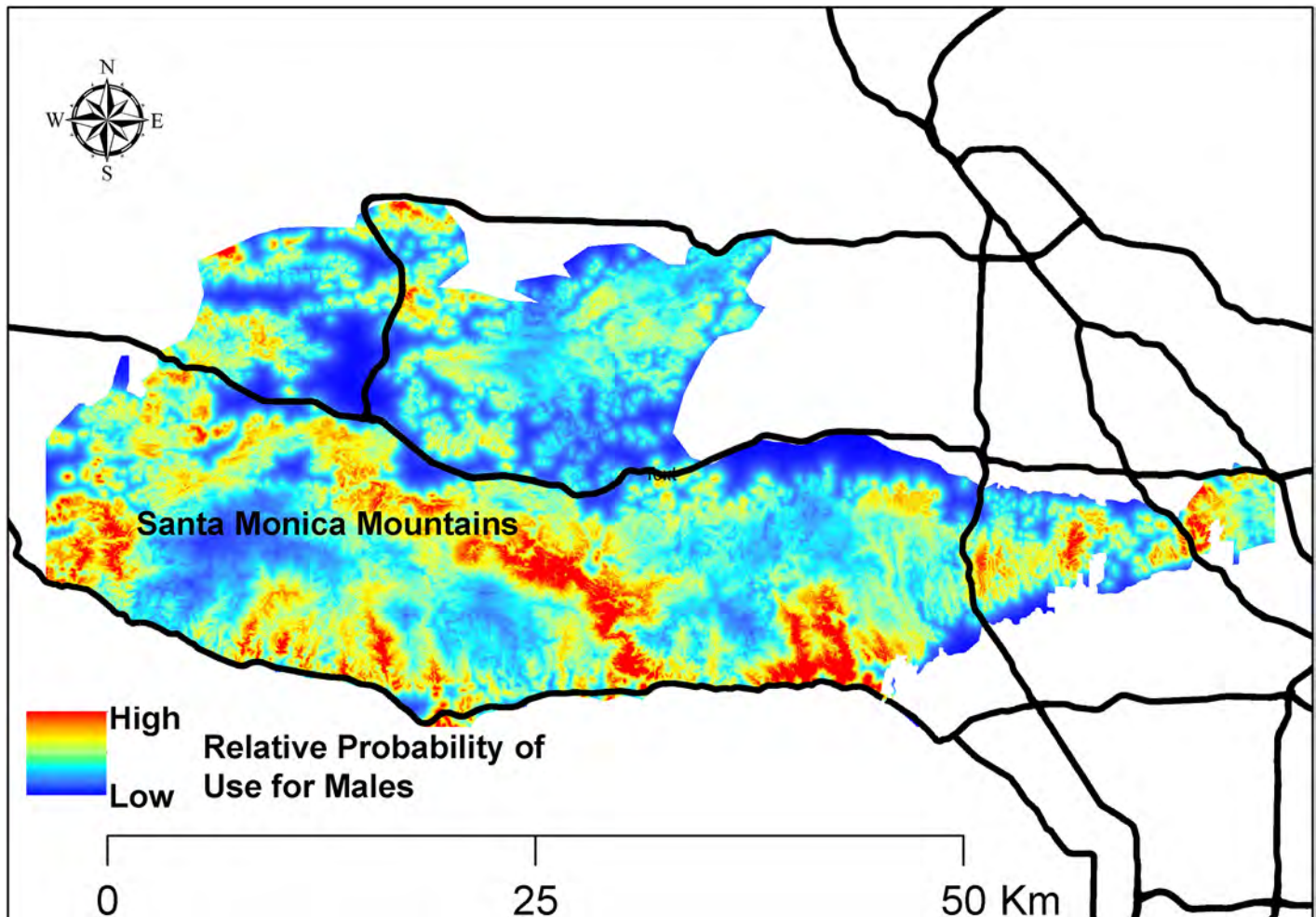
doi:10.1371/journal.pone.0158006.g002

## Discussion

Our results indicate that multiple environmental variables influence the location of mountain lion-mule deer predation events in the fragmented landscape along the urban-wildland gradient in the greater Los Angeles metropolitan area. Unfortunately no studies of mule deer have been conducted within our study area, so there is little information about mule deer abundance and distribution relative to habitat types and other environmental variables. Nonetheless, our results clearly reflect areas where mule deer were present, as well as where they were vulnerable to predation by mountain lions. Given the importance of obtaining sufficient large ungulate prey for maintaining healthy populations of mountain lions [13], understanding where mountain lions are able to kill mule deer is a valuable first-step in understanding the spatial ecology and resource selection of mountain lions in and adjacent to the Santa Monica Mountains.

Females selected mule deer feeding sites closer to developed areas at the population-level, and fed on deer marginally closer to developed areas than males, relative to availability. We point out that this selection was in a distance-based context and that no feeding sites for females were actually located within developed areas (mean distance to developed areas = 1316 m, range = 95–5165 m,  $n = 186$  sites from 10 females). Thus, female mountain lions fed on mule deer closer to developed areas than expected, rather than within developed areas. We did find 2 feeding sites for males within developed areas (mean = 1304 m, range 0–4773,  $n = 234$  sites from 16 males). Wilmers et al. [14] also documented female mountain lions selecting



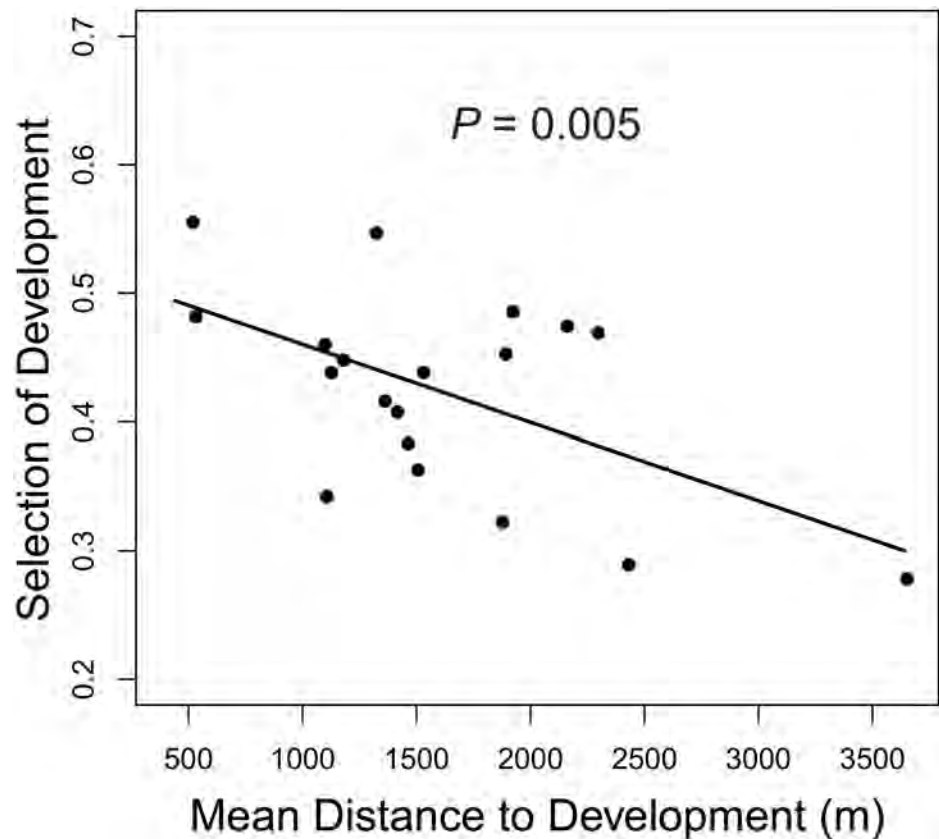


**Fig 3. Relative probability of use of mule deer feeding sites by male mountain lions selection in the Santa Monica Mountains and Simi Hills, southern California, 2002–2015.** Relative probability of use predicted by generalized linear mixed model of resource selection.

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developed areas more than males (while traveling) and suggested that deer may be more abundant in developed areas in central California. Indeed, deer are often attracted to disturbed areas and cultivated vegetation [36]. In southern California, mule deer might also be abundant near developed areas due to the paucity of natural water sources, as residences provide water from sprinklers, swimming pools, and other sources. The extreme drought in southern California from 2012–2015 may have made these anthropogenic water sources, and the relatively lush vegetation they support, particularly important to deer.

However, there was additional individual variation in the selection of developed areas at the individual-level that was consistent with a functional response in resource selection. Mountain lions with home ranges with greater availability of developed areas selected developed areas less than those in more remote areas. This finding suggests that some developed areas can be beneficial to mountain lions and further supports previous contentions that anthropogenic disturbance is associated with greater prey availability [14, 20]. However, developed areas may also represent increased mortality risk for mountain lions [37]. Thus, there may be a trade-off for mountain lions associated with development as the potential negative effects of human disturbance appeared to outweigh the benefits at higher levels of urbanization. The developed



**Fig 4. Functional response by mountain lions feeding on mule deer relative to development.**

Functional response is exhibited by the linear relationship between a selection proportion for developed areas (used distance/ used + available distance; y axis) and the mean distance to developed areas across each mountain lions home range (x axis). Selection proportions < 0.5 indicates mountain lions were closer than expected, whereas proportions > 0.5 indicate mountain lions were farther than expected from the resource relative to availability.

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areas in the highly urbanized portions of the study area, such as the densely populated neighborhoods surrounding Griffith Park and the Verdugo Mountains were characterized by higher levels of human activity and tended to be larger than developed areas in remote areas such as the Santa Monica Mountains (see Fig 1). Thus, both the size (as seen in Fig 1) and availability (quantified in our functional response analysis) of developed areas may influence where mountain lions kill mule deer. Killing and consuming deer farther from developed areas in more populated areas appears to be one way that mountain lions minimize interactions with humans in southern California.

The functional response we documented was contrary to the response exhibited by mountain lions in Alberta, where individuals decreased their avoidance of oil and gas pipelines and well sites as these features became more prevalent on the landscape [20]. There are several potential explanations for this apparent discrepancy. First, human populations and activity were considerably greater in the Los Angeles area (18.5 million people) than in west-central Alberta where populations in communities and rural areas ranged from 515–7231 people [20]. Thus, in rural areas that are relatively sparsely populated, mountain lions may select anthropogenic features more as these features become more abundant to compensate for reductions in natural habitat and to exploit potentially greater prey availability in these areas, as suggested by

Knopff et al. [20]. When human presence and development reaches higher levels, as in southern California, mountain lions may stop selecting these features or even avoid them. Second, although deer may be attracted to lower and intermediate levels of disturbance and development [14, 36], they may be less common in highly developed areas in southern California making these areas less attractive to mountain lions.

Mountain lions in general resource selection studies in Washington and central California did not exhibit functional responses to development [14, 38]. Although these studies were conducted in human-altered landscapes, the mountain lions they studied almost certainly did not encounter human population densities as high as those found within and adjacent to Los Angeles, the second largest metropolitan area in the United States. That our results differ from areas where human population sizes are lower highlights the important and unique nature of our study area where mountain lions can be studied across a steep gradient of human disturbance that spans areas from within the city of Los Angeles, to relatively remote areas of protected lands within the Santa Monica Mountains. Understanding the range of behavioral responses of mountain lions to varying levels of urbanization and human disturbance is critically important if we are to maintain healthy populations of top predators, and relatively intact ecosystems, as development, urbanization, and human populations continue to increase.

In the strongest intersexual difference documented by our analyses, males showed strong selection of riparian woodlands, whereas females avoided these areas. Riparian woodlands might be attractive to male mountain lions because they are visited by mule deer taking advantage of the relative abundance of lush vegetation in these habitat patches in the dry Mediterranean landscape. Indeed, previous studies have shown that mule deer select riparian habitat types and that they are distributed in close proximity to water and succulent vegetation [39–41]. Additionally, riparian woodlands may be used by males because they represent corridors that facilitate travel across their large home ranges as these woodlands offer vegetative cover and terrain that is likely easier to traverse than the steep ridges and rugged canyons that are common throughout the study area. Although riparian woodlands may also be attractive to females, we suspect females may have avoided them to minimize encounters with aggressive males. The leading cause of death for mountain lions in our study area is intraspecific aggression, as males often kill other mountain lions including females and their offspring [8]. Confrontations over prey carcasses are thought to be a major reason why male mountain lions kill conspecifics [13]. Interestingly, an earlier study of general habitat selection by mountain lions in the Santa Ana Mountains adjacent to Los Angeles showed that riparian woodlands were selected above all other habitats by a sample of mountain lions that was mostly females [42]. This apparent discrepancy may be explained by the fact that we studied feeding sites specifically, or because intraspecific aggression does not appear to be a major source of mortality for mountain lions in the Santa Ana Mountains [43]. Thus, the higher intraspecific mortality risk in our study area may lead to stronger intersexual differences in resource selection.

The difference in the use of water by males and females may also reflect a trade-off made by females between selecting feeding sites where prey are abundant and vulnerable, and avoiding encounters with males. Standing water in ponds and streams is relatively rare in our study area and these water sources, and the vegetation they support, likely attract abundant mule deer. Indeed, proximity to water sources was a strong predictor of mule deer fawn and doe distribution in San Diego County [40]. However, anthropogenic sources of water (e.g., pools and sprinklers) are available in our study area and also may attract deer. It is possible that males prey on deer closer to natural water sources, whereas females prey on deer closer to developed areas which represent alternative areas where water is available and deer congregate. Given that mountain lion hunting is illegal in California, and that human activity in many developed areas would be relatively low at night when mountain lions are killing and eating deer, this

trade-off could be beneficial from a fitness standpoint. However, Smith et al. [21] recently showed that females left mule deer kills sooner and compensated with higher kill rates in areas of greater development in central California. This suggests that there could be energetic costs for females preying on mule deer near developed areas. Although avoiding areas of natural habitat where deer are abundant and vulnerable may reduce intraspecific mortality risk, increased energetic expenditures associated with foraging near developed areas could potentially negatively influence fitness of females by lowering reproductive output or offspring survival.

Finally, previous studies have found that mountain lions select habitats with dense understory vegetation and noted the importance of adequate stalking cover to allow for successful hunting [14, 25, 38, 42]. Our results support these findings as chaparral, a habitat-type characterized by extremely dense shrubs, was selected by mountain lions at mule deer feeding sites and males strongly selected riparian woodlands which would also have dense stalking cover. Correlation between elevation and distance from coastal sage scrub habitat prevented us from completely separating avoidance of higher elevations and selection for coastal sage scrub. Exploratory analyses suggested both variables were important when included separately in different models, although the avoidance of higher elevation was considerably stronger than selection for coastal sage scrub. We chose to include elevation in our final model to avoid conducting regression with strongly correlated variables, but we do not suggest that coastal sage scrub is not potentially important foraging habitat for mountain lions in southern California. That 22% of the mule deer carcasses killed by mountain lions we documented were discovered in coastal sage scrub habitat highlights this point.

Our results and maps of relative probability of use of mule deer feeding sites should be incorporated into land management decisions in the Santa Monica Mountains National Recreation Area, as well as in other state, federal, city, and private parks and protected areas across the greater Los Angeles area to conserve mountain lions and naturally-functioning predator-prey dynamics. Our finding that mountain lions feed on their primary prey farther from development relative to availability as a function of increasing urbanization is broadly important because it extends understanding of how anthropogenic disturbance influences mountain lion resource selection at feeding sites with data in and around a major metropolitan area. Our results suggest that continued development in areas used by mountain lions adjacent to Los Angeles and other metropolitan areas could reduce the quality of foraging habitat for mountain lions, as they fed on mule deer farther from development when there was greater availability of developed areas within their home ranges. This functional response also indicates that, at least with respect to their behavior while preying on mule deer, mountain lions in and adjacent to Los Angeles appear to exhibit behavior that should reduce encounters and potential conflicts with humans. Our current results should be linked with analyses of resource selection by mountain lions during other activities, such as traveling and denning, to provide a more comprehensive understanding of how mountain lions use the landscape along the urban-wildland gradient in southern California. Our current model, combined with additional resource-selection analyses, could be used to evaluate the potential influence of new development projects on the relative probability of use of these areas by mountain lions.

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## Author Contributions

Conceived and designed the experiments: JFB JAS SPDR. Performed the experiments: JAS SPDR. Analyzed the data: JFB. Wrote the paper: JFB JAS SPDR.

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# Extinction vortex dynamics of top predators isolated by urbanization

JOHN F. BENSON,<sup>1,2,8</sup> PETER J. MAHONEY,<sup>3</sup> T. WINSTON VICKERS,<sup>4</sup> JEFF A. SIKICH,<sup>5</sup> PAUL BEIER,<sup>6</sup> SETH P. D. RILEY,<sup>2,5</sup>  
HOLLY B. ERNEST,<sup>7</sup> AND WALTER M. BOYCE<sup>4</sup>

<sup>1</sup>School of Natural Resources, University of Nebraska, Lincoln, Nebraska 68583 USA

<sup>2</sup>La Kretz Center for California Conservation Science, Institute of the Environment and Sustainability, University of California, Los Angeles, California 90095 USA

<sup>3</sup>School of Environmental and Forest Sciences, University of Washington, Seattle, Washington 98195 USA

<sup>4</sup>Karen C. Drayer Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, California 95616 USA

<sup>5</sup>National Park Service, Santa Monica Mountains National Recreation Area, Thousand Oaks, California 91360 USA

<sup>6</sup>School of Forestry, Northern Arizona University, Flagstaff, Arizona 86011 USA

<sup>7</sup>Department of Veterinary Sciences, University of Wyoming, Laramie, Wyoming 82071 USA

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*Abstract.* Extinction risk is elevated in small, isolated populations due to demographic and genetic interactions. Therefore, it is critical to model these processes realistically in population viability analyses (PVA) to inform local management and contribute to a greater understanding of mechanisms within the extinction vortex. We conducted PVA's for two small mountain lion populations isolated by urbanization in southern California to predict population growth, extinction probability, and loss of genetic diversity with empirical data. Specifically, we (1) provide the first PVA for isolated mountain lions in the Santa Ana Mountains (SAM) that considers both demographic and genetic risk factors and (2) test the hypothesis that variation in abundance and mortality between the SAM and Santa Monica Mountains (SMM) result in differences in population growth, loss of heterozygosity, and extinction probability. Our models predicted 16–21% probability of local extinction in the SAM due purely to demographic processes over 50 yr with current low levels or no immigration. Our models also predicted that genetic diversity will further erode in the SAM such that concern regarding inbreeding depression is warranted unless gene flow is increased, and that if inbreeding depression occurs, rapid local extinction will be highly likely. Dynamics of the two populations were broadly similar, but they also exhibited differences driven by larger population size and higher mortality in the SAM. Density-independent scenarios predicted a rapidly increasing population in the SMM, whereas growth potential did not differ from a stable trend in the SAM. Demographic extinction probability and loss of heterozygosity were greater in the SMM for density-dependent scenarios without immigration. However, higher levels of immigration had stronger, positive influences on both demographic viability and retention of genetic diversity in the SMM driven by lower abundance and higher adult survival. Our results elucidate demographic and genetic threats to small populations within the extinction vortex, and how these vary relative to demographic structure. Importantly, simulating seemingly attainable increases in connectivity was sufficient to greatly reduce extinction probability. Our work highlights that conservation of large carnivores is achievable within urbanized landscapes, but requires land protection, connectivity, and strategies to promote coexistence with humans.

*Key words:* demographic stochasticity; extinction; heterozygosity; inbreeding; mortality; population viability analysis; Puma concolor; urbanization.

## INTRODUCTION

Demographic and genetic processes, and interactions between them, influence probability of extinction for small, isolated populations (Saccheri et al. 1998, O'Grady et al. 2006). Specifically, deterministic stressors, demographic and environmental stochasticity, and

inbreeding depression can all contribute to increased extinction probability (Mills and Smouse 1994, Beissinger et al. 2008). However, the relative influence of these processes in different wildlife populations remains difficult to predict and empirical demonstrations are rare (Palomares et al. 2012, Wootton and Pfister 2013). The predicted decline to extinction of small populations from these interacting processes is referred to as the extinction vortex (Gilpin and Soulé 1986). Modeling dynamics of small, isolated populations provides critical information to local conservation efforts and also

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<sup>8</sup>E-mail: benson.johnf@gmail.com

contributes to a more general understanding of the forces influencing extinction.

All populations with small numbers of breeding individuals are likely to be destabilized by demographic stochasticity (Lande 1993, Morris and Doak 2002) and are also the most likely to suffer from inbreeding depression (Mills and Smouse 1994). However, variation in local environmental conditions, and resulting differences in demographic structure, can influence population growth, the rate at which genetic diversity is lost, and extinction probability (Stacey and Taper 1992, Reed 2005). Prior to the onset of inbreeding depression, some small populations continue to exhibit strong survival and reproduction (Benson et al. 2016a), while others suffer from poor demographic performance due to ongoing deterministic stressors (Caughley 1994). Comparing dynamics of isolated populations of the same species but of varying abundance, and with different vital rates and associated deterministic stressors, will increase our understanding of demographic and genetic processes of small populations.

Mountain lions (*Puma concolor*) exist at low density, have female-biased sex ratios, and often exhibit highly skewed male reproductive success (Johnson et al. 2010, Riley et al. 2014). These traits reduce effective population size (Mills and Smouse 1994) and have made mountain lions important study species for investigating small population dynamics (Johnson et al. 2010, Benson et al. 2016a). Indeed, one of the clearest demonstrations of inbreeding depression driving a population to the brink of extinction was with endangered Florida panthers (a subspecies of mountain lions, *Puma concolor coryi*; Johnson et al. 2010). Panthers exhibited reduced fitness from inbreeding depression and declined to fewer than 30 individuals; however, extinction was avoided and the population rapidly increased following genetic restoration (Johnson et al. 2010).

Small, isolated populations of mountain lions have also persisted within the highly urbanized landscape of southern California in the Santa Monica Mountains (SMM) and Santa Ana Mountains (SAM) northwest and southeast of Los Angeles. These two populations exhibit the lowest genetic diversity documented for the species aside from Florida panthers (Ernest et al. 2014, Riley et al. 2014). Recently, a population viability analysis (PVA) indicated that mountain lions in the SMM population exhibited strong survival and reproduction and predicted generally stable population growth for the next 50 yr (Benson et al. 2016a). However, this PVA also predicted potential for extinction due purely to demographic factors, as well as rapid loss of genetic diversity that raised concern about inbreeding depression (Benson et al. 2016a). An earlier PVA for mountain lions occupying the SAM indicated that the population was demographically unstable and that additional habitat loss would lead to a high risk of extinction (Beier 1993). This PVA explicitly considered the influence of corridors and habitat loss on extinction probability due to

demographic processes, but ignored potential effects of inbreeding depression. Furthermore, most of the demographic rates came from the literature rather than from empirical data collected within the SAM (Beier 1993). Given the isolation and low genetic diversity documented for this population (Ernest et al. 2014, Gustafson et al. 2017), as well as additional fragmentation of the available habitat that has occurred (Burdett et al. 2010), an updated PVA constructed with empirical genetic and demographic data is needed for mountain lions in the SAM to evaluate the influence of interactions between genetics, demography, and landscape connectivity in this heavily human-dominated landscape.

The SMM and SAM are both occupied by small populations of mountain lions in similar habitats isolated by anthropogenic barriers and exhibiting low levels of genetic diversity (Ernest et al. 2014, Riley et al. 2014). However, there are notable differences in demographic structure of the two populations that could have consequences for population dynamics and viability. First, the estimated number of breeding adults in the SAM was approximately twice that estimated for the SMMs (Beier 1993, Ernest et al. 2014, Riley et al. 2014, Benson et al. 2016a). Differences in abundance were clearly related to the smaller patch of available habitat within the SMM relative to the SAM (Beier 1993, Benson et al. 2016a). Importantly, smaller population and habitat island size are strong predictors of reduced genetic diversity (Frankham 1995). Second, survival rate of radiocollared adult mountain lions in the SAM, where the main cause of death was collisions with vehicles, was lower than other un hunted populations (Vickers et al. 2015). In contrast, adult survival in the SMM was as high or higher than most un hunted populations and the main cause of death was intraspecific strife (Riley et al. 2014, Benson et al. 2016a). This could have important implications because mountain lion population growth is most strongly influenced by adult female survival (Lambert et al. 2006, Benson et al. 2016a). Thus, comparing the dynamics of these populations will inform conservation efforts and provide empirical insight into the influence of variation in demographic structure (i.e., abundance and survival rate) on the relative influence of demographic and genetic processes, and how they interact to influence extinction risk. Such research would represent an important case study for understanding the dynamics of isolated populations and provide insight into management strategies for maintaining viable populations of top predators within human-dominated landscapes.

We used the individual-based population model of Benson et al. (2016a) parametrized with empirical demographic and genetic data collected during long-term studies of mountain lions in our focal populations to model dynamics and viability. We constructed starting populations with empirical, multi-locus genotypes that reflected the age, sex, and genetic structure of the current populations and projected models forward to estimate

stochastic population growth, extinction probability, and measures of genetic diversity over the next 50 yr. We used these model projections to address multiple questions regarding the viability of populations of top predators in isolated mountain ranges within highly urbanized landscapes. First, we investigated the dynamics and viability of mountain lions in the SAM to evaluate the influence of demographic and genetic processes on probability of extinction. Second, we hypothesized that variation in population abundance and mortality patterns in small, isolated mountain lion populations would result in differences in population growth, the rate of loss of genetic diversity, and extinction probability. We predicted that reduced adult survival would result in lower population growth and greater extinction probability due purely to demographic processes (P1a). We also tested the alternative prediction that the greater number of breeding adults and carrying capacity in the SAM would offset the lower survival and result in similar growth and extinction probability between the two populations (P1b). Next, we predicted that genetic diversity would erode more quickly in the SMM population given the smaller number of individuals and smaller amount

of available habitat (P2). Finally, we predicted that reductions in vital rates due to inbreeding depression would result in high probability of extinction for both populations (P3). We provide the first PVA for mountain lions in the SAM that explicitly models both demographic and genetic processes. More broadly, our results elucidate how variation in abundance, carrying capacity, vital rates, and sources of mortality influence mechanisms underlying the extinction vortex for isolated populations in fragmented landscapes. Thus, our work provides a case study that will help to inform conservation of isolated wildlife populations in human-dominated landscapes.

## MATERIALS AND METHODS

### *Study area*

We studied mountain lions in two isolated mountain lion populations occupying mountain ranges southeast (SAM: Orange, Riverside, and San Diego Counties) and northwest (SMM: Los Angeles and Ventura Counties; Fig. 1) of the city of Los Angeles. The SAM population



FIG. 1. Greater Los Angeles, southern California, USA showing the location of the Santa Monica (blue polygon) and Santa Ana (red polygon) Mountains within which we studied population dynamics of mountain lions. Also shown are other nearby mountain ranges, major (white lines) and more minor (gray lines) roads, and areas where natural habitat has been replaced by urbanization (dark gray) and agriculture (lighter gray).



inhabited approximately 1,533 km<sup>2</sup> in the SAM, a portion of the Peninsular Ranges including federal, state, county, and private lands. The SMM population inhabited approximately 600 km<sup>2</sup> in the Santa Monica Mountains, part of the Santa Monica Mountains National Recreation Area, a unit of the National Park Service that included an assemblage of federal, state, and privately owned lands. The areas occupied by both populations were bordered by a combination of anthropogenic (freeways, development, agriculture) and natural (Pacific Ocean) barriers that have drastically restricted movement of mountain lions between the populations and surrounding areas. Both were characterized by a Mediterranean climate, with cool, wet winters and hot, dry summers. Vegetation consisted mainly of mixed chaparral, coastal sage scrub, oak woodlands and savannahs, riparian woodlands, and nonnative annual grasslands. Mountain lions were the only remaining large carnivore and the only wild ungulates were mule deer (*Odocoileus hemionus*). Both study areas have been described extensively elsewhere (Burdett et al. 2010, Riley et al. 2014, Vickers et al. 2015, Benson et al. 2016b).

#### *Capture and monitoring*

We captured mountain lions using Aldrich foot-snares or cable restraints, baited cage-traps, or by treeing them with trained hounds. We deployed global positioning system (GPS) or very high frequency (VHF) radio-collars on adult and subadult mountain lions. In the SMM, we also captured 3–5 week old kittens at natal dens by hand and implanted VHF transmitters in their peritoneal cavities (Moriarty et al. 2012). We monitored survival and determined causes of mortality of radio-instrumented mountain lions as described previously (Beier and Barrett 1993, Vickers et al. 2015, Benson et al. 2016a). We monitored reproduction of all collared females in the SMM using GPS telemetry to locate natal dens and count kittens (Moriarty et al. 2012). In the SAM, all capture and handling was conducted under Protocol 10950/PHS, Animal Welfare Assurance number A3433-01, with capture and sampling procedures approved in Protocol number 17233 by the Animal Care and Use Committee at the University of California, Davis, and Memoranda of Understanding and Scientific Collecting Permits from the California Department of Fish and Wildlife (CDFW). In the SMM, animal capture and handling protocols were approved by the National Park Service Institutional Animal Care and Use Committee under protocol PWR\_SAMO\_Riley\_Mt.Lion\_2014.A3.

#### *Genotyping*

We genotyped all captured mountain lions at 44 (SAM) or 54 (SMM) microsatellite loci using laboratory methods and markers described previously (Ernest et al. 2014, Riley et al. 2014). Briefly, we extracted DNA from

blood or tissue using DNeasy Blood & Tissue Kit (QUIAGEN, Valencia, California, USA). The loci used for genotyping mountain lions in both populations conformed to expectations for Hardy-Weinberg and linkage equilibria (Ernest et al. 2014, Riley et al. 2014). We used many of the same genotypes analyzed by Ernest et al. (2014) and Riley et al. (2014) to parameterize our model but also included genotypes from mountain lions captured more recently. We also genotyped mountain lions from samples obtained from areas adjacent to our focal populations to simulate immigration in our models.

#### *Demographic parameters*

We separated mountain lions into three age classes for parameter estimation. Kittens were dependent offspring with their mother (0–14 months), subadults were independent animals prior to reproduction (females, 14–25 months; males, 14–42 months), and adults were breeding animals (females, >25 months; males, >42 months; Benson et al. 2016a). We estimated sex and age-class specific survival rates using the Kaplan-Meier estimator generalized for staggered entry (Pollock et al. 1989) implemented in R version 3.1.3 (R Development Core Team 2015) with the package “survival”. We estimated survival for adults and subadults separately for the SMM and SAM using empirical data from each population. We used survival data collected during 1987–1993 (Beier and Barrett 1993) and 2003–2016 (Vickers et al. 2015; T. W. Vickers et al., *unpublished data*) for the SAM, and during 2002–2015 for the SMM (Riley et al. 2014, Benson et al. 2016a). Females in the model bred in the first month after reaching adulthood and again following loss or independence of kittens, consistent with documentation in our field study (Benson et al. 2016a). We estimated the probability of females having two, three, or four kittens in a litter based on the proportion of these litter sizes documented in the SMM during 2004–2017 (all input demographic parameters are shown in Appendix S1: Table S1). Although the samples sizes used to estimate demographic parameters were relatively small numerically, they should be representative given the small size of the populations.

#### *Model overview*

We used the individual-based population model for mountain lions of Benson et al. (2016a) that incorporated demographic and environmental stochasticity, as well as a simple form of density dependence. We did not have data to understand the influence of catastrophes on vital rates of mountain lions in these populations, so our model assumes these unpredictable events do not occur during our projections. We began models with starting populations of individuals that reflected the sex, age, and genetic structure of the populations and projected the models forward to estimate the demographic and genetic structure of future populations. In the SAM, we

combined information from published estimates of population density and available habitat, as well as information from our ongoing 15-yr field study to assemble the starting population. Beier and Barrett (1993) and Beier (1993) estimated 2,070 km<sup>2</sup> of available habitat for the SAM population. We adjusted this estimate by subtracting 506 km<sup>2</sup> to remove the Chino Hills that are now isolated from the SAM by highway 91 and no longer occupied by mountain lions (Fig. 1). We further reduced the available habitat by 2% to reflect habitat loss during 1993–2017 based on estimates of Burdett et al. (2010). Thus, our estimate of available habitat for mountain lions in the SAMs was 1,533 km<sup>2</sup>. Beier and Barrett (1993) estimated mountain lion density to be 0.7 females and 0.35 males/100 km<sup>2</sup>. We applied estimates of mountain lion density (0.7 females and 0.35 males/100 km<sup>2</sup>; Beier and Barrett 1993) to our habitat area estimate, which yielded 11 adult females and 5 adult males. We also included 9 kittens and 4 subadults. Although we did not formally estimate population density in our study, the abundance:habitat area ratios we used from Beier and Barrett (1993) agreed with observations made using telemetry, genetic analysis, and camera trapping during our intensive 15-yr study. We assigned empirical genotypes at 44 loci to all starting individuals in the SAM. The starting population for the SMM population was 15 mountain lions (including 5 adult females and 2 adult males) with empirical genotypes at 54 loci as described by Benson et al. (2016a).

We ran simulations consisting of 5,000 population projections of 50 yr unless noted otherwise. Although researchers sometimes attempt to predict extinction probability farther into the future (e.g., 100 yr), we followed the recommendation of Morris and Doak (2002:452) to avoid projecting population viability far into the future because of the increased uncertainty of predictions made over longer time periods. The population dynamics simulated by the model were a reflection of individual-based demographic processes specified by empirical probability distributions estimated with data collected in both populations. We imposed mortality (survival senescence) on all mountain lions of both sexes in the model that reached 15 yr of age (Benson et al. 2016a). We incorporated density dependence by imposing a maximum number of adult, breeding males (SMM,  $n = 2$ ; SAM,  $n = 5$ ) and females (SMM,  $n = 6$ ; SAM,  $n = 11$ ) that could exist in the population at any given time. For the SMM, we felt confident that our estimates were the maximum numbers of breeding individuals that could occupy the available habitat. The greater area and size of the SAM population contributed to uncertainty in our carrying capacity estimates; thus, we also explored an alternate scenario with a greater carrying capacity of 7 adult males and 14 adult females. For all scenarios, when all the adult slots of a given sex were occupied, we eliminated individuals of that sex that would have otherwise transitioned from sub-adults to adults. This process simulated density-dependent population regulation

through death or dispersal. Although the upper limits for adult males and females were fixed, the number of adults varied stochastically during model projections due to variation in survival and reproduction. When breeding occurred within the model, we assigned genotypes to resulting offspring based on principles of Mendelian genetics (i.e. 1 allele randomly inherited from each parent at each loci). Additional details of the model and submodels are provided by Benson et al. (2016a).

### Submodels

*Survival.*—We incorporated environmental and demographic stochasticity into age-class-specific survival rates as in Benson et al. (2016a). Specifically, we generated environmentally stochastic monthly survival probabilities by transforming survival rates and their standard deviations estimated from each study population into beta shape parameters using the betaval function in the R package popbio. At each monthly time step, we drew a random survival value from this beta distribution, which was used as the environmentally stochastic survival probability for all individuals of the same sex and age class during that time step. We then assessed demographically stochastic survival of each individual using a Bernoulli trial with the monthly survival probability as the threshold between survival and mortality.

*Reproduction.*—We designated reproductive males and females in the starting population and, thereafter, randomly selected breeding animals from subadults eligible to transition to adults when openings became available. Female age at first reproduction varied stochastically between 25 and 33 months in our model. Males reaching breeding status remained reproductive until death. If no adult males were present in our simulated populations, males were allowed to begin breeding at 36 months as the reason for delayed breeding in males is presumably due to social constraints imposed by dominant adult males. Breeding females were eligible to become pregnant until death whenever they did not have dependent offspring. Litter size varied stochastically by generating a random, uniform value between 0 and 1 for each reproductive female and comparing the value to a cumulative probability distribution for litter sizes we documented. We determined the sex of each offspring using a Bernoulli trial with a probability of 0.5.

*Immigration.*—We assigned a fixed annual immigration rate prior to starting a simulation. We transformed this into a monthly probability and assessed immigration stochastically using Bernoulli trials during each monthly time step. We restricted immigration to subadult males. Subadult males are more likely to disperse and to undertake longer and riskier dispersal events than females (Sweaner et al. 2000). Indeed, all immigration documented into the SMM and SAM populations has involved subadult males (Riley et al. 2014, Gustafson

et al. 2017). We assigned genotypes to immigrants from mountain lions genotyped in adjacent areas north and east of the SMMs ( $n = 18$ ) and east of the SAM ( $n = 83$ ). We modeled different immigration scenarios ranging from no immigration to a rate of one immigrant per year for our main analyses. We also modeled immigration rates for both populations based on immigration observed with radio-tracking and genetic analysis of mountain lions within and adjacent to our focal populations. Specifically, we observed two immigrants in 15 yr in the SMM (Riley et al. 2014; S. Riley et al., *unpublished data*) and three immigrants in 15 yr in the SAM (Gustafson et al. 2017). We were conservative with respect to modeling how much additional immigration could occur in our main analyses so we limited these to 1 immigrant per year. However, we also conducted additional scenarios to explore the hypothetical influence of two immigrants per year. For additional details of all submodels see Benson et al. (2016a).

#### Model outputs

**Demography and extinction.**—We estimated  $\lambda_t$  (Lambda [population growth] at time  $t$ ) as  $N_t/N_{t-1}$ , where  $N_t$  is total population size at time  $t$ . We estimated  $\lambda_s$  (stochastic lambda) across time periods of interest with the formula:

$$\frac{\left[\sum^{N_{\text{years}}} \ln(\lambda_t)\right]}{N_{\text{years}}}$$

We report median  $\lambda_s$  from the distribution of values across all projections for simulations of interest. We estimated credible intervals for  $\lambda_s$  using the highest posterior density (HPD) derived using the R package coda (v. 0.17-1). We estimated probability of extinction as the proportion of projections that went extinct during a given simulation and derived estimates of variability by conducting a nonparametric bootstrapping procedure implemented in the R package boot (v. 1.3-17). We ran 1,000 bootstraps of 5,000 population projections to estimate uncertainty regarding extinction probability with 95% HPD intervals. We estimated the effective population size based on a census of the breeding animals in simulated populations using the formula:  $N_e = (4 \times N_{\text{BF}} \times N_{\text{BM}}) / (N_{\text{BF}} + N_{\text{BM}})$  (Crow and Kimura 1970), where  $N_e$  is the effective population size,  $N_{\text{BF}}$  is the number of breeding females, and  $N_{\text{BM}}$  is the number of breeding males.

**Genetic parameters.**—We estimated measures of genetic diversity from genotypes of mountain lions in populations simulated by our models 1–50 yr in the future using mean values across all projections. Specifically, we estimated expected ( $H_e$ ) and observed ( $H_o$ ) heterozygosity, individual inbreeding coefficient ( $F_{is}$ ), the mean number of alleles per loci ( $N_A$ ), and the proportion of polymorphic loci using the R package adegenet v. 2.0.0.

Our genetic predictions varied stochastically because they were realistically linked to the stochastic demographic processes we modeled. Thus, by running 5,000 projections for each scenario, our models captured considerable environmental, demographic, and genetic stochasticity.

**Elasticity analysis.**—We investigated proportional sensitivity (elasticity) of  $\lambda_s$  to small (5%) increases in vital rates (Morris and Doak 2002). We conducted these analyses with the density-independent model to investigate which demographic parameters had the greatest influence on  $\lambda_s$  in the absence of density-dependent limitations. We calculated sensitivity values ( $S$ ) for each demographic parameter:

$$S = \frac{\text{Log}\lambda_s(\text{increased}) - \text{Log}\lambda_s(\text{original})}{\text{parameter}(\text{increased}) - \text{parameter}(\text{original})}$$

and elasticity ( $E$ ) for each demographic parameter following Morris and Doak (2002):

$$E = S \times \left( \frac{\text{parameter}_{\text{original}}}{\text{parameter}_{\text{adjusted}}} \right).$$

**Inbreeding depression.**—We simulated inbreeding depression by running population projections with input parameters reduced to reflect proportional changes in age- and sex-specific survival rates documented between inbred and outbred Florida panthers following the genetic restoration program (Hostetler et al. 2010, Benson et al. 2011; see Appendix S2: Table S1).

## RESULTS

### Population viability in Santa Ana Mountains

Density-dependent simulations predicted stable median stochastic population growth over the next 50 yr in the SAM, regardless of the level of immigration (Table 1). However, there was an 11–21% probability of extinction across all immigration scenarios in the density-dependent simulations, inversely related to the level of immigration (Table 1, Fig. 2). The scenarios without immigration, or with the low level observed in our study, resulted in substantial loss of genetic diversity (e.g., 28–49% of expected heterozygosity) over 50 yr (Fig. 3; Appendix S3, S4). Predicted loss of heterozygosity decreased with higher levels of immigration, and heterozygosity was largely maintained with one immigrant per year (Fig. 3; Appendix S3: Table S1, Appendix S4: Fig. S1). Other measures of genetic diversity including percent polymorphism, inbreeding coefficient, and the number of alleles per loci responded to varying degrees of isolation and immigration similarly over time (Appendix S3: Table S1). When we explored the influence of a larger carrying capacity in the SAM (7 adult males and 14 adult females), population growth



TABLE 1. Demographic results predicted by individual-based population model for mountain lions in the Santa Ana and Santa Monica Mountain, Southern California, USA.

Parameter	No immigration		Observed immigration		1 immigrant/2 yr		1 immigrant/1 yr	
	Estimate	95% HPD†	Estimate	95% HPD†	Estimate	95% HPD†	Estimate	95% HPD†
<b>Santa Anas</b>								
$\lambda_s$ ‡	1.00	0.89, 1.01	1.00	0.95, 1.01	1.01	0.93, 1.02	1.01	0.95, 1.02
Extinction probability	0.22	0.20, 0.23	0.16	0.15, 0.17	0.11	0.10, 0.11	0.08	0.07, 0.09
Time to extinction (yr)	31	12, 50	31	11, 50	33	13, 50	33	13, 50
Adults ( $n$ )§	8	0, 11	9	0, 15	9	0, 15	10	0, 15
$N_E$ §	6	0, 11	6	0, 12	6	0, 12	7	3, 14
<b>Santa Monicas</b>								
$\lambda_s$ ‡	1.00	0.89, 1.02	1.01	0.93, 1.02	1.01	0.98, 1.02	1.01	1.00, 1.02
Extinction probability	0.29	0.28, 0.30	0.16	0.15, 0.17	0.04	0.04, 0.05	0.02	0.01, 0.02
Time to extinction (yr)	31	13, 50	31	13, 49	33	12, 50	32	11, 48
Adults ( $n$ )§	5	0, 8	5	0, 8	6	0, 8	7	4, 8
$N_E$ §	4	0, 6	4	0, 6	4	0, 6	5	3, 6

Notes: Estimates are median or mean estimates at year 50 based on 5,000 population projections. HPD, highest posterior density;  $\lambda_s$ , stochastic population growth. † 95% highest posterior density credible intervals. ‡ Median value. § Effective population size (mean value).

rate was similar ( $\lambda_s = 1.01$  [0.92, 1.02]), but extinction probability was reduced (10% with observed level of immigration; Appendix S5: Table S1). All immigration scenarios with higher carrying capacity yielded lower probability of extinction, ranging from 12% with no immigration to 5% with one immigrant per year (Appendix S5: Table S1). Loss of genetic diversity slowed slightly and effective population size increased with greater carrying capacity, although diversity still declined substantially with no immigration or the observed level (Appendix S5: Table S2). Simulating inbreeding depression in the SAM by reducing age-specific survival rates proportional to reductions documented in inbred Florida panthers, resulted in rapidly declining population growth ( $\lambda_s = 0.84$ , [0.61, 0.96]), 100% probability of extinction over fifty years, and median time to extinction of 11.7 yr (5.2, 23.5; Fig. 4).

*Comparing dynamics of SAM and SMM*

Median stochastic population growth rate predicted by the density-dependent scenarios was similarly stable in the two populations (Table 1, Fig. 2). However, the density-dependent scenarios for both populations also predicted extinction probabilities of 16–28% over 50 yr with no or observed immigration (Table 1, Fig. 2). Extinction probability due purely to demographic processes was reduced for both populations with higher levels of immigration, but more so for the SMM (Table 1, Fig. 2). Density-independent scenarios predicted a rapidly increasing population in the SMM ( $\lambda_s = 1.17$  [1.11, 1.22]), whereas the predicted trend in the SAM did not differ from stable ( $\lambda_s = 1.06$  [0.89, 1.12]; Fig. 5). Sensitivity and elasticity analysis showed that adult female survival had the strongest influence

on density-independent population growth in both populations (Appendix S6: Table S1). Female subadult survival, female kitten survival, and litter size had moderate influence on population growth for both populations, whereas male survival parameters had little influence (Appendix S6: Table S1). When we explored the influence of two immigrants per year, extinction probability was further reduced and genetic diversity increased beyond the starting values in 50 yr (Appendix S7: Tables S1, S2).

Genetic diversity declined rapidly in both populations with no or observed immigration (Fig. 3; Appendix S3, S4). No immigration resulted in a greater loss of genetic diversity for SMM (57% loss expected heterozygosity) compared with SAM (49% loss; Fig. 3; Appendix S3, S4). However, the SMM population responded more strongly to increased levels of immigration as with one immigrant every 1–2 yr, the SMM retained more of its genetic diversity over 50 yr relative to the SAM (Fig. 3; Appendix S3, S4). Similar to the SAM, simulating inbreeding depression in the SMM resulted in predictions of declining population growth ( $\lambda_s = 0.89$ , [0.75, 0.96]), high probability of extinction (>99%) over 50 yr, and rapid median time to extinction (15.1 yr; Fig. 4).

DISCUSSION

Our modeling predicted a 16–21% probability of local extinction for mountain lions in the SAM over the next 50 yr with the low level of immigration observed in our study or no immigration. Thus, demographic and environmental stochasticity leave the SAM population vulnerable to extinction even before considering inbreeding depression, consistent with earlier predictions for this population (Beier 1993). Furthermore, our results

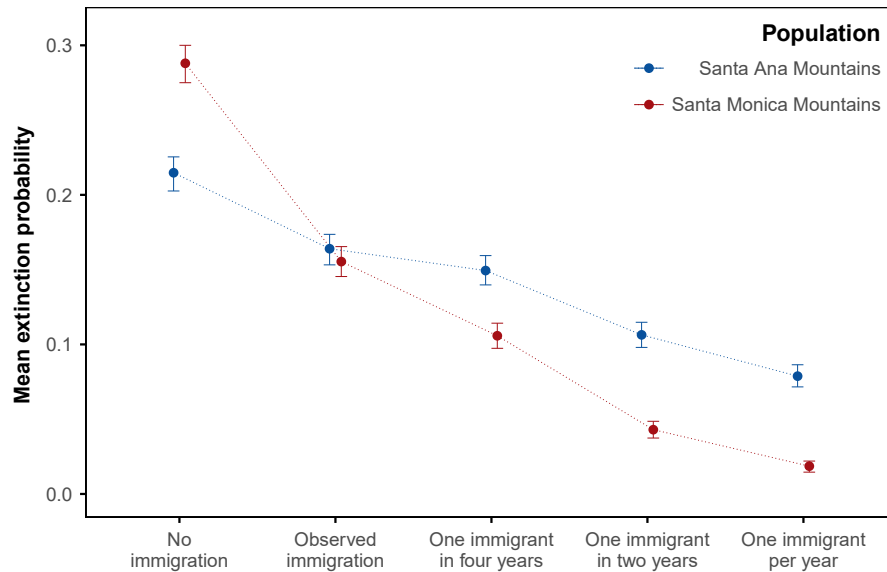


FIG. 2. Estimated extinction probability (without considering potential inbreeding effects) in 50 yr for mountain lion populations in the Santa Ana and Santa Monica Mountains from an individual-based population model based on 5,000 projections and varying levels of immigration.

suggest that, unless gene flow is increased, genetic diversity will rapidly erode in the SAM, and that, if inbreeding depression occurs rapidly, local extinction will be highly likely. We acknowledge that it is impossible to predict exactly when inbreeding depression will occur in a wild population, but our predictions with respect to genetic diversity are alarming and far surpass proportional losses of heterozygosity suggested by previous researchers to warrant concern regarding inbreeding depression (e.g., 5–10% loss in 100 yr; Soulé et al. 1986, Allendorf and Ryman 2002). Importantly, our predictions suggest that the loss of genetic diversity in SAM mountain lions in the next 50 yr will approach proportional losses experienced in another population of the same species (Florida panthers) that nearly went extinct due to poor demographic performance associated with inbreeding depression (Johnson et al. 2010; Appendix S4). Simulating a higher carrying capacity of 7 adult males and 14 adult females resulted in reduced extinction probability and slowed the loss of heterozygosity, highlighting benefits of even small increases in additional habitat and number of breeding adults (Frankham 1995). However, even with higher carrying capacity and abundance, the model predicted a 10% probability of extinction and 24% loss of expected heterozygosity over 50 yr.

Dynamics of the SAM and SMM populations were broadly similar, but our simulations revealed differences in their dynamics caused by variation in deterministic stressors, survival rates, and population abundance. The density-independent scenarios provided partial support for our prediction that lower survival in the SAM would negatively influence growth rate (P1a). Clearly, density independence is unrealistic given the

space limitations experienced by both populations; however, these scenarios were instructive to compare growth potential and dynamics. Density-independent models predicted a rapidly increasing population for the SMM, whereas density-independent  $\lambda_s$  in the SAM did not differ significantly from a stable trend. Extinction probability was approximately three times greater (5.6%) in the SAM compared to the SMM (1.8%) in the absence of density dependence. Furthermore, in our density-dependent scenarios, higher levels of immigration (1–2 per year) in the SMM raised the credible interval of  $\lambda_s$  above 1, predicting a slightly increasing trend, whereas credible intervals overlapped 1 for all predictions of  $\lambda_s$  in the SAM, even with similarly high levels of immigration (Table 1; Appendix S7: Tables S1, S2). Clearly, realized population growth is limited by available habitat in both populations, but growth potential also appears to be limited by high human-caused mortality in the SAM. The leading cause of death for radiocollared mountain lions in the SAM was vehicle strikes, which did not differ in frequency by age or sex class, and resulted in high mortality of adults (Vickers et al. 2015). Although poor adult male survival had relatively little influence on density-dependent population growth, it influenced extinction probability by causing male extinction in some simulations for this small population with a female-biased adult sex ratio. These dynamics appear to be realistic as there was evidence of occasional male extinction in the SAM during previous research (Beier 1993). Conversely, adult survival of both sexes was high in the SMM where population growth appears to be mainly limited by the lack of additional habitat. Subadults survive poorly in the SMM due to the difficulty of successfully

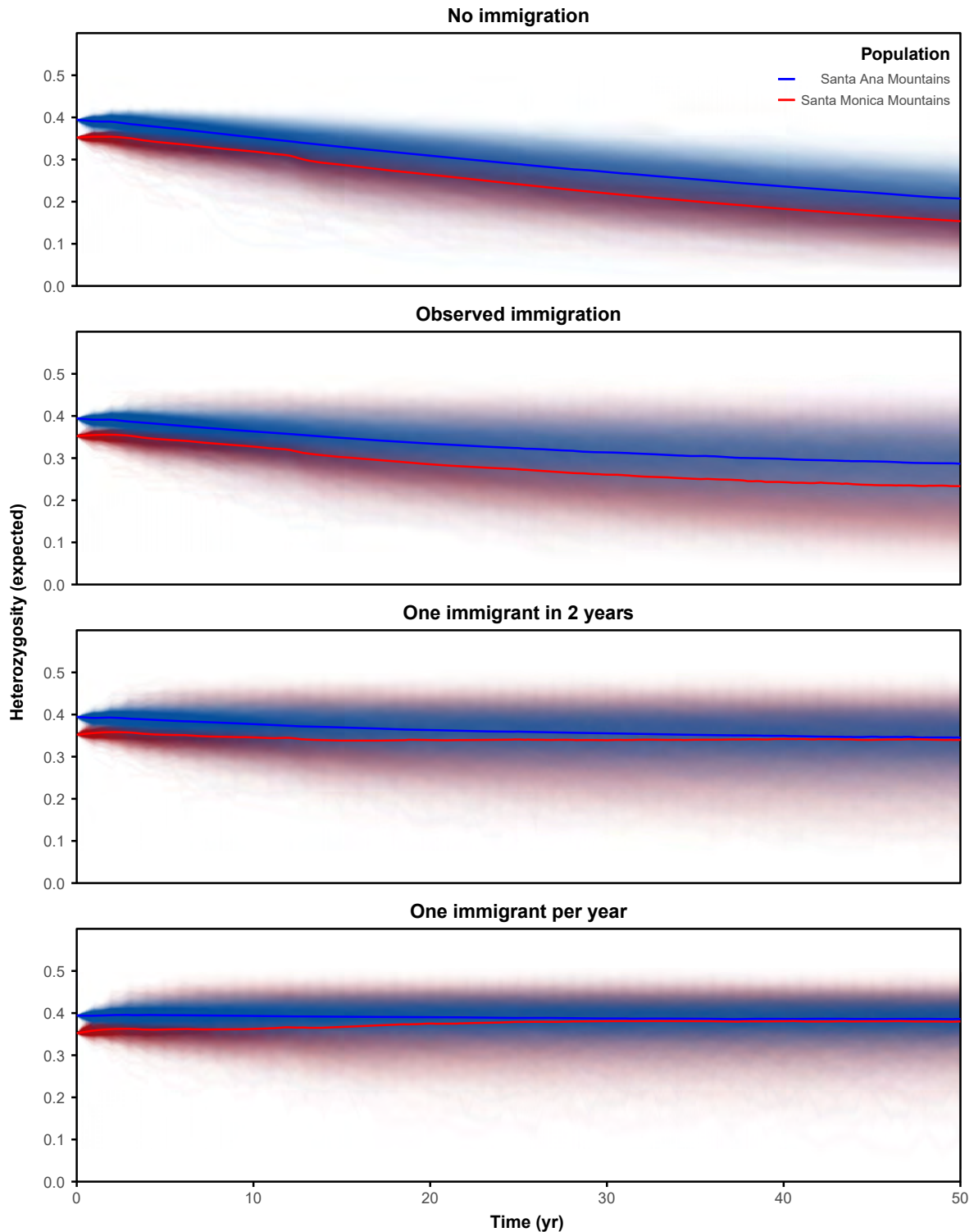


FIG. 3. Estimated expected heterozygosity over 50 yr for mountain lion populations in the Santa Ana and Santa Monica Mountains from and individual-based population model based on 5,000 projections and varying levels of immigration.

dispersing, as many young animals are killed by breeding males or hit by vehicles before or during dispersal (Riley et al. 2014). The difficulty of dispersal,

combined with high survival of breeding adults in a space-limited population provides few opportunities for mountain lions born in the SMM to breed.

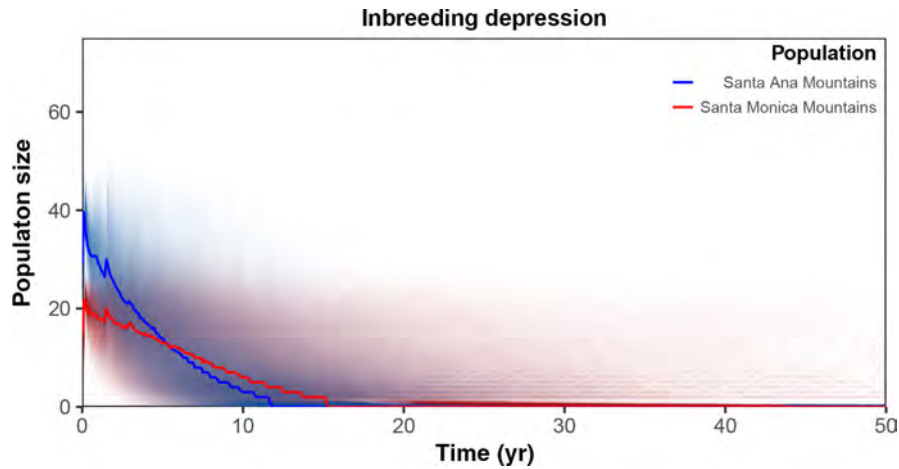


FIG. 4. Density-dependent demographic projections from individual-based population model showing predicted population sizes for mountain lions in the Santa Ana and Santa Monica Mountains over 50 yr based on 5,000 projections when we simulated inbreeding depression with the observed level of immigration.

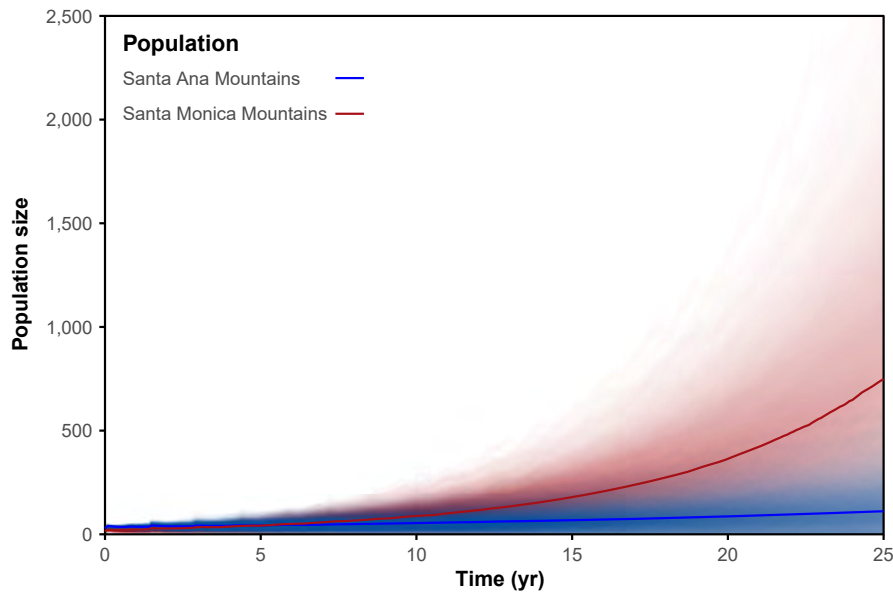


FIG. 5. Density-independent demographic projections from individual-based population model showing predicted mountain lion population size in the Santa Ana and Santa Monica Mountains over 25 yr based on 5,000 projections.

The SMM population had a slightly higher probability of extinction with no immigration than the SAM in our density-dependent scenarios, but increasing immigration resulted in a more pronounced reduction in extinction probability for the SMM. In fact, with one immigrant per year, extinction probability in the SMM did not differ from that predicted by the density-independent model suggesting that increased connectivity could largely mitigate the effects of isolation and limited habitat in the SMM, at least with respect to demographic extinction risk. The lesser positive impact of immigration on demographic extinction probability in the SAM was likely associated with the lower survival of

adult males, which meant that tenure of immigrants successfully establishing as breeding adults was often short-lived. Although these comparisons were useful for evaluating the influence of variation in demographic structure on the dynamics of small populations, we recommend cautious interpretation of these differences for practical purposes. Indeed, predictions regarding extinction probability from PVA are probably best viewed as relative assessments (Morris and Doak 2002).

The greatest long-term threat to both populations appears to be the rapid loss of genetic diversity associated with their isolation from mountain lions in surrounding areas. With no immigration, the predicted rate

of loss of expected heterozygosity over 50 yr was greater for the smaller SMM population relative to the SAM population. This provided support for our prediction (P2) and is consistent with theoretical and empirical work indicating that population abundance and habitat island size are strong, positive predictors of genetic diversity (Crow and Kimura 1970, Frankham 1995). However, with immigration rates observed during the last 15 yr, predicted loss of heterozygosity was similar in the two populations. Importantly, simulating increased immigration and gene flow had a stronger positive influence on heterozygosity in the smaller SMM population. Thus, although heterozygosity is lost more rapidly in smaller populations, immigration events can also more quickly reverse these losses and restore diversity. In the SMM, only one or two males generally breed at any one time, such that when a radiocollared male immigrant entered the population in 2009 and began breeding it resulted in a rapid increase in population-level genetic diversity (Riley et al. 2014). A single breeding immigrant also positively influenced genetic diversity in the SAM (Gustafson et al. 2017), and relatively few immigrants have similarly influenced small populations of other large mammals (Vilà et al. 2003, Hogg et al. 2006, Adams et al. 2011). However, the key to maintaining diversity in small populations is to ensure that immigration occurs consistently (Mills and Allendorf 1996), to prevent reversal of short-term diversity gains as immigrants begin breeding with their offspring (Riley et al. 2014, Benson et al. 2016a). In addition to the larger population size, lower adult survival likely contributed to a reduced positive influence of immigration on genetic diversity in the SAM by limiting the reproductive success of immigrants. This finding further highlights the link between demographic and genetic factors in terms of influencing extinction in small populations. Despite interesting differences, we stress that our models predict rapid loss of diversity in both populations, indicating that viability will likely be compromised by interactions between genetics and demography unless gene flow is increased.

Mountain lions are not endangered in southern California and genetically diverse populations of mountain lions exist in areas such as the Sierra Nevada Mountains and other mountain ranges in southern California (Ernest et al. 2014, Riley et al. 2014). However, there is value to conserving viable populations of a native top predator within the SAM and SMM to maintain stable predator-prey dynamics and naturally functioning ecosystems within these isolated mountain ranges. This contention echoes growing recognition among ecologists and managers that conservation efforts should prioritize ecological function and maintaining ecosystem processes across extensive geographic areas, rather than simply preserving minimum viable populations somewhere across the range of a species (Soulé et al. 2003, Ritchie et al. 2012). Predators and other highly interactive species may be especially important to conserve in as many places as

feasible to maintain important species interactions and ecosystem functions (Soulé et al. 2003, Lindenmayer et al. 2008, Cadotte et al. 2011). Indeed, research from around the world has begun to highlight the potential for conserving large predators within human-dominated landscapes (Athreya et al. 2013, Chapron et al. 2014, Riley et al. 2014). Our work suggests that conserving mountain lions in isolated mountain ranges in greater Los Angeles is feasible with relatively modest increases in landscape connectivity. If achieved over the long-term, this would be an important step toward maintaining intact, functioning ecosystems in these mountain ranges that lie within one of the most human-impacted landscapes in the world.

Our results suggest mitigation strategies for mountain lions in SAM and SMM should target two main threats: isolation and mortality. Increasing connectivity between both populations and the areas across the freeways should (1) decrease extinction probability due purely to demographic processes, and (2) maintain genetic diversity and prevent the onset of inbreeding depression. Translocation of outbred animals can be effective to quickly increase genetic diversity in threatened mountain lion populations (Johnson et al. 2010), but strategically located highway crossing structures (Gloyne and Clevenger 2001) allowing for dispersal and gene flow could be a more comprehensive long-term strategy. Our results suggest that maintaining genetic diversity in these populations would require at least one migrant every 1–2 yr. Given the expense of erecting highway crossing structures, translocation would certainly be a less expensive strategy, especially in the short-term. Indeed, the estimated cost for a bridge to connect the SMM population with habitat north of the 101 Freeway (Fig. 1) is approximately US\$60 million. However, our results indicate that animals would need to be translocated frequently and indefinitely if connectivity is not improved, whereas a highway crossing structure would provide long-term connectivity once erected. Furthermore, populations of other species are also isolated by the freeways and other barriers surrounding these habitat islands (Delaney et al. 2010, Riley et al. 2006). Thus, construction of highway crossing structures, although unquestionably an expensive initial investment, would likely provide regular, consistent immigration of mountain lions and many other species that should increase the likelihood of maintaining healthy populations and intact ecosystems within these isolated mountain ranges. However, we certainly do not discount the value of translocation as a management tool. Translocation may be an especially valuable option if proposed development further degrades or prevents improvement of currently available passageways, and if the significant financial challenges delay construction of new crossing structures. As a specific example, extensive residential and resort development projects have been proposed for construction in the primary corridor area that has facilitated some movement of mountain lions between the SAM and habitat east of the



Interstate Highway 15 (Gustafson et al. 2017). Our results show that further reduction in immigration and gene flow, which are likely to occur with new development in corridor areas, would increase demographic extinction probability and hasten the loss of genetic diversity.

Our sensitivity analyses and inbreeding simulations show that increased mortality could have rapid, negative consequences for population growth and extinction probability in both populations, supporting our prediction (P3). Despite the smaller population size, predicted demographic extinction probability in the SMM was generally similar to that in SAM under the current levels of immigration largely because of the strong growth potential afforded by higher adult female survival. If female mortality increases in future years from the multitude of mortality agents documented in the SMMs (e.g., aggression from males, vehicle strikes, rodenticide poisoning) this could destabilize the population and increase extinction probability. Thus, reducing mortality in both populations is important and should decrease probability of extinction due to environmental and demographic stochasticity. In addition to highway crossing structures, exclusionary fencing strategically implemented along roadways where mountain lions are killed can be effective at reducing mortality (Foster and Humphrey 1995), such as that recently constructed along SR 241 in the SAM (Vickers et al. 2015). Strategies to promote best practices for housing domestic animals could reduce mortality from depredation permits issued to kill mountain lions threatening livestock (Vickers et al. 2015). To reduce mortality in the SAM and SMM from depredation mortality, the California Department of Fish and Wildlife (CDFW) has recently changed policies regarding depredation permit issuance in these two populations such that non-lethal deterrence methods must be attempted before lethal removal can occur (CDFW 2017).

Differences in demographic structure between the two populations revealed important aspects that have contributed to their persistence and highlighted management priorities for both populations. The greater demographic vigor of the SMM population is critical to its persistence, as a population with six to eight adults would clearly be at much higher risk of local extinction if survival and reproduction declined. Thus, in addition to management efforts to reduce mortality from documented causes such as vehicle strikes and rodenticide (Riley et al. 2014), it would be prudent to evaluate and monitor population dynamics of their main prey (mule deer) in the SMM to ensure the prey base remains adequate to support strong survival and reproduction. Greater population abundance in the SAM reduced demographic extinction probability and slowed the erosion of genetic diversity in simulations without immigration. Thus, the larger population size is beneficial to the persistence of mountain lions in the SAM, especially during periods when no immigration occurs. If

additional habitat loss or fragmentation reduced the number of breeding adults that could occupy the SAM, this would have negative consequences for both demographic extinction risk and loss of genetic diversity. For instance, a population as small as the SMM population, but with the poor survival of the SAM would have a higher probability of extinction than we documented for either population. As noted above (see *Model overview*), both habitat loss and isolation appear to have reduced the population size over the last 25 yr. Our model results suggest it is critical to ensure that future habitat loss in the SAM is prevented and that fragmentation does not isolate portions of the current population.

Although our model realistically models demographic and genetic processes in these small populations with empirical data, we acknowledge that our model and data have limitations. For instance, although we were able to account for demographic and genetic processes, density dependence, and varying levels of immigration, we did not have sufficient data to understand the influence of catastrophes on the vital rates and viability of these populations. Two unpredictable forces that could potentially cause catastrophes include wildfires and disease outbreaks. Wildfires have become larger and more frequent in southern California shrubland ecosystems, and increasingly destructive wildfires appear to be linked to expansion of the urban-wildland interface (Keeley et al. 1999). Wildfires have directly caused mortality of mountain lions within our study populations (Vickers et al. 2015) and can also temporarily displace mountain lions (Jennings et al. 2016; S. P. D. Riley and J. A. Sikich *unpublished data*). Previous research on Iberian lynx (*Lynx pardinus*) has noted the potential that outbreaks of disease such as feline leukemia and reduced immune response associated with low genetic diversity could negatively affect population viability (Millán et al. 2009, Palomares et al. 2012). We note that catastrophic mortality associated with wildfires, disease, or other unpredictable events could substantially increase extinction probability above the predictions generated by our model.

Our results demonstrate that small populations isolated by freeways and urbanization are subjected to elevated extinction risk due to interactions between demography and genetics. We agree with previous authors that demographic and genetic risk factors for small populations should not be considered in isolation (Mills and Smouse 1994, Soulé and Mills 1998) and that both must be addressed in any comprehensive wildlife conservation strategy within urbanized landscapes (Benson et al. 2016a). Indeed, other small, isolated populations of felids are threatened by a combination of limited habitat and mortality, such as the highly endangered Iberian lynx (Ferrerás et al. 2001). Inbreeding depression and extinction vortex dynamics are also concerns for Iberian lynx, and their conservation will require restoring habitat and improving demographic parameters (Palomares et al. 2012). As urbanization increases globally, it



will be necessary to (1) protect habitat patches large enough to facilitate persistence of populations of large carnivores, (2) mitigate anthropogenic deterministic stressors, and (3) restore and maintain connectivity within and between habitat patches if we are to maintain populations and ecosystem processes (e.g., predator–prey interactions) within urban landscapes (Crooks 2002). Our results also show that relatively small changes in abundance and key demographic parameters can influence loss of genetic diversity as well as extinction probability due to non-genetic processes. The difficulty of conserving top predators in the modern world are well documented (Woodroffe 2000, Ripple et al. 2014) and our work further details the demographic and genetic challenges facing large carnivores in human-dominated landscapes. Yet our results also provide reason for optimism, as seemingly realistic increases in gene flow appear sufficient to substantially reduce probability of extinction of top predators due to combined demographic and genetic threats within the second largest metropolitan area in the United States. Long-term conservation of mountain lions in greater Los Angeles would provide compelling evidence that large carnivores and abundant human populations are compatible, even within the most intensely developed landscapes.

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## SUPPORTING INFORMATION

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## DATA AVAILABILITY

Data are available on Zenodo: <https://doi.org/10.5281/zenodo.2548917>

## **An evaluation of a mitigation strategy for deer-vehicle collisions**

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## An evaluation of a mitigation strategy for deer-vehicle collisions

John A. Bissonette & Silvia Rosa

High mule deer *Odocoileus hemionus* mortality in southwestern Utah led to the establishment of a mitigation strategy with two major objectives: 1) reduction of wildlife-vehicle collisions and 2) restoration of landscape connectivity to facilitate wildlife movement across the roaded landscape. During our study, we assessed the effectiveness of the mitigation measures in reducing mule deer mortality in the following ways: 1) we compared the number of deer-vehicle collisions in the newly fenced area with a control area without fencing; 2) we analyzed the 'end-of-the-fence' problem, defined here as increased mortality of mule deer at the ends of the 2.4-m high exclusion fences; and 3) we evaluated the frequency of animal crossings of the new underpasses using remotely-sensed cameras and compared them with crossing frequency rates for a 20-year-old control underpass. We compared six years of pre-construction mortality (during 1998-2003) with two years of post-construction data on mortality (during 2005-2006) and found a 98.5% decline in deer mortalities in the treatment (i.e. fenced, jump-outs and underpasses) vs a 2.9% decline in the control (i.e. no fences, no jump-outs and no underpasses). We detected no end-of-the-fence problems related to deer mortality. Migratory movements during fall and spring were clearly reflected in the use of underpass. Overall results demonstrated that the mitigation strategy was effective and reduced the number of deer-vehicle accidents, while allowing wildlife movement across the landscape.

*Key words:* crossing structures, end-of-the-fence problem, escape ramps, exclusion fencing, landscape connectivity, mitigation, mortality, mule deer, *Odocoileus hemionus*, road-kill, underpasses, wildlife-vehicle collisions

John A. Bissonette & Silvia Rosa\*, U.S. Geological Survey - Utah Cooperative Fish and Wildlife Research Unit, Department of Wildland Resources, College of Natural Resources, Utah State University, Logan, Utah 84322-5290, USA - e-mail addresses: john.bissonette@usu.edu (John A. Bissonette); silviarosa2007@gmail.com (Silvia Rosa)

\*Present address: Praceta Infanta Dona Beatriz, nº4, 1ª ESQ 2800-263 Almada, Portugal

Corresponding author: John A. Bissonette

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The increase in animal-vehicle collisions worldwide is a reflection of the increased anthropogenic transformation of the landscape. Current estimates of the total landscape transformed by human influences (e.g. forest removal, agricultural activities including crop planting and livestock grazing) range from 39 to 50% of the total earth surface (Vitousek et al. 1997). When Riitters & Wickham (2003) measured the proximity of different land-cover types in the U.S. to the proximity of a road using nine distance classes, they found that the proportion of land area within a defined distance to a road increased rapidly with distance. Of all land area in the U.S., 50% was within 382 m of a road; only 18% was > 1,000 m of a road. Clearly, as road density increases as a function of

human development, so does mean animal proximity to roads. The U.S. has a mean road density of 0.75 km/km<sup>2</sup> with concomitant habitat loss, animal mortality, isolation and barrier effects (Jaeger & Fahrig 2004, Jaeger et al. 2005, Row et al. 2007).

As road networks have expanded, so have traffic volumes, which have been linked to deer mortality (Gunson et al. 2006). In the U.S., traffic volumes in 1998 totaled 2,625,367 × 10<sup>6</sup> vehicle miles; in 2007 traffic volume had increased to 3,003,218 × 10<sup>6</sup>, ~ a 14.4 % increase (Available at: <http://www.fhwa.dot.gov/ohim/tvtw/07dectvt/page2.htm>). For Utah, annual vehicle-miles traveled (VMT) in 2007 totaled 26.8 billion miles (Available at: <http://www.udot.utah.gov/main/f?p=100:pg:0:::V,T:,530>), an in-

crease of ~ 26.4 % from the 1998 VMT of 21.2 billion miles.

One of the most evident effects of the increased traffic volume on wildlife is the increased number of wildlife-vehicle collisions (Bissonette & Cramer 2008, McCollister & van Manen 2010). Even though Skölving (1987), Berthoud (1987) and Seiler (2005) suggested that high traffic volumes tended to cause road avoidance by animals; nevertheless, nationwide estimates of 1.1 million deer-vehicle collisions (DVCs) during the period between 1 July 2008 and 30 June 2009, or ~ 21,150/week (State Farm Insurance Company® 2009), reveal the growing importance of the problem in the U.S. When seven years of data were recalculated in 3-year time steps to smoothen extraordinary high or low years of DVCs, 2006-2009 showed a 15.3% increase over the previous three years. The comparable figure for Utah is 25%. State Farm® estimated that the likelihood of any vehicle colliding with a deer in 2010 was 1:208 for the U.S. and 1:404 for Utah. In the Intermountain West, wildlife-vehicle collisions primarily involve ungulates in general and mule deer *Odocoileus hemionus* in particular. In Utah, mule deer numbers have declined generally over the past several decades with current estimates of < 300,000 animals, from an estimated 500,000 deer in the 1950s (Utah Department Wildlife Resources 2009).

In 2003, to increase driver's safety, reduce deer mortality and provide deer access to their traditional seasonal ranges across I-15, three agencies (Utah Division of Wildlife Resources (UDWR), Utah Department of Transportation (UDOT) and the Bureau of Land Management (BLM)) jointly created a mitigation strategy that included three integrated actions: 1) construction of two wildlife underpasses, 2) construction of exclusion fencing and 3) installation of 1-way earthen escape ramps. The underpasses were constructed to allow below-grade road crossing, thereby reducing the putative barrier effect created by wildlife exclusion fencing and the road (Foster & Humphrey 1995, Bruinderink & Hazebroek 1996, Jaeger & Fahrig 2004). Exclusion fencing is seldom, if ever, 100% effective, even with continued maintenance (Putman 1997), so earthen 1-way escape ramps were constructed being spaced ½ mile apart to allow deer that accessed the fenced right-of-way (ROW) an escape route. The overall objectives of the mitigation were to improve driver safety, reduce the number of DVCs and to restore landscape connectivity for migrating deer.

For the mitigation strategy to be considered ef-

fective and because formally established criteria were unavailable, we established three *a priori* criteria. First, DVCs on the treatment section needed to be reduced by  $\geq 70\%$ . We chose this threshold based on studies of mule deer in northern Utah (Lehnert 1996, Lehnert et al. 2008) and reductions in mortality observed in successful mitigations strategies elsewhere (McDonald 1991, Clevenger et al. 2001). Second, there should not be an increase in DVCs at the ends of the exclusion fencing (i.e. the so-called 'end-of-the-fence' problem; Bellis & Graves 1971, Clevenger et al. 2001). Third, because of habituation, there should be an increase in underpass use by deer, and use should increase with time (Ward 1982).

We conducted a study using six years of pre-construction data (1998-2003) and three years of post-construction data (2004-2006). We examined if fences and escape-ramps jointly reduced deer mortality on the road, and if underpasses were used by mule deer during seasonal migrations. We evaluated the prediction that the average change in mortality in the treatment area was equal to or lower than in a control area.

### Study area

Our study area was located on I-15 in southern Utah, between the I-15 and I-70 interchange at Mile Post (MP) 132 and MP 112 just north of Beaver (Fig. 1). This area was paired with a control area located between MP 137 and MP 144. I-15 is a four-lane divided paved interstate highway. These stretches of road historically have had heavy deer mortality (Kassar 2005). In this area, deer traditionally migrated east to summer ranges at higher elevations, and west to winter ranges at lower elevations, frequently crossing I-15. The upgrade of this road to an Interstate in the 1960s and 1970s blocked the traditional migratory route, causing considerable deer mortality (B. Bonebrake, Utah Division of Wildlife Resources, pers. comm. and unpubl. data), and coupled with heavy traffic volumes disrupted the migratory routes. Annual Average Daily Traffic (AADT) for the study site in 1998 was 12,835 vehicles/day; in 2009 it was 16,680 vehicles/day, an increase of 30% (Available at: <http://www.udot.utah.gov>). Despite the high kill, deer continued to cross the highway during the spring and autumn migrations and as a consequence, a 9.6 km stretch of road (MP 121-126) still recorded heavy mortality. The surrounding habitat included patches of big sagebrush *Artemisia tridentata*, pinyon pine *Pinus edulis*, juniper *Juniperus osteosperma*, agricultural



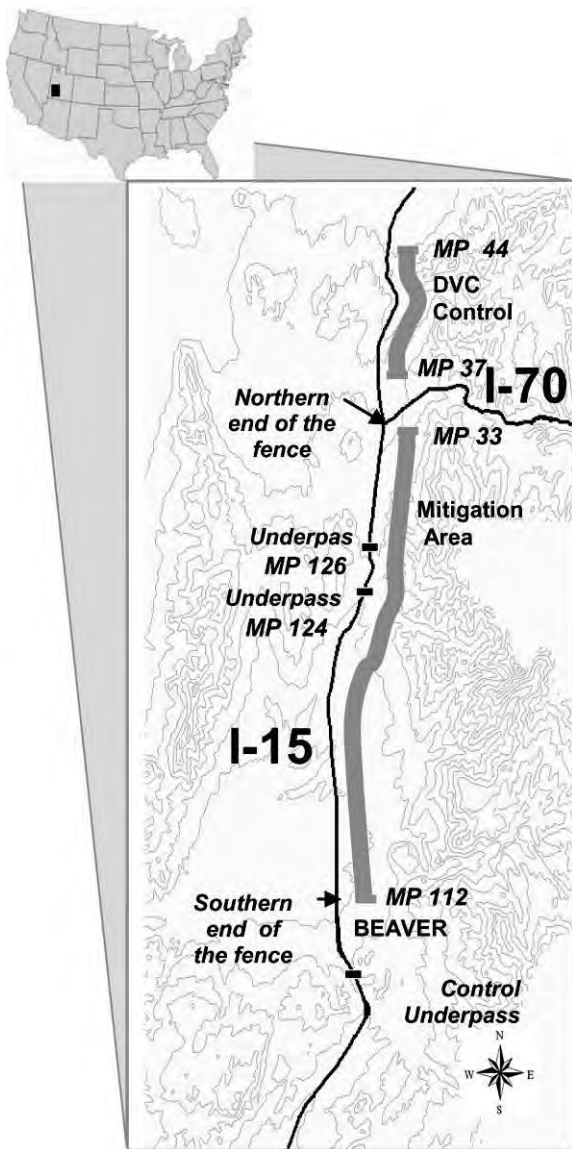


Figure 1. Study area location in southern Utah, USA, showing the location of deer-vehicle collision (DVC) control area, mitigation area, monitored underpasses and fence extension in the study area.

fields and small towns. The posted speed limit on I-15 in the area was 120.7 km/hour (75 mph).

### Mitigation strategy description

Mitigation construction started in spring 2004 and ended in autumn 2004. Construction crews erected a 2.44-m (eight feet) deer-exclusion fence on both sides of the road during summer 2004 from MP 112 to 132. Additional fencing extended the northern end of the fence to MP 133 during the summer of 2005 to prevent deer from accessing the highway via the I-15 - I-

70 interchange. Construction crews installed earthen escape ramps ( $N = 64$ ) throughout the 32.2 km stretch of the study area at approximately 0.81 km (0.5 mile) intervals. Two underpasses specifically designed for wildlife were constructed and placed at the hotspot areas of greatest kill according to prior data on mortality of deer. Underpass 1 (UP1) was constructed at MP 126, and Underpass 2 (UP2) at MP 124 (see Fig. 1). Both structures were oval-shaped tunnels, made of corrugated metal, with large open middle areas. UP 1 (Fig. 2A) had an openness-ratio score of 3.68 (6.55 m height x 11.13 m width/19.82 m length) in each tunnel section and incorporated a dirt road with recreational traffic. UP2 (Fig. 2B) had an openness-ratio score of 1.62 (4.23 m height x 8.12 m width/21.23 m length) in each tunnel section and was designed solely for wildlife use. Foster & Humphrey (1995) and Clevenger & Waltho (2005) suggested that crossings with higher openness ratios were more likely to be used by large mammals. UP 2 followed the topography of Wildcat Creek (but was not impacted by the stream) and hence the two parts of the underpass were not aligned (see Fig. 2B). We baited the new structures irregularly with alfalfa hay, apples and salt blocks placed near the entrances at the beginning of the migrations in spring and fall to encourage use by deer.

## Method

### Mitigation monitoring

#### *Deer-vehicle collisions*

To assess the joint effects of fencing and escape ramps in reducing mortality of mule deer on the road, we analyzed carcass-removal counts before and after mitigation. Data from carcass-removal surveys from UDOT databases were available. Contract personnel removed deer carcasses from the road in an average of four times per month from 1998 to 2006. To distinguish mitigation effects from the usual yearly fluctuation of road mortality, we monitored a similar control area located north of the study area (MP 137-144; see Fig. 1). This area had high mortality, but no exclusion fencing. We used a Before-After-Control-Impact (BACI) approach to assess if variation on road mortality was related to the intervention (Eberhardt 1976, Green 1979). By itself, a drop in mortality on the treatment area would not necessarily be a consequence of the mitigation, but a higher proportional decrease of mortality when compared



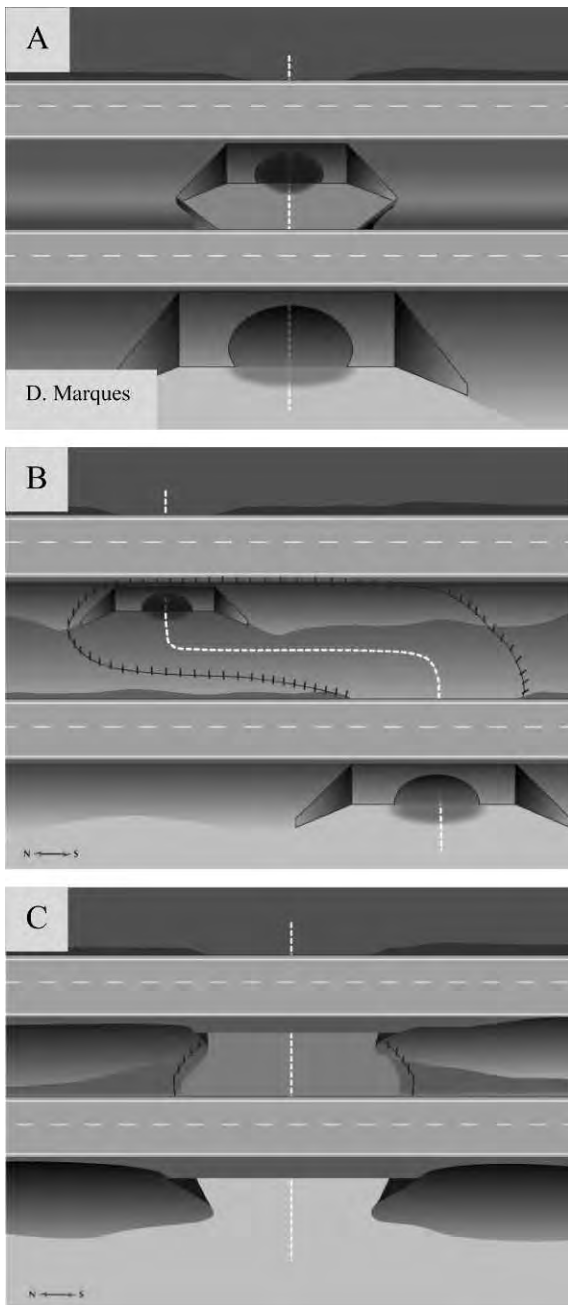


Figure 2. Schematic representation of underpasses monitored in the study area on I-15, southern Utah, USA. (A: UPI; B: UP2, C: Control UP). Images ©Diana Marques (www.dianamarques.com).

with a control area would reflect a successful mitigation. We compared the annual DVC average for six years before and two years after construction. For each year, we estimated difference in mortality counts between control and treatment areas by using T-tests, and corrected for multiple comparisons. We compared mortality before and after mitigation for the

duration of the study, averaged by year and during autumn (October-January) and spring migrations (April-July), and we assessed whether the mitigation was effective in reducing mortality at the hotspot area (MP 120-126) by comparing annual averages of deer mortality before and after the mitigation. To test if end-of-the-fence problems existed (mortality that occurred within 2.4 km (1.5 miles) at either end of the fence), we compared annual deer mortality before and after the mitigation at the northern (MP 131-134) and the southern (MP 111-113) ends of the fence.

#### *Underpass use*

We monitored a 20-year-old control underpass (Control UP) to compare mule deer use between new and established structures. The Control UP was located south of the study area (MP 103) in a similar mule deer migration area (see Fig. 1). The Control UP (see Fig. 2C) was comprised of two double-span bridges with an openness-ratio score of 4.43 each (4.12 m height  $\times$  21.49 m width/20 m length) and a large open median area. This Control UP was in a more remote area, did not have a dirt road under it and an exclusion fence was present. Mule deer and elk *Cervus elaphus* use had been previously reported.

We placed Reconyx® cameras (digital, triggered by motion and heat, with infrared illumination) inside the median of each underpass to record animal crossings. We chose camera placement to assure approximately equal photo capture probabilities in all the structures and camouflaged them by mounting inside locked urban electric boxes to reduce the probability of damage or theft. We equipped cameras with 512 Mb memory cards, which were examined on average twice each month from October 2004 to August 2006. We set the cameras for maximum sensitivity, with a 2-second lag between triggers and one picture/trigger. We sampled four migration periods (autumn: October - November 2004; spring: April - June 2005; autumn: September - November 2005; spring: April - June 2006).

We used camera data to: 1) characterize overall use of the structures and 2) estimate deer crossing frequency and temporal variation. We categorized all photos into classes (mule deer, humans, cattle and other wildlife). We used photos taken of mule deer to estimate use and changes with time. Because all cameras were fully functional for > 90% of the monitoring period (i.e. a total of 678 days), the results constitute a census rather than sample data. As a result, null hypotheses and significance testing have

little theoretical interpretation (Berger 1985, Gill 2001). Thus, analysis of underpass use and changes over time are primarily descriptive, using summary statistics and simple  $\chi^2$  tests. Throughout this paper, we employed simple statistics, following the advice of Guthery (2008) and Thompson (2010).

Generally speaking, mule deer are not individually identifiable by unique external characteristics (e.g. pelage markings). This impeded the estimation of the exact number of different individuals using the structures and the frequency at which the same individuals crossed. Therefore, we only counted the total number of crossings detected. We also noted direction of the crossings: west to winter ranges and east to summer ranges. We calculated the net number of crossings from the difference between crossings recorded in each direction. We used net crossings to monitor changes in movement in either direction through time. This allowed the detection of migration periods as well as changes in use of new underpasses.

We used SPSS 15.0.1 (2006) for all analyses. Animal welfare protocols were followed according to Utah State University IACUC Protocol Number 1139. Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

## Results

### Deer-vehicle collisions

The BACI analyses of carcass removal data indicated that reduction in DVCs was related to the mitigation and not to stochastic annual oscillations in mortality in the study area. To be conservative, we included 2004 in the post-treatment analysis, even though the mitigation was not completed until late in the year. We documented a significant decrease in annual DVC levels ( $t = 4.244$ ,  $P = 0.004$ ,  $df = 7$ ) that corresponded to a 77% reduction in mortality after the mitigation (Fig. 3A). We calculated a Cohen's  $d$  of 2.32 with an effect size  $r = 0.757$ . DVC levels in spring decreased ( $t = 2.903$ ,  $P = 0.027$ ,  $df = 7$ ) corresponding to a 96% mitigation-induced reduction in mortality (Fig. 3B). Finally, DVC levels in autumn were similarly reduced ( $t = 2.463$ ,  $P = 0.049$ ,  $df = 7$ ) to levels that corresponded to 76% of the original mortality (Fig. 3C). If we consider 2004 as a transition year and include only 2005 and 2006 mortality in our post-construction analysis, with 1998-2003 as the pre-construction period, we found a

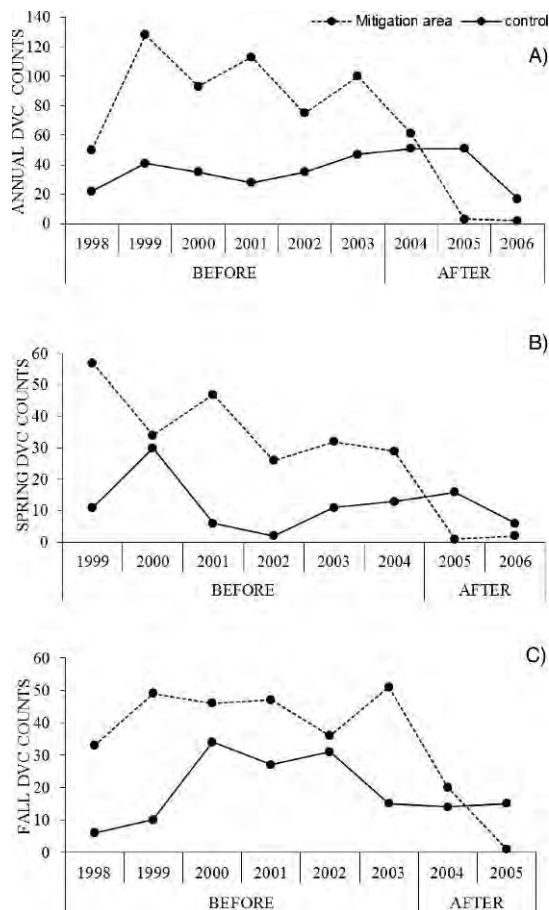


Figure 3. Deer-vehicle collision (DVC) counts in control and mitigated areas on an annual basis (A), during spring (B) and fall (C). The dashed line represents mitigation strategy implementation. Data from UDOT deer carcass removals on I-15 in southern Utah, USA.

98.5% decline in deer mortalities in the treatment and a 2.9% decline in the control (i.e. from a  $\bar{x} = 93$  kills pre-construction to a  $\bar{x} = 3$  mortalities post-construction). Additionally, we did not document an increase of mortality at the ends of the exclusion fences. We observed lower levels of mortality at the northern end ( $t = 2.831$ ,  $P = 0.022$ ,  $df = 7$ ) and equal levels of mortality in the southern end ( $t = 1.274$ ,  $P = 0.238$ ,  $df = 7$ ); thus, DVC levels were not higher at either end of the fence when compared to non-fenced areas.

### Underpass use

We documented considerable differences in underpass use between the underpasses. From a total of 47,759 pictures (UP1: 18,829, UP2: 14,421 and Control UP: 14,509, respectively), we noted similar-

ities between UP2 and the Control UP and a different pattern of use in UP1. UP1 had the highest level of human use, differing significantly from UP2 ( $\chi^2 = 7,910, P < 0.001$ ) and the Control UP ( $\chi^2 = 8,010, P < 0.001$ ). It also had the lowest number of mule deer detections both in absolute and proportional terms when compared with UP2 ( $\chi^2 = 5,238, P < 0.001$ ) and to the Control UP ( $\chi^2 = 1,782, P < 0.001$ ). In UP2 and the Control UP, we recorded a higher proportion of deer use and frequently detected other wildlife (e.g. coyotes *Canis latrans*, desert cottontail rabbits *Silvilagus audubonii* and birds). Elk were detected only in the Control UP. UP 2 and the Control UP differed in proportion of cattle ( $\chi^2 = 1,687, P < 0.001$ ) and mule deer ( $\chi^2 = 906, P < 0.001$ ). Deer and cattle used the Control UP simultaneously  $< 10$  times. Occasionally, deer and elk were detected using the structure at the same time.

Deer exhibited similar crossing behaviour in all the structures. They would either enter the structure to cross the road directly, or remained in the proximity of the structure, crossing several times in either direction. In the new structures, some photos showed active use of alfalfa, with deer groups frequently spending up to an hour feeding. In the Control UP, movements were direct, but water and salt accumulations often caused deer to remain inside the structure for periods of  $> 2$  hours. Photo evidence showed that deer were often startled by traffic when inside the structures.

We identified two different types of deer movement (Fig. 4A). During certain periods, deer exhibited what appeared to be residential daily movements, crossing in equal numbers east and west. For example, in the Control UP (see Fig. 4A) from December through March, deer displayed a similar number of crossings in each direction. During migration (October-May), however, deer crossed disproportionately more in one direction than the other. When we analyzed UP1 (Fig. 4B) and UP2 (Fig. 4C), we noted that higher numbers of crossings during migratory periods were not as evident in the new structures compared with the control. Nonetheless, both UP1 and UP2 showed spring migratory movements in May 2005 and 2006.

We documented four migratory movements (Fig. 5). We did not detect migratory activity through UP1 and UP2 during the first migration period in autumn 2004 when the mitigation activities were not yet complete. Subsequent migrations, however, did occur through the new crossing structures and were similar in timing to the Control UP. The frequency of

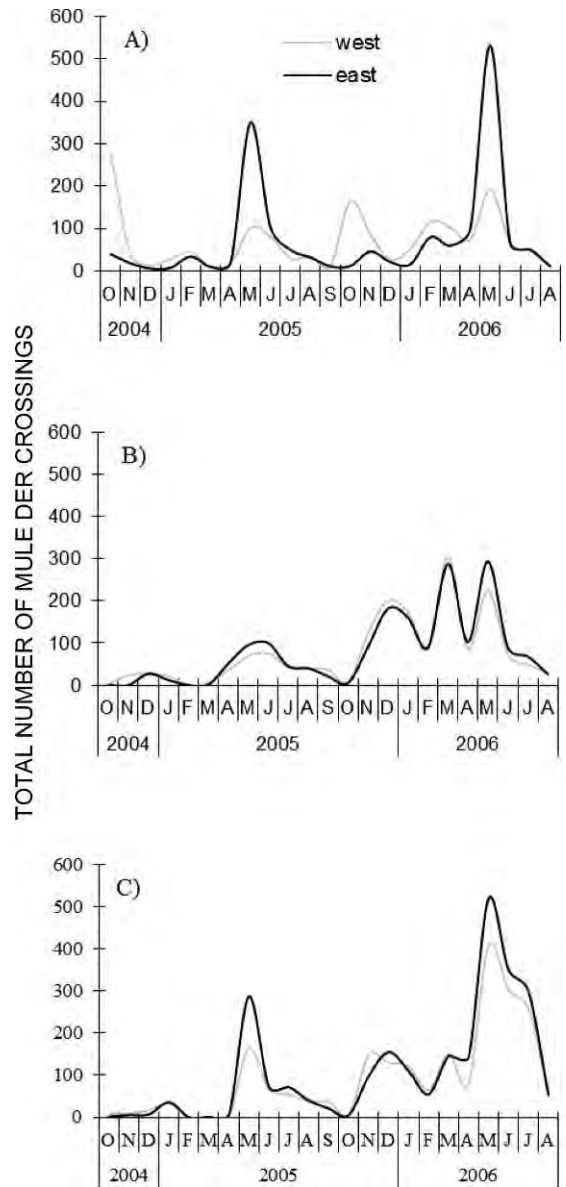


Figure 4. Monthly counts of mule deer crossings detected in both directions (west and east) on the monitored underpasses (A: Control UP, B: UP1, C: UP2) on I-15, southern Utah, USA.

crossings during spring migrations was generally higher than during autumn migrations, but autumn migrations extended over a longer time with some migration movements occurring from January to March. Finally, net crossings during migration indicated an increasing use with time of UP1 and UP2 (Fig. 6). Our results show that the number of crossings in the new structures gradually approached the number of crossings in the Control UP. During the first migration period (autumn 2004), UP1 registered 12.6% of the movement observed in the

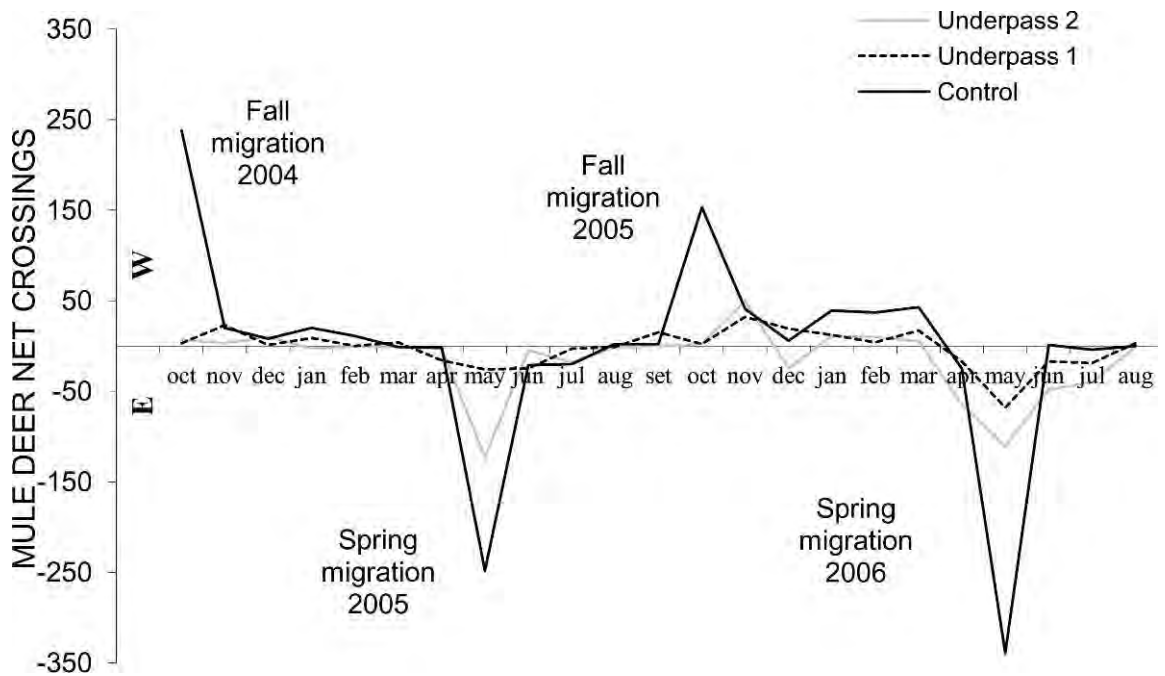


Figure 5. Mule deer net crossings through time (per month) for each underpass on I-15, in southern Utah, USA. Positive values represent movement towards the west; negative values represent movement towards the east.

Control UP, whereas during the last migration sampled (spring 2006) crossings increased to 33%. Similarly, UP2 increased from 5.9% in the first migration to 71.7% in the last migration, nearly matching crossings documented at the Control UP.

## Discussion

Based on the three *a priori* established criteria, we considered the I-15 mitigation strategy to be effective in reducing DVC without attendant end-of-the-fence problems. Even when we included the 2004 transition year, when the exclusion fencing was not yet in place until autumn, annual mortality in the study area was reduced by 77%. During most of 2004, the fences had several gaps that were used by deer to gain access to

the road. Our mortality reduction of 98.5% is perhaps better than ordinarily expected. This outcome may have been related, in part, to the close spacing of 0.81 km (1/2 mile) of ROW exit ramps that allowed deer easy escape to the wild side of the fence. A qualitative examination of tracks on the escape ramps near the crossings during winter with snow on the ground indicated infrequent use, suggesting that few deer accessed the ROW during the first year post construction. The area in which we worked was also relatively flat, so erosion did not have serious impact on fence integrity. The additional carcass collections conducted in the years 3 and 4 post study (autumn 2006-2008) suggest that the mortality reductions were likely to be long-term (Fig. 7).

The significance of our observed reduction in mortality on the deer population is best understood

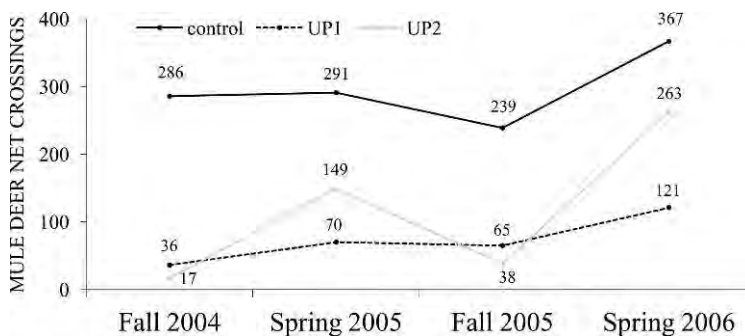


Figure 6. Mule deer net crossings in monitored migration periods (fall: October-January; spring: April-July) during 2004-2006 for each underpass on I-15, southern Utah, USA.



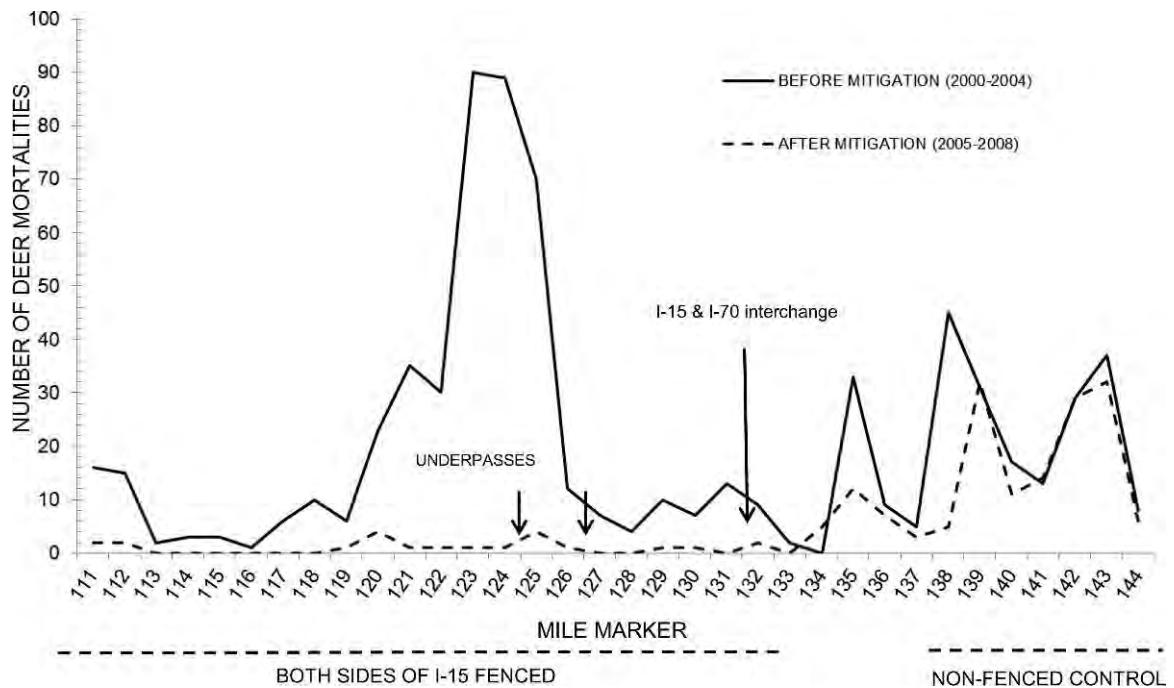


Figure 7. Mortality of mule deer on I-15 near Beaver Utah during pre-construction period (in 2000-2004) and the post-construction period (in 2005-2008). The punctuated line at the bottom of the figure shows the extent of the exclusion fences.

with data on vital rates, however; when survivorship and recruitment data are lacking, it is still possible to estimate how much reduction in mortality is required to reverse population declines. In another study in Utah, Lehnert (1996:62) conducted simulations based on a partial compensation (50%) model and reported that a 60% reduction in road kill was required to halt the population decline displayed by the simulated population using pre-treatment mortality rates. Population information for the I-15 deer herd was insufficient to define a data-based reduction threshold; however, from Lehnert's (1996) research, a 70% reduction was most likely adequate to reverse the declining population trend. Clevenger et al. (2001) reported reductions of 80% in levels of ungulate-vehicle collisions in Banff National Park; Braden (2005) reported a reduction of 83-92% in Key deer *Odocoileus virginianus*-vehicle collisions in Florida and McDonald (1991) described a 70% reduction in moose *Alces alces* mortality in Alaska after mitigation.

An important result is that the mitigation did not cause an end-of-the-fence problem, indicating that deer used the new available underpasses; these deer that may have entered the ROW were able to escape using the ramps. Apparently, exclusion fences extended far enough from deer-kill hotspots (~ 11.3

km (7 miles) north and ~ 19.3 km (12 miles) south of the underpasses) so that few deer moved around the end of the fence. To our knowledge, our study is the only one in which mitigation-exclusion fencing did not cause end-of-the-fence problems. Our results clearly demonstrated that a multi-faceted mitigation combining exclusion fencing, escape ramps and wildlife underpasses was effective in reducing DVCs and should help maintain landscape connectivity for mule deer. We argue that the use of exclusion fencing is justified only in the areas where traffic volumes are high, DVCs are otherwise unavoidable, and where effective structures to promote passage are present.

### Management implications

Many factors influence use of crossing structures including location, availability of approach cover, disturbance and the dimensions of the structure itself (Grilo et al. 2010, Clevenger & Waltho 2005). Additionally, human disturbance can interfere with use (Clevenger & Waltho 2000, Rosa 2006); in our study, the very large UPI showed little use when our cameras recorded human traffic through it. Structures with high openness-ratios are more likely to be used. The most effective structures appear to be rela-

tively short and less tunnel-like. For example, the Nugget Canyon section of Route 30 (M.P. 30-42) in southwestern Wyoming, USA, historically has had high deer mortality, especially during the spring and fall migrations. In 2001, the Wyoming Department of Transportation installed game fencing and a concrete box structure underpass. Its approximate dimensions were 6.1 m wide by 3.1 m high by 18.3 m long (i.e. an openness ratio of  $\sim 1.02$ ). It received heavy deer use (Gordon & Anderson 2003). Accordingly, six additional underpasses of similar size were built between MP 35 and 40. From 1 October 2009 to 31 May 2010, Sawyer & LeBeau (2010) documented 13,362 mule deer crossings using these underpasses and a bridge span. The relatively short length of the underpasses appeared to facilitate deer passage. A large number of elk ( $N = 487$ ) also passed through one of the Nugget Canyon underpasses during 2008 and 2009. In our study, the two separate sections of UP2 were short (21.23 m length with an openness-ratio score of 1.62 for each section) and had continual use and the lowest repel rate (failure to cross) of all underpass crossings in Utah (C. Cramer, Utah State University, unpubl. data). No vehicular traffic passed through UP2. It appears that given at least a minimum height and width, the most effective crossings for mule deer are short (20-25 m) and have little human disturbance.

Understanding what is required to reduce DVCs and increase landscape connectivity is not necessarily difficult. To get the appropriate state agencies to act in coordination and cooperation is essential. Effective mitigation requires recognition of the extent of the problem as well as cooperation between agencies in mitigating human-wildlife conflicts. Transportation and wildlife agencies bring different perceptions and perspectives to solutions for solving animal-vehicle collision problems. Transportation agencies are primarily concerned with human safety, whereas the goal of wildlife agencies with regards to roads is reducing DVCs and maintaining the traditional movement patterns (Beckman et al. 2010). Mitigation is less likely to solve the problem if it only accounts for traffic issues and disregards wildlife concerns. Our results should be applicable for other areas if the following are incorporated into mitigation: 1) exclusion fences are maintained and extend well beyond the hotspot(s) of deer mortality, 2) ROW escape ramps are provided to allow animals to escape the right-of-way and 3) the crossing structures are of appropriate configuration to allow animals to cross.

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# Permeability of Roads to Movement of Scrubland Lizards and Small Mammals

CHERYL S. BREHME,\* ‡ JEFF A. TRACEY,\* LEROY R. McCLENAGHAN,† AND ROBERT N. FISHER\*

\*Western Ecological Research Center, U.S. Geological Survey, 4165 Spruance Road, Suite 200, San Diego, CA 92101-0812, U.S.A.

†Biology Department, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182-4614, U.S.A.

**Abstract:** *A primary objective of road ecology is to understand and predict how roads affect connectivity of wildlife populations. Road avoidance behavior can fragment populations, whereas lack of road avoidance can result in high mortality due to wildlife-vehicle collisions. Many small animal species focus their activities to particular microhabitats within their larger habitat. We sought to assess how different types of roads affect the movement of small vertebrates and to explore whether responses to roads may be predictable on the basis of animal life history or microhabitat preferences. We tracked the movements of fluorescently marked animals at 24 sites distributed among 3 road types: low-use dirt, low-use secondary paved, and rural 2-lane highway. Most data we collected were on the San Diego pocket mouse (*Chaetodipus fallax*), cactus mouse (*Peromyscus eremicus*), western fence lizard (*Sceloporus occidentalis*), orange-throated whiptail (*Aspidoscelis hyperythra*), Dulzura kangaroo rat (*Dipodomys simulans*) (dirt, secondary paved), and deer mouse (*Peromyscus maniculatus*) (highway only). San Diego pocket mice and cactus mice moved onto dirt roads but not onto a low-use paved road of similar width or onto the highway, indicating they avoid paved road substrate. Both lizard species moved onto the dirt and secondary paved roads but avoided the rural 2-lane highway, indicating they may avoid noise, vibration, or visual disturbance from a steady flow of traffic. Kangaroo rats did not avoid the dirt or secondary paved roads. Overall, dirt and secondary roads were more permeable to species that prefer to forage or bask in open areas of their habitat, rather than under the cover of rocks or shrubs. However, all study species avoided the rural 2-lane highway. Our results suggest that microhabitat use preferences and road substrate help predict species responses to low-use roads, but roads with heavy traffic may deter movement of a much wider range of small animal species.*

**Keywords:** avoidance, connectivity, conservation planning, habitat fragmentation, heteromyid, reptiles, road ecology, urban ecology

**Resumen:** *Un objetivo principal de la ecología de caminos es entender y predecir como afectan los caminos la conectividad de las poblaciones silvestres. El comportamiento de evitación de caminos puede fragmentar poblaciones, mientras que la falta de evitación puede resultar en alta mortandad debido a colisiones. Muchas especies animales pequeñas enfocan sus actividades a microhábitats particulares dentro de su hábitat mayor. Buscamos estudiar como los diferentes tipos de caminos afectan el movimiento de pequeños vertebrados y conocer si ciertas respuestas hacia los caminos pueden ser predecibles basándose en la historia de vida del animal o el microhábitat. Rastreamos los movimientos de animales marcados con fluorescencia en 24 sitios distribuidos entre 3 tipos de caminos: tierra de bajo uso, camino secundario pavimentado de bajo uso, y carretera rural de 2 carriles. La mayoría de los datos que colectamos fueron sobre *Chaetodipus fallax*, *Peromyscus eremicus*, *Sceloporus occidentalis*, *Aspidoscelis hyperythra*, *Dipodomys simulans* (tierra, pavimentación secundaria), y *P. maniculatus* (solamente en carretera). *C. fallax* y *P. eremicus* se movían hacia los caminos de tierra pero no hacia una carretera de baja pavimentación de anchura similar o hacia la carretera, indicando que evitan los caminos con sustrato pavimentado. *S. occidentalis* y *A. hyperythra* se movían hacia la tierra y los caminos secundarios pavimentados pero evitaban la carretera rural de 2 carriles, indicando que pueden evitar el ruido, las vibraciones o el disturbio visual de un constante flujo de tráfico. *D. simulans* no evitaba el camino de tierra ni los caminos secundarios con pavimento. En general, el camino de tierra y los caminos*

‡email [cbrehme@usgs.gov](mailto:cbrehme@usgs.gov)

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secundarios fueron más permeables para las especies que prefieren forrajear o tomar el sol en áreas abiertas de su hábitat en lugar de bajo rocas o arbustos. *D. simulans* no evitó el camino de tierra ni los caminos secundarios pavimentados. Sin embargo todas las especies estudiadas evitaron la carretera de 2 carriles. Nuestros resultados sugieren que las preferencias de uso de microhábitat y sustrato de caminos ayudan a predecir las respuestas de las especies hacia caminos de bajo uso, pero los caminos con tráfico pesado pueden disuadir el movimiento de un rango mucho mayor de especies animales pequeñas.

**Palabras Clave:** conectividad, ecología de caminos, ecología urbana, evitación, fragmentación de hábitat, heterómodo, planificación de la conservación, reptiles

## Introduction

Terrestrial and aquatic areas have become increasingly permeated by roads. Roads affect movement patterns, demographics, and spatial distribution of local species. They can adversely affect wildlife by fragmenting habitats, creating population sinks, and acting as conduits for the spread of invasive species (e.g., Forman et al. 2003; Fahrig & Rytwinski 2009; Taylor & Goldingay 2010). They can positively affect wildlife by increasing connectivity between suitable habitat patches and food resources (e.g., Huey 1941; Getz et al. 1978; Forman et al. 2003).

A current need in the field of road ecology is to understand and predict how roads affect the probability wildlife populations will persist (Roedenbeck et al. 2007; Fahrig & Rytwinski 2009; Rytwinski & Fahrig 2012). This will likely require the development of demographic and spatial-movement models that incorporate behavioral responses to roads (e.g., Jaeger et al. 2005; Tracey 2006; Frair et al. 2008). Roads are highly variable, ranging from rarely traveled dirt roads to multilane highways with heavy traffic. Correspondingly, the responses of animals to different road types are expected to be highly variable.

To address variation in animal responses to different road attributes and traffic patterns, Jaeger et al. (2005) incorporated 3 types of road-specific avoidance behavior (road-surface avoidance related to road substrate and width, and, noise and car avoidance related to traffic) in their model for predicting when animal populations are at risk from roads. However, data to test these models are lacking because much of the current literature on road-related movement behavior typically focuses on either a single species or road type (e.g., Fahrig & Rytwinski 2009; Taylor & Goldingay 2010). There are also relatively few data available on reptiles, although this taxon is thought to be substantially and negatively affected by roads (Andrews et al. 2008). Finally, few researchers have incorporated both multiple road types and taxonomic classes in their studies to ascertain how animal communities respond to these linear features of the landscape.

Scrublands are distributed throughout mid-latitude deserts and areas with Mediterranean-type climates. Scrublands are characterized by low-growing shrubs adapted to arid conditions and range from open habitats with sparse vegetation cover to areas with dense

vegetation (Kellman 1980). Our study area was in coastal sage scrubland of southern California (U.S.A.). Much of this area is fragmented by urbanization, disturbed, or permeated with highways, secondary roads, dirt roads, and trails (O'Leary 1995; Noss et al. 2000).

We sought to understand how roads affect habitat connectivity for small vertebrate populations within these scrublands. We assessed the movement patterns of 4 small-mammal species and 2 lizard species relative to 3 types of roads: low-use dirt roads, a secondary paved road, and a primary paved highway. We also examined whether animal responses to roads differed among species with different life-history strategies and whether species' microhabitat-use preferences could be used to predict their responses to roads.

## Methods

### Study Site

Our study area was in San Diego County, California, within the San Diego National Wildlife Refuge (Otay-Sweetwater Unit) and in Rancho Jamul, a 1915-ha ecological preserve managed by the California Department of Fish and Game. The coastal sage scrub (CSS) vegetation was dominated by California sagebrush (*Artemisia californica*), buckwheat (*Eriogonum fasciculatum*), and a variety of herbs and grasses. The region has a Mediterranean-type climate characterized by hot, dry summers and cool, wet winters. Average annual precipitation is 350 mm, and approximately 95% of the annual mean rainfall occurs from November through April. The CSS vegetation averaged 63% shrub cover, 30% grass and herb cover, and 28% open ground (total greater than 100% due to measures at multiple height categories [Brehme 2003]). There were 3 road types in the study area: 1.8 km of low-use unimproved dirt roads with an average width of 4.7 m (SD 1.3) and traffic volume of 0–20 vehicles/day; a 1.6-km low-use, secondary, 2-lane paved road (Millar Ranch Road) with an average width of 6.6 m (SD 0.2) and traffic volume of 200–500 vehicles/day (Traffic Section of San Diego County Public Works); and over 24 km of high-use, primary, 2-lane paved highway (State Highway 94) with an average width of 11.2 m (SD 0.9) and traffic volume of 7,400–18,000 vehicles/day

(California Department of Transportation). Road widths were measured as the width of grading for dirt roads and width of pavement for paved roads. Native soil or vegetation extended to the road edge for all unimproved and improved road types. During the study, there was no evidence of mowing or other vegetation-management activities.

### Data Collection

Eight linear trapping arrays were installed along the length of each of the 3 road types. We chose sites where CSS vegetation extended at least 50 m from both sides of the road to avoid confounding the presence of a road with any other edge. Linear trapping arrays consisted of 3, 9-L pitfall traps connected by a 15-m drift fence (7.5 m between each bucket), 4 Sherman live traps (along both sides of fence halfway between each bucket), and one funnel trap. We baited all traps with birdseed and rolled oats. Arrays were diagonal to the road to increase effectiveness of intercepting animals moving both parallel and perpendicular to the road. At one end of the array, the pitfall trap was 1 m from the road edge, and at the other end, the pitfall trap was 11 m from the road edge. The middle pitfall trap was 5 m from the road edge. Pitfall-array materials and installation procedures are described in Fisher et al. (2008). Trap arrays remained open during each trapping period and were checked every morning at sunrise. We conducted ten 3-night trapping sessions at each array from April to December of 2001.

We used fluorescent-powder tracking (Lemen & Freeman 1985; Fellers & Drost 1989) to track the movements of small mammals and reptiles captured in the trap arrays. The fluorescent powder (Radiant Color, Richmond, California, U.S.A.) is nontoxic and is a safe and effective means of tracking small-scale animal movements (Stapp et al. 1994). The powder-tracking technique allowed us to study species' direct responses to roads. Tracking movements over longer distances and periods of time (e.g., with radiotelemetry) would better document infrequent crossings, but the use of fluorescent dye allows for documentation of fine-scale movement activity that telemetry does not (Lemen & Freeman 1985).

To differentiate among individuals, we dusted each animal released from an array with 1 of 20 base colors or unique mixtures of base colors. We were careful to dust only the body and to avoid the head area to prevent the animal from breathing in the powder (Stapp et al. 1994). Prior to their natural activity period, we placed it on the lid of the center bucket 5 m from the road edge. This allowed for a standard release distance from the road for all animals without the drift fence acting as a barrier to movement in any direction. When releasing an animal, the handler crouched down parallel to the animal and the road, released the animal, slowly backed away staying parallel to the road, and then left the area. This release strat-

egy was to prevent the handler from scaring the animal toward or away from the road. We traced the fluorescent powder tracks at night with a portable 12-watt long-wave ultraviolet lamp. We laid a 50-m measuring tape over the trail until the powder could no longer be traced. For each animal, we recorded the total distance of the fluorescent track and made a diagram of the animal's movements in relation to the road. We recorded locations of burrows where tracks ended at burrow entrances. We tracked the movement of most individuals only one time to avoid problems with pseudoreplication (Hurlbert 1984). We traced a small number of animals on several occasions to examine the variability of results for individuals. For these animals, only the result of their first tracking occasion was used in statistical analyses.

We categorized all movements as either road use or habitat use. Road use was when an animal moved over the road for any distance of the track length. Habitat use was when an animal stayed in the scrubland during the entire tracking period. We included in our analyses only animals tracked for a minimum of 10 m. For the Dulzura kangaroo rat (*Dipodomys simulans*), we included 2 movements of approximately 9.5 m because there were a low number of total tracks. Because all animals were released within 5 m of the road, this minimum track distance allowed us to document movements relative to the road or well away from the array in any direction. We calculated permeability as the number of animals that exhibited road use divided by the total numbers of animals tracked for each species and road type.

### Analyses

To test whether animals avoided or used the roads more than expected by chance, we compared observed species movement paths with paths simulated from species-specific correlated random walk (CRW) models. The CRW models represent predicted movement without any behavioral response to the roads. We parameterized CRW models with tracking data from at least 3 individuals of each species. We used only paths within the interior scrubland and well away from the road to represent typical movements within an animal's habitat. We used recorded spatial coordinates at 1.0-m intervals along the path to calculate move and turn angles. The move angle was the direction of movement, and the turn angle was the angle of the current move step minus the angle of the previous move step.

We parameterized the simulations in 2 stages. First, for each individual animal's movement path, we estimated the mean turn angle and concentration parameter that determined the dispersion of a von Mises distribution (Fisher 1993). Second, we fitted a von Mises distribution to the mean turn angles for all paths and a gamma distribution to the concentration parameter of the turn angles for all paths. When simulating a path, we randomly



drew a mean turn angle from the von Mises distribution and a concentration parameter from the gamma distribution. We added the turn angle to the move angle of the previous move step to obtain the move angle for the current move step. The move-step length was 1.0 m, and the total length was constrained to the average length of the observed paths for each species. We simulated 1000 paths for each species. To determine the expected number of animal movements onto roads if there was no barrier effect, we determined the number of CRW paths that transected a line 5 m from the start point. We parameterized and simulated all CRW models with a program written in R (R Development Core Team 2010). We compared the number of observed versus expected road movements with Fishers' exact tests. A significant result suggested the animals moved onto roads more or less than expected under the null hypothesis.

Individual animal movement behavior may be affected by population density (Swihart & Slade 1984; Hanski 1999). Therefore, we determined whether relative abundance differed among the roadside habitats with one-way analysis of variation for each species. For our index of species abundance, we used the minimum number of animals known alive. We calculated this index by removing all recaptures within each 3-day trapping session at each array. Although minimum number known alive can be biased as an abundance estimator, it is proportional to population sizes and is thus a reasonable index of abundance (Slade & Blair 2012).

## Results

We dusted 306 animals with fluorescent powder and released them 5 m from the road edge. One-third of the animals were not included in our analyses because their track lengths were <10 m. Most of the small mammals that were not used in the analyses were tracked to a nearby burrow on the side of the road on which they were released, and there were no obvious tracks coming out of the burrow. Small reptiles and those with smooth scales (many snakes, skinks, side-blotched lizards [*Uta stansburiana*], and whiptails [*Aspidoscelis* spp.]) did not retain the powder dye well; thus, many of their tracks were lost within several meters. Some species were excluded due to too few captures. The 181 individuals we used in the analyses (125 small mammals, 56 lizards) were followed an average of 20.7 m (SE 0.8).

We also tracked 19 animals on a second occasion to test the repeatability of individual results. All these animals repeated their initial movement types. Seventeen (12 mammals and 5 lizards) stayed within the scrubland on both tracking occasions, whereas 2 (1 mammal and 1 lizard) repeatedly crossed the road. We present the results for 4 small mammal species and 2 lizard species. These species represent movements of 54 San

Diego pocket mice (*Chaetodipus fallax*), 57 cactus mice (*Peromyscus eremicus*), 6 Dulzura kangaroo rats (dirt and secondary paved road only), 8 deer mice (*Peromyscus maniculatus*) (highway only), 26 western fence lizards (*Sceloporus occidentalis*), and 30 orange-throated whiptail lizards (*Aspidoscelis hyperythra*) (secondary paved road and highway only).

### Small Mammals

San Diego pocket mice were tracked an average distance of 25.1 m (SE 1.6) from the point of release. Species-specific movement simulations predicted a permeability of 42% (percentage of animals moving onto road) if the roads had no effect on movement. Twenty-seven percent of San Diego pocket mice movements were tracked onto the dirt roads (Fisher's exact test,  $n = 22$ ,  $p = 0.194$ ). The majority of these movements (4 out of 5) were crossing events to the habitat on the other side of the road. The percentage of movements onto the secondary road was significantly lower than expected at 9.5% ( $n = 21$ ,  $p = 0.003$ ). The 2 movements onto the secondary road were not crossings, but along the edge of the road returning to the habitat on the same side of the road. There were no movements of San Diego pocket mice onto the primary highway ( $n = 11$ ,  $p = 0.004$ ) (Fig. 1). The relative abundance of pocket mice did not differ significantly among the 3 road types ( $F_{2,21} = 1.493$ ,  $p = 0.248$ ).

Cactus mice were tracked an average distance of 19.0 m (SE 1.2). Species-specific movement simulations predicted an expected road permeability of 30%. All the movements onto the dirt road were direct crossing events to the other side of the road (Fig. 2). Although 25% of the individuals went onto the dirt road (meaning there was no significant barrier effect [ $n = 20$ ,  $p = 0.626$ ]), no individuals were tracked onto the secondary paved road or primary highway ( $n = 18$ ,  $p = 0.003$  and  $n = 19$ ,  $p = 0.002$ , respectively). Relative abundance of cactus mice did not differ significantly among the 3 road types ( $F_{2,21} = 0.676$ ,  $p = 0.522$ ).

Dulzura kangaroo rats were tracked an average of 14.6 m (SE 2.4). Movement simulations for this species predicted a road permeability of 41%. Although there were few animals tracked, most of them went onto the roadways. Of the 3 individuals tracked near the dirt road, all went onto the road ( $n = 3$ ,  $p = 0.070$ ), which indicates the road was more permeable to this species than the surrounding habitat. One individual's burrow entrance was in the middle of the roadway. Two out of 3 individuals tracked went onto the secondary paved road ( $n = 3$ ,  $p = 0.572$ ), which indicates this road was not a barrier to movement. One individual ran along the length of the road and the other crossed the road (Fig. 3).

Deer mice were tracked adjacent to the highway for an average length of 19.9 m (SE 2.3). Species-specific

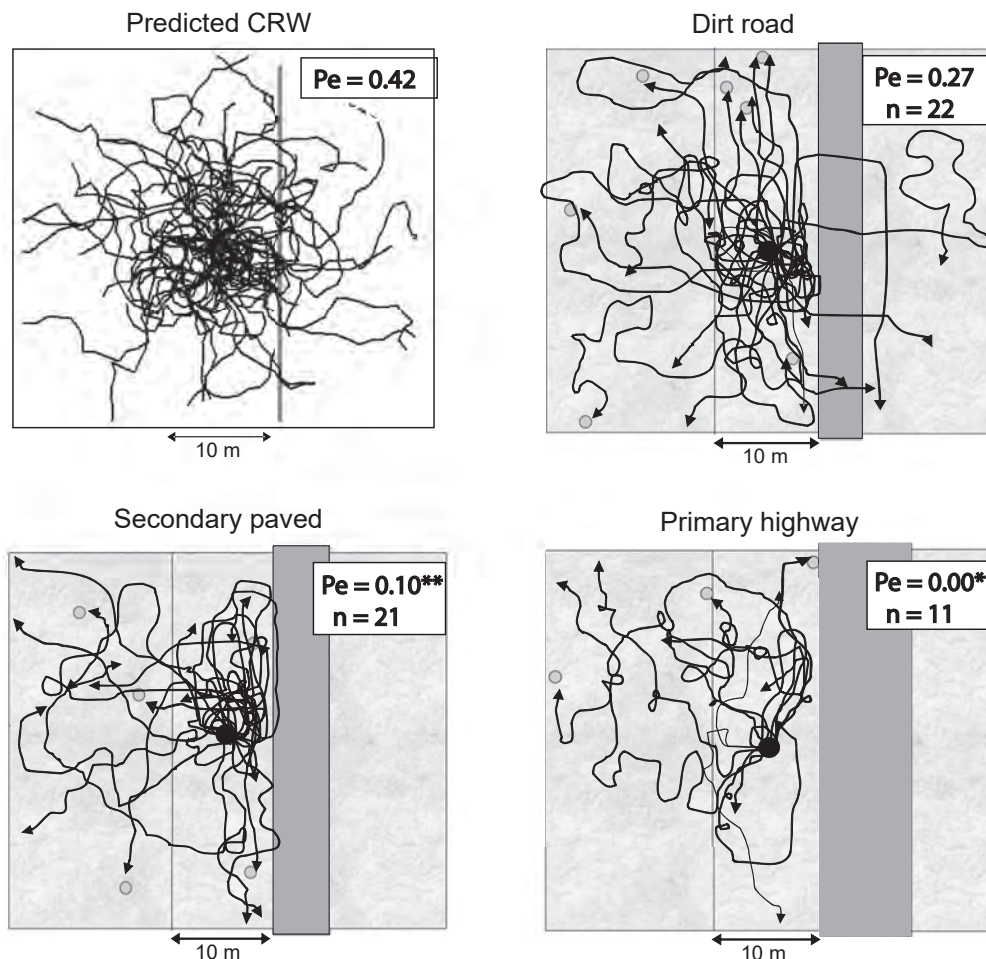


Figure 1. Predicted (correlated random walk, CRW) and observed permeability ( $Pe$ ) of road types to movement of the San Diego pocket mouse (*Chaetodipus fallax*). Each drawing shows movements tracked at multiple independent release sites superimposed onto a single frame (gray circles, burrows;  $**p < 0.01$ ).

movement simulations predicted a road permeability of 37%. No deer mice went out onto the road, which indicates the rural highway was a significant barrier for this species ( $n = 8, p = 0.030$ ). Many individuals were tracked to burrow entrances that were within a few meters of the road.

### Lizards

Western fence lizards were tracked an average distance of 17.4 m (SE 2.2) from point of release. Species-specific movement simulations predicted an expected road permeability of 31%. The permeability of the dirt roads to movement of western fence lizards was higher than expected; 66% of lizards went onto the dirt road ( $n = 9, p = 0.030$ ). These were a mixture of crossing events and movement along the road. A high percentage (56%) of individuals also went onto the secondary paved road ( $n = 9, p = 0.146$ ). These movements were all along the road and no crossing events were recorded. However, most of these tracks were lost on the pavement,

so we could not determine which side of the road the animal went to. In comparison, not a single western fence lizard went onto the highway (Fig. 4). Although permeability between the expected and observed values for the highway was not significant ( $n = 6, p = 0.186$ ), the permeability of the highway to fence lizard movements was significantly lower than permeability of the dirt ( $p = 0.028$ ) and secondary paved roads ( $p = 0.044$ ) to movements of fence lizards. Their relative abundance did not differ among road types ( $F_{2,21} = 0.006, p = 0.994$ ).

Movement simulations predicted road permeability of 31% for orange-throated whiptail if the roads had no effect on movement behavior. The average track length was 17.0 m (SE 1.3) by the secondary and primary paved roads. Although 33.3% of orange-throated whiptails crossed the secondary paved road ( $n = 6, p = 1.00$ ), none were tracked out onto the highway ( $n = 24, p \leq 0.001$ ) (Fig. 5). Only one whiptail was captured by the dirt road, and its track length was  $< 10$  m. Whiptail abundance next to the paved road and highway did not differ significantly ( $t_{14} = 1.612, p = 0.129$ ). However, the



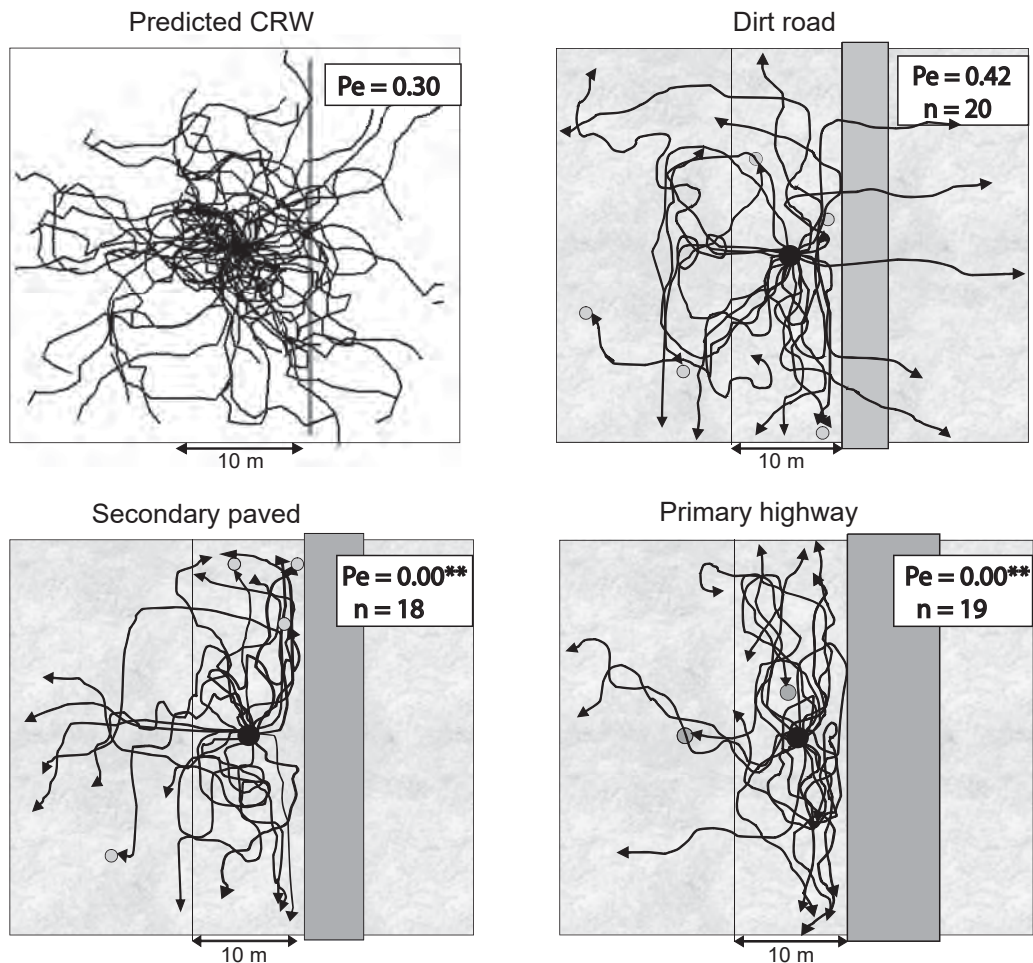


Figure 2. Predicted (correlated random walk, CRW) and observed permeability ( $Pe$ ) of road types to movement of the cactus mouse (*Peromyscus eremicus*). Each drawing shows movements tracked at multiple independent release sites superimposed onto a single frame (gray circles, burrows; \*\* $p < 0.01$ ).

success rate in tracking the whiptail for distances  $> 10$  m was significantly greater by the highway (24/32) than by the paved road (6/20,  $p = 0.002$ ).

## Discussion

Although they live in open scrub habitats, San Diego pocket mice and cactus mice prefer to move and forage under microhabitats of shrub and rock cover rather than open areas (Meserve 1976; Price & Kramer 1984). Thus, they may quickly pass through or avoid areas of open ground. This is consistent with their movements relative to the dirt road, which were primarily direct crossings to shrub and rock cover on the other side of the road. One cactus mouse crossed the dirt road on 2 occasions. This result indicates the dirt road was within its home range. In contrast to the dirt road, there were no documented movements of either species across the secondary paved road or highway even though the distances required to cross either road were well under the average

tracked distances of the species. The secondary road differed from the dirt roads by an average added width of 1.9 m, the addition of pavement, and an increased traffic volume averaging one vehicle every 5 minutes. It is unknown which of these factors or combination thereof resulted in their avoidance of this road. However, because of the low traffic volume and little difference in width, it is likely that these species were avoiding the road substrate. White-footed mice (*Peromyscus leucopus*) and eastern chipmunks (*Tamias striatus*) avoid crossing paved roads regardless of traffic volume (McGregor et al. 2008). By comparing roads with different substrates and traffic volumes, our results support the hypothesis that many small mammal species avoid paved road substrates. The reasons for this are not understood and deserve further study. However, mammals are particularly sensitive to odors in their environment. Road pavement surfaces, such as asphalt and coal tar, contain complex mixtures of volatile and non-volatile compounds. Even very minute concentrations of smells and chemicals that mimic pheromones may elicit instinctive behavioral

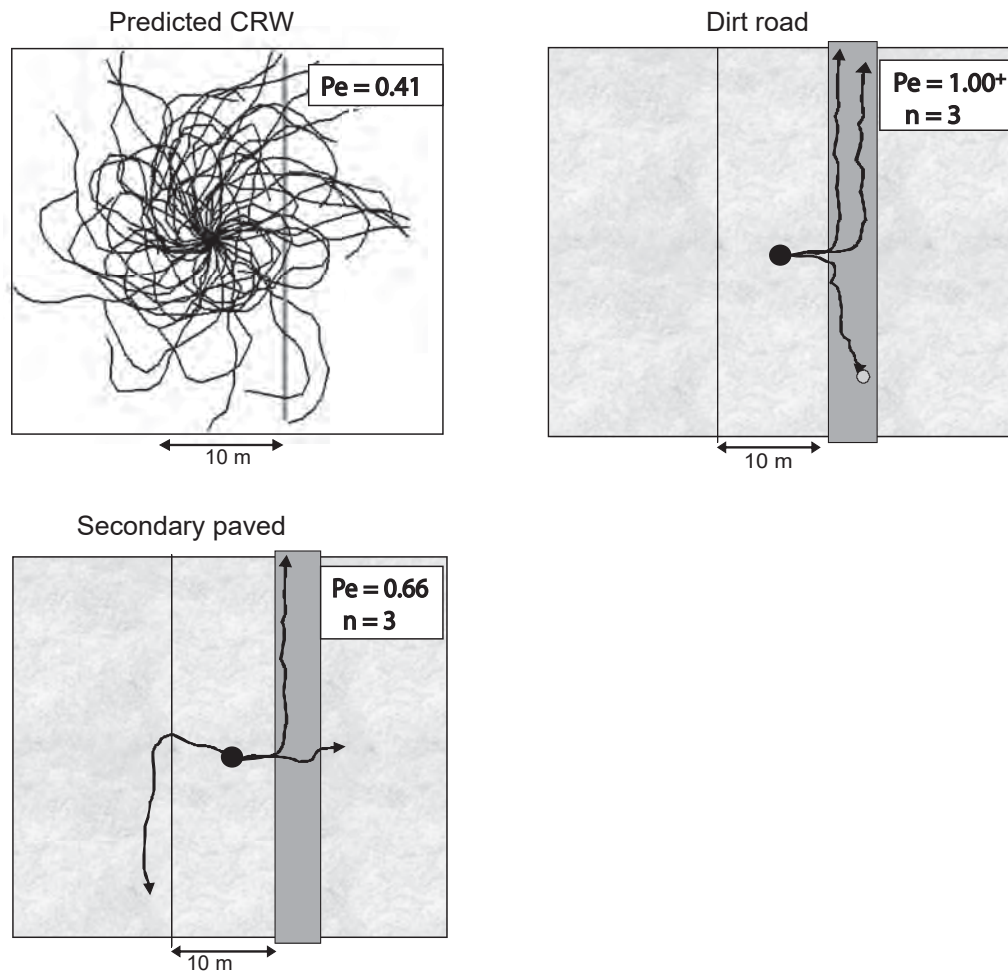


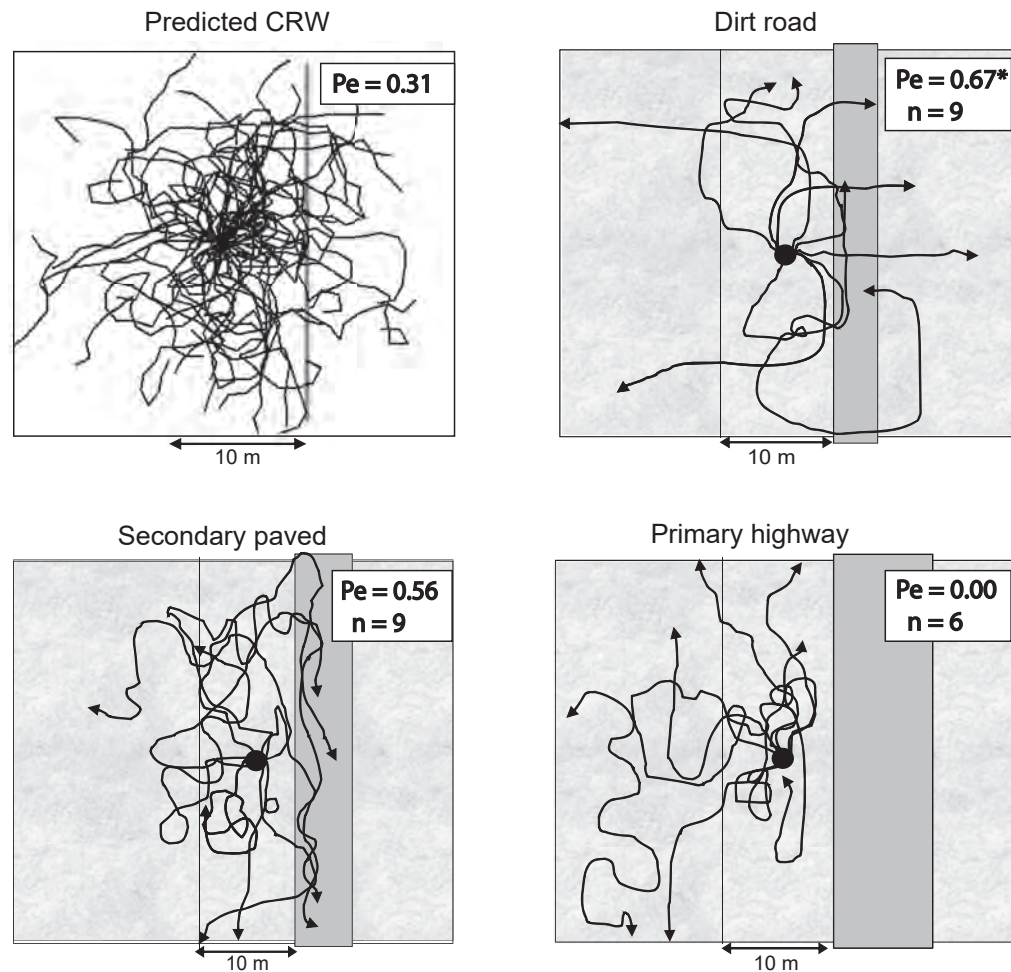
Figure 3. Predicted (correlated random walk, CRW) and observed permeability ( $Pe$ ) of road types to movement of *Dulzura kangaroo rat* (*Dipodomys simulans*). Each drawing shows movements tracked at multiple independent release sites superimposed onto a single frame (gray circle, burrows;  $+p < 0.10$ ).

responses in some species (e.g., Leinders-Zufall et al. 2000).

However, the avoidance of pavement is not generalizable to all species of small mammals. The yellow-necked mouse (*Apodemus flavicollis*) regularly crossed both dirt and paved roads of similar width (Rico et al. 2007). In our study, 2 out of 3 *Dulzura kangaroo rat* went out onto the secondary paved road. Although we did not capture any *Dulzura kangaroo rat* by the highway, this species accounted for the majority of dead animals we observed on the highway (3 out of 7) (Brehme 2003), which indicates the highway was also somewhat permeable to movement for this species. The higher than expected permeability of dirt roads to movements of the *Dulzura kangaroo rat* is consistent with results of a previous study on the Stephens' kangaroo rat (*D. stephensi*) (Brock & Kelt 2004). Kangaroo rats may preferentially use dirt roads for movement within their habitat. These bipedal heteromyids prefer to move and forage within open-ground areas of scrub habitats and respond positively

to disturbances such as fire (e.g., Meserve 1976; Price & Kramer 1984; Brehme et al. 2011). In areas with denser vegetation, low-use dirt roads and trails may provide an increased opportunity for kangaroo rats to disperse to open scrub habitats. Alternately, we would expect negative effects from high-traffic roads on kangaroo rats. Traffic noise can disrupt communication in kangaroo rats (Shier et al. 2012) and nonavoidance of these roads would very likely result in increased mortality rates from vehicular traffic.

Because many reptiles may be attracted to open spaces and paved surfaces for thermoregulatory purposes, it is often hypothesized that these animals do not avoid roads (e.g., Klauber 1939; Jochimsen et al. 2004; Andrews et al. 2008). The dirt and secondary paved roads in our study were highly permeable to movement of western fence lizards (67% and 56%, respectively). Their movements on the dirt roads consisted of crossings and movements along the road; thus, the road was in part used as a conduit for movement. In contrast, their



**Figure 4.** Predicted (correlated random walk, CRW) and observed permeability ( $Pe$ ) of road types to movement of the western fence lizard (*Sceloporus occidentalis*). Each drawing represents movements tracked at multiple independent release sites that are superimposed onto a single frame (\* $p < 0.05$ ).

movements on the secondary road were often erratic and irregular along the road edge. This suggests the paved road was used for basking which was regularly observed during the study. The complete absence of movements onto the highway was in stark contrast to their response to the dirt and secondary paved roads. Similarly, although the secondary road was permeable to movement of the orange-throated whiptail, this species also completely avoided the highway.

Delaney et al (2010) found that genetic diversity is lower in populations of western fence lizards that are separated by a highway than in populations in continuous habitat. Because of the high permeability of the secondary paved road to these 2 species, we think it is unlikely that the additional width of the highway (4.6 m) alone adequately explains their marked avoidance of the highway. However, the level of traffic (average 1 vehicle/7 seconds) was 40-fold higher on the highway than on the secondary paved road; thus, the constant stream

of vehicular traffic and corresponding noise and vibration may have been sufficient to deter use of the highway. On the basis of our own literature search and recent reviews on responses of reptiles to roads (Andrews et al. 2008; Rytwinski & Fahrig 2012), we believe ours is the first study to document behavioral road avoidance in lizards.

All the study species exhibited increased road avoidance and thus experienced decreased connectivity as road improvement and traffic increased. By studying both small mammals and reptiles we were able to make direct comparisons of behavior between taxa with different microhabitat preferences and life-history strategies. Species microhabitat-use preferences within their habitat may be an important predictive factor for road permeability (Fig. 6). Animals that are more likely to focus their activities in open areas within their habitat were more likely to venture out onto low-use roads. In our study, the 3 species (Dulzura kangaroo rat, western fence lizard, orange-throated whiptail) that use open areas for foraging



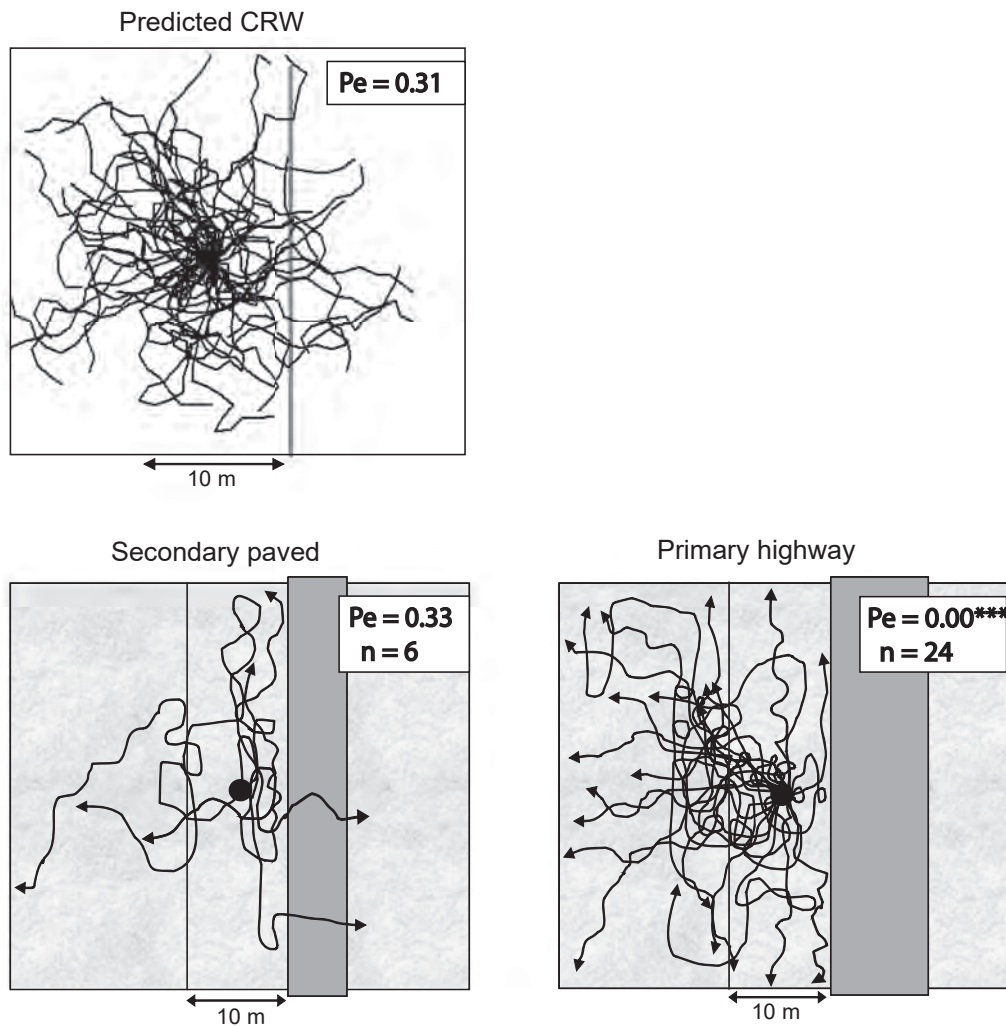


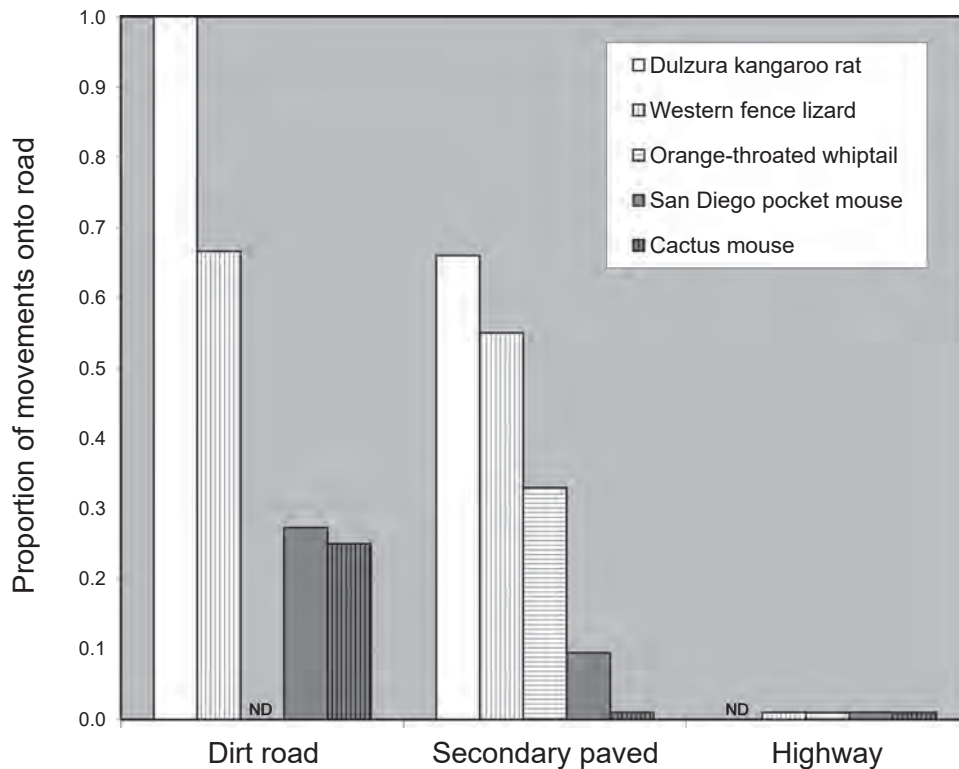
Figure 5. Predicted (correlated random walk, CRW) and observed permeability ( $Pe$ ) of road types to movement of orange-throated whiptail lizard (*Aspescoscelis hyperythbra*). Each drawing shows movements tracked at multiple independent release sites superimposed onto a single frame ( $***p < 0.001$ ).

or thermoregulation ventured onto dirt and secondary paved roads more than the species (San Diego pocket mouse, cactus mouse) that prefer to forage within or under the cover of rocks and shrubs.

Thus, one would predict that the populations of small animals with closed microhabitat preferences would be in most danger of becoming fragmented by any type of road. For instance, small mammal and reptile species that avoid open ground, such as the cotton rat (*Sigmodon hispidus*), prairie vole (*Microtus ochrogaster*), Eastern massasauga rattlesnake (*Sistrurus c. catenus*), rosy boa (*Lichanura trivirgata*), and many rainforest species, avoid crossing even narrow dirt roads (Swihart & Slade 1984; Weatherhead & Prior 1992; Goosem 2001; Rochester et al. 2005). Whereas generalist species and those with open microhabitat preferences would be more likely to cross roads, use roads for activity, and as conduits for movement. However, even these species may avoid roads with heavy traffic due to the constant

disturbance from noise, vibrations, and lights. Therefore, roads with moderate traffic would be expected to pose the greatest risk of vehicular mortality for generalists and open microhabitat specialists due to the use of roads by both animals and vehicles (Seiler 2003). Our results pertain to small mammals and lizards with home ranges that are small relative to the road matrices within the study area. It is expected that movements onto roads would be more common for animals that make long migratory movements or that have large home ranges relative to the road matrices within their habitat.

Our results show that a 2-lane rural highway through open scrubland can create a significant movement barrier for species of small mammals and reptiles. Behavioral mechanisms appear to be road surface avoidance for some small mammal species and traffic avoidance for lizard species. Avoidance of improved roads may be a beneficial response in that mortality from vehicular traffic is avoided or minimized. However, networks of



*Figure 6. Road permeability relative to species microhabitat-use preferences (white bars, species that typically forage in and use open areas of their habitat; gray bars, species that primarily forage under vegetation cover; ND, no data for species at specific road type). Expected permeability range 0.30–0.41 with no road response.*

roads throughout a landscape may divide habitat into fragments that are too small to sustain some populations over the long term. Barrier fencing and safe-crossing structures may reduce the effects of habitat fragmentation for species that avoid roads and reduce road mortality for species that do not avoid roads (e.g., Boarman & Sazaki 1996; Dodd et al. 2004).

More research is needed to determine whether road response patterns are consistent across other habitats and small animal species, whether microhabitat-use preferences can also help predict the use of road-crossing structures, and to further understand the population-level effects of movement-behavior decisions (Fahrig 2007; Rytwinski & Fahrig 2012). If generalizations are found, they will help us to identify vulnerable species and potentially detrimental roads within their habitat, inform population and spatial-movement models, and inform management decisions and mitigation measures for both studied and unstudied species.

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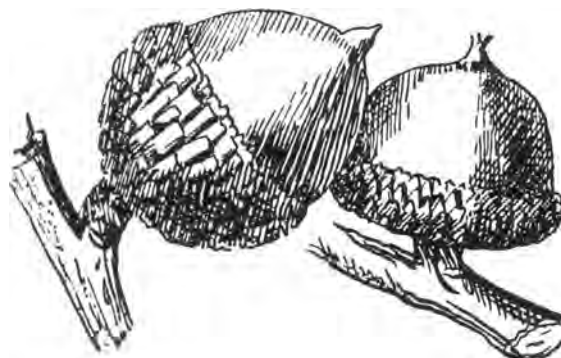
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# An objective road risk assessment method for multiple species: ranking 166 reptiles and amphibians in California

Cheryl S. Brehme  · Stacie A. Hathaway  · Robert N. Fisher 

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## Abstract

**Context** Transportation and wildlife agencies may consider the need for barrier structures and safe wildlife road-crossings to maintain the long-term viability of wildlife populations. In order to prioritize these efforts, it is important to identify species that are most at risk of extirpation from road-related impacts.

**Purpose** Our goal was to identify reptiles and amphibians in California most susceptible to road mortality and fragmentation. With over 160 species and a lack of species-specific research data, we developed an objective risk assessment method based upon road ecology science.

**Methods** Risk scoring was based upon a suite of life history and space-use characteristics associated with negative road effects applied in a hierarchical manner from individuals to species. We evaluated risk to both aquatic and terrestrial connectivity and calculated buffer distances to encompass 95% of population-level movements. We ranked species into five relative categories of road-related risk (very-high to very-low) based upon 20% increments of all species scores.

**Results** All chelonids, 72% of snakes, 50% of anurans, 18% of lizards and 17% of salamander species in California were ranked at high or very-high risk from negative road impacts. Results were largely consistent with local and global scientific literature in identifying high risk species and groups.

**Conclusions** This comparative risk assessment method provides a science-based framework to identify species most susceptible to negative road impacts. The results can inform regional-scale road mitigation planning and prioritization efforts and threat assessments for special-status species. We believe this approach is applicable to numerous landscapes and taxonomic groups.

**Keywords** Reptile · Amphibian · Road mortality · Habitat fragmentation · Road ecology · Risk assessment · Road

## Introduction

There have been many attempts to better characterize and quantify threat criteria in order to classify species at higher risk of extinction at state, national, and global levels (Congress 1973 (U.S. Endangered Species Act); Mace et al. 2008; Hobday et al. 2011; Thomson et al. 2016; IUCN 2017). Roads are a significant threat to wildlife populations (e.g., Forman et al. 2003;

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C. S. Brehme (✉) · S. A. Hathaway · R. N. Fisher  
U.S. Geological Survey, Western Ecological Research  
Center, San Diego, CA, USA  
e-mail: cbrehme@usgs.gov

Andrews et al. 2015a; van der Ree et al. 2015), causing both barrier (habitat fragmentation) and depletion (road mortality) effects. Barrier effects occur when animals avoid crossing roads, in which case roads essentially fragment species habitat. Barrier effects include reduced size and quality of available habitat, reduced effective population size, reduced ability to find mates and resources, increased genetic structuring, and increased probability of local extirpation (e.g., Forman et al. 2003; Fahrig and Rytwinski 2009; D'Amico et al. 2016). Depletion effects occur when animals attempt to cross roads and are killed by vehicles. Depletion effects include all of the risks from barrier effects as well as reduced survivorship, making high road mortality an even greater concern (Jackson and Fahrig 2011). Among other stressors, such as habitat loss and fragmentation, invasive species, pesticide use, changing climate, and disease, the negative impacts from roads may independently or cumulatively threaten the persistence of populations and even species.

Amphibians and reptiles have been identified as being particularly susceptible to the negative effects of roads within their habitat (e.g., Klauber 1931; Forman et al. 2003; Rytwinski and Fahrig 2012; Andrews et al. 2015a, b; D'Amico et al. 2015). Many are slow moving, do not avoid roads, and are simply too small for drivers to see and avoid. During rains many amphibians make long linear terrestrial movements regardless of the presence of intersecting roadways (Glista et al. 2008), and because paved roads typically absorb and retain more heat than the surrounding habitat, snakes and lizards are often attracted to roads for thermoregulation (Case and Fisher 2001; Jochimsen et al. 2004). In fact, road surveys are one of the most common methods for surveying these reptiles (e.g., Sullivan 2012). Many herpetofauna species utilize both aquatic and terrestrial habitat for breeding, development, foraging, and overwintering and therefore require connectivity within and between both aquatic and terrestrial habitats to support basic life history requirements.

The primary goal of this study was to provide information to transportation and other planning agencies in California to assist them in prioritizing road mitigation efforts for amphibian and reptile species. Although there is still a lot to learn about the effectiveness of different designs of road mitigation

systems, the use of barrier systems, underpasses, and overpasses can reduce road mortality and help to maintain connectivity and safe passage across roads for herpetofauna and other wildlife (Jochimsen et al. 2004; Colino-Rabanal and Lizana 2012; Langton 2015; Langen et al. 2015b). Because it is currently unrealistic and cost prohibitive to mitigate all roadways for all species, it is vital to identify species most susceptible to road-related impacts. Within species ranges, risks to populations and need for mitigation can then be evaluated based upon local road densities and matrix, road-types, traffic, and road locations in relation to species habitat and movement corridors (e.g., Jaeger 2000; Litvaitis and Tash 2008; Langen et al. 2015b; Zimmermann Teixeira et al. 2017).

Here we describe a road risk assessment methodology applied to native amphibian and reptile species in California, a global biodiversity hotspot (Myers et al. 2000). We also included analysis of subspecies if they had special federal or state protection status. This includes 166 species and subspecies of frogs, toads, salamanders, snakes, lizards, turtles, and tortoise. Rankings and prioritizations such as these can be very subjective. In order to avoid including low risk species that may be favored by the assessors or to unintentionally overlook species that are at high risk, it was important for this be done in an objective manner informed by current road ecology literature.

Very few quantitative data are available on the impact of roads on population persistence. Jaeger et al. (2005) were the first to develop a relative ranking system to compare the impact of roads on wildlife populations. Their ranking system was largely based upon behavioral responses of animal species to the road surface, road size, traffic noise, and vehicles with varying road sizes and traffic volumes. However, knowledge of these detailed behavioral responses to ranges in road and traffic characteristics is rarely found in literature and the link between individual behavior and population-level effects has not been clearly established (Rytwinski and Fahrig 2012, 2013).

Rytwinski and Fahrig (2012) performed a meta-analysis of wildlife groups to test whether certain life history characteristics were related to negative responses to roads. High reproductive rate (fecundity) was negatively associated with the magnitude of population-level effects for amphibians. No associations were significant in reptiles, although there were

few studies to inform this analysis. However, a strong link was shown between body size, greater mobility, lower reproductive rates and the magnitude of negative road effects in mammals, the most studied wildlife group. Conversely, simulations predicted populations of species with small home ranges and high reproductive rates were the least likely to be affected by roads (Rytwinski and Fahrig 2013).

We used these findings as a basis for creating a multi-tiered system to rank and identify reptile and amphibian species that may be most susceptible to road impacts. We based our ranking upon a suite of species life history and space-use characteristics associated with negative road effects, as well as including species distribution and conservation status. We evaluated risk to both aquatic and terrestrial connectivity and include buffer distances that were calculated to encompass 95% of population movements. Relative confidence in these distances is given for each species based upon the amount of support from scientific studies. We solely focused on the direct effects of roads as barriers and sources of road mortality and not impacts from road construction and maintenance or indirect effects from increased human use of the landscape once a road is in place (see review by Langen et al. 2015a).

Because we based the risk assessment solely upon space-use and life history characteristics, this represents a species relative susceptibility to road impacts. It is understood that circumstances associated with particular populations (e.g., local road types, locations, densities) may elevate or reduce the risk for certain populations and species.

## Methods

### Road risk assessment (overview)

We assessed the relative risk of California herpetofauna species to negative road-related impacts at three scales in a hierarchical fashion. We first assessed risk at the scale of an individual animal and then expanded the risk to the population and then to species (Fig. 1).

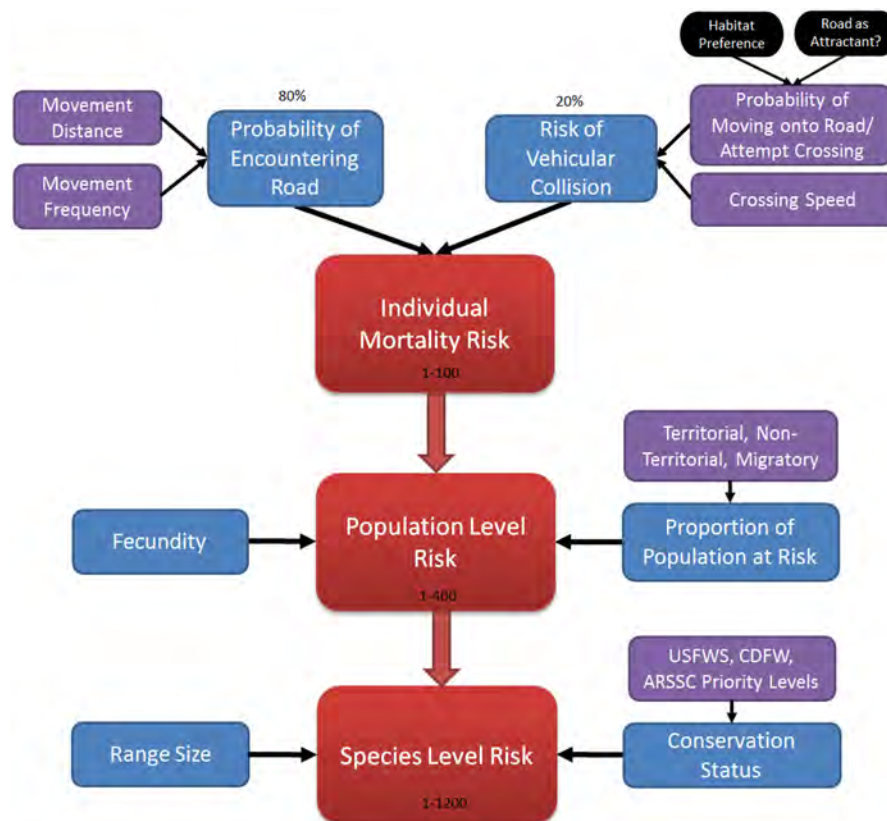
At the individual-level, we based road risk primarily upon the likelihood that an individual would encounter one or more roads. We considered this a product of movement distance (home range, seasonal migrations) and movement frequency (e.g., active

foragers, seasonal migrants, sit-and-wait predators vs. sedentary species) (e.g., Bonnet et al. 1999; Carr and Fahrig 2001). Because many species are semi-aquatic, movement distance and frequency were scored separately for both aquatic and terrestrial habitats.

There is a theorized higher risk associated with depletion effects (i.e., road mortality) in comparison to barrier effects (Fahrig and Rytwinski 2009; Jackson and Fahrig 2011). Therefore, we gave additional weight to those species more likely to go out onto a road surface and be killed by vehicular traffic. For this we considered factors of habitat preference (e.g., open vs. closed), roads as potential attractants (e.g., for basking), and movement speed (e.g., slow vs. fast). However, individuals within and among species may respond differently to roads (attraction vs. avoidance) based upon local landscape features, road width, traffic volume, and perceived danger (Forman et al. 2003; Andrews 2005; Brehme et al. 2013; Jacobson et al. 2016). Because a state-wide analysis encompasses extreme variation in landscape and road characteristics, the extent to which roads act as barriers or sources of direct mortality within a species range is unknown. The risk disparity between depletion and barrier effects could also be highly variable. Therefore, we limited the additional weight for potential depletion effects to twenty percent of the individual risk score.

We assessed population-level road risk by multiplying individual risk with scores representing: (1) the relative proportion of the population at risk; and (2) the species ability to sustain higher rates of mortality. For instance, the proportion of the population at risk was expected to be higher for migratory species than for territorial species. Highly fecund species were expected to better withstand (or more quickly recover from) higher mortality in comparison to those with few annual offspring.

Finally, we assessed species-level road risk by multiplying population road risk with scores for range size (both within and outside of California) and conservation status according to the U.S. Fish and Wildlife Service (USFWS 2016) and the California Department of Fish and Wildlife (CDFW 2016a; Thomson et al. 2016). Species with smaller ranges typically have fewer populations and are thus less resilient to population-level stressors. Endangered, threatened, and special concern species have already been designated at risk of extirpation, often due to



**Fig. 1** California reptile and amphibian road risk assessment conceptual model (ARSSC Amphibian and Reptile Species of Special Concern (Thomson et al. 2016))

multiple stressors, and are thus thought to be less likely to be resilient to additional road impacts.

Although we present both aquatic and terrestrial risk scores for semi-aquatic species, we used the higher of the two scores for the overall risk ranking.

#### Literature review

Species life history data were primarily taken from and cross-checked among the following species account review sources;

1. U.S. Fish and Wildlife Service (USFWS) Recovery Plans and 5-year Reviews <https://www.fws.gov/endangered/>.
2. California Amphibian and Reptile Species of Special Concern (ARSSC; Thomson et al. 2016).
3. A Field Guide to Amphibians and Reptiles of California (Stebbins and McGinnis 2012)
4. Amphibian declines: the conservation status of United States species (Lannoo 2005).
5. Conservation Status of Amphibians and Reptiles on USDA National Forests, Pacific Southwest Region, 2012 (Evelyn and Sweet 2012).
6. NatureServe Explorer (natureserve.org): Species Accounts largely authored by G. Hammerson (2003–2016).

When these reviews were lacking life history information needed for the road risk assessment, we then searched for supplementary peer-reviewed literature using the Google Scholar search engine. Because movement distances (terrestrial, aquatic, home range, migratory) were so important for the risk assessment, we acquired referenced articles from the species accounts and independently searched the literature to acquire these data. Search terms included the species common name, scientific name, or genus and terms such as “movement”, “home-range”, “spatial”, and “telemetry”. We also reviewed articles for citations of other studies to find more recent information on movement. This literature included published articles,

book chapters, M.S. Theses, Ph.D. dissertations, agency reports, and consultant reports. In the case that specific life history or movement information was not found for a species, we chose a surrogate species based upon phylogeny, habitat, and body size. We first looked for the closest related species within the genus or family and chose a closely related surrogate based upon similar habitat and body size. If surrogates were used, these are clearly reported.

#### Road risk metrics

The following section describes in detail the rank scoring used for Individual-level Road Risk, Population-level Road Risk, and Species-level Road Risk. All rank values are meant to represent the relative contribution of each attribute to either additive or multiplicative road risk.

#### *Individual-level risk (100 points possible)*

Out of a total of 100 points for individual road mortality risk, we attributed up to 80 points (80%) to the risk of encountering a road and up to 20 points (20%) for the risk of an individual moving onto a road and being killed by a motor vehicle.

The risk of encountering a road was based on a combination of movement distance and general movement frequency. Movement distance was ranked 1–40 based upon home range movement distances (diameter) for non-migrants or migration distances for seasonal migrants that spanned from 0 to > 1200 m (Table 1). The scores are linearly correlated with increasing movement distance.

For species that use both terrestrial and wetland/stream/riverine habitats, such as frogs, toads, aquatic snakes and turtles, we scored aquatic and terrestrial movement distances and frequencies separately. This was necessary as some species move much larger distances and at different frequencies in one habitat versus the other. This also informs the type(s) of mitigation structures that may be warranted based upon habitat type, buffer distances and risk scores for each species. Aquatic movement distances were not calculated for pond-breeding amphibians. Ponds are typically small ephemeral bodies of water and terrestrial movements of amphibians to and among ponds

**Table 1** Individual-level Road Risk (IRR): Score criteria for risk of individuals encountering a road

Risk of individuals encountering a road = Movement distance × frequency			
Movement distance (m)	Score	Frequency	Score
> 1200	40	Active throughout home range	2
901–1200	32	Migratory (2–4 × per year)/ non-migratory sit and wait foragers	1.5
601–900	24	Sedentary, confined to specialized habitat	1
451–600	16		
301–450	12		
201–300	8		
101–200	5		
51–100	3		
0–50	1		

account for the majority of movement for these species.

The calculations and rankings for movement distances were well considered and deserve further explanation. Our original thinking was that maximum distances should reflect relative movement distances across species and these data were commonly reported in species accounts. However, it became increasingly difficult to determine whether maximum distances reported were seasonal migration movements, home range movements or rarer dispersal events. We believed this assessment should reflect annual movement distances and not rare dispersal events. We considered using average/median movement distances; however, these often underestimate the movement of seasonal migrants because in many cases a sizeable portion of the population may remain close to a breeding site, while another sizable portion make longer distance migrations causing an average or median to be uninformative. Therefore, we decided to use a buffer distance that incorporates the movement distances of 95% of the population studied. A 95% population movement distance is commonly accepted for the delineation of terrestrial buffer zones for amphibians (i.e., Semlitsch 1998; Semlitsch and Bodie 2003) and we believe it was the most biologically



meaningful and useful measure for this study. This measure, which we will refer to as Maximum Population Movement Distance (MPMD), should include almost all population movements, such as seasonal migration distances and annual home ranges (diameter), but not rare dispersal events. The MPMD should also be useful for local risk assessments as these distances can be used to aide in mapping and mitigation decisions.

The calculation we used for MPMD is commonly known as the 95% upper tolerance interval (Vangel 2015). A tolerance interval is an interval that is meant to contain a specified percentage of individual population measurements. This should not be confused with a confidence interval, which is an interval that is meant to contain the population mean. We chose a 50% confidence level for the upper 95% confidence limit of movement distances which is equal to the 95% prediction interval for future observations and is the mean + 1.645 × standard deviation. In cases where a standard deviation was not reported, we back calculated standard deviation from the standard error and sample size, calculated it from the individual data, or estimated it based on the methods recommended by Hozo et al. (2005). Although non-parametric tolerance intervals would be more appropriate for non-normally distributed movement data, the data required to calculate these is rarely reported in the published literature. In the case of non-normally distributed data where medians, sample sizes and ranges are reported, Hozo et al. (2005) methods allow for approximation of means and standard deviations with no assumption of the underlying data distribution. We found the resulting MPMDs to be reasonable in excluding large outliers but including multiple long distance movements below the maximum movement distance.

We recognize that for any species there can be substantial variability in movement distances that depend upon varying local, landscape, and climatic factors. This was often reflected in studies with sometimes widely varying estimates of home range and migration distances. We attempted to be conservative by using the study data for calculation of MPMD in which the largest population movement distances were observed. For studies where movement distance significantly varied between females and males, we used the information from the wider ranging sex. For migratory distances, we did not use distances from extreme environments, such as Canada, where

suitable overwintering sites are typically much farther away from breeding and summer activity areas than in milder California climates (e.g., Gregory 1984). We did use study data from adjacent states or lower estimates of migration distances from those reported in Midwestern states. In some cases where little information was available, we made an educated guess based upon limited study data and/or closely related species and noted these in the tables. For all MPMDs, we report a relative confidence level based upon the number and quality of studies, sample sizes, and locations in or adjacent to California. It is intended that the scores be adjusted as new information becomes available.

To compute the risk of encountering a road, the MPMD was multiplied by a relative index of the expected frequency of longer distance movements (1–2 points; Table 1). We defined three frequency categories largely based upon annual migratory movements or foraging strategies for non-migratory species. The highest category included actively foraging predators which are characterized by frequent wandering movements throughout their home range (Pianka 1966). Less frequent movers included seasonal migrants traveling among breeding, summer foraging, and/or overwintering sites and non-migratory ‘sit-and-wait’ predators that remain still for long periods of time to ambush prey (Pianka 1966). Finally, low frequency included highly sedentary species with high site fidelity, particularly specialized rock, crevice, soil, or tree dwellers that may rarely traverse terrestrial or aquatic habitats.

The risk of an individual moving onto a road and being killed by a moving vehicle was ranked by attributes of habitat preference, road use, and movement speed (Table 2). Habitat preference represents the degree to which an individual is expected to go out onto or avoid an open road as predicted from their habitat and microhabitat preferences. Open habitat specialists and generalists were expected to more readily move onto a road than species that prefer cover (e.g., Forman et al. 2003; Brehme et al. 2013). Although many amphibians are closed habitat specialists, most readily move through open habitats during rain events, when most overland migratory movements tend to occur (Glista et al. 2008). Therefore, amphibians were considered open habitat specialists for this ranking. An additional factor that may increase road use is for thermoregulation for lizards



**Table 2** Individual-level Road Risk (IRR): Score criteria for risk of road mortality

Risk of road mortality = Habitat preference + road use + movement speed					
Habitat preference	Score	Road use	Score	Movement speed	Score
Open habitat specialist/amphibians	10	Thermoregulation (snakes/lizards)	4	Slow (< 0.6 m/s)	6
Generalist	8	Other	0	Medium (0.6–2.0 m/s)	3
Edge specialist	4			Fast (> 2.0 m/s)	0
Closed habitat or aquatic specialist	0				

**Table 3** Population-level Road Risk (PRR): Score criteria for population level road risk

PRR = IRR × (Fecundity + Proportion of population at risk)					
Fecundity	Ave. potential offspring/year	Score	Proportion of population at risk	Score	
Low	0–10	2	Seasonal migrants (Migratory)	2	
Med	11–25	1.5	Wandering	1.5	
High	26–100	1	Territorial	1	
Very high	> 100	0			

and snakes, as roads often retain more heat than the surrounding environment (Colino-Rabanal and Lizana 2012; Mccardle and Fontenot 2016). Finally, there is an increased risk of road mortality for slow versus fast moving species (see Andrews and Gibbons 2005; Mazerolle et al. 2005; Andrews et al. 2015b).

#### *Population-level Road Risk (400 points possible)*

To assess the risk of negative road impacts on the persistence of a population we incorporated scores for population-level movement behavior and fecundity (Table 3). For the proportion of a population expected to encounter a road, we scored the greatest risk to species that seasonally migrate to overwintering and breeding areas (Jackson et al. 2015). For those that do not migrate, we expected higher proportions of non-territorial or loosely territorial species (“wandering”) to encounter roads than species that defend distinct territories.

Species with low fecundity are less resilient to road mortality impacts than highly fecund species (Rytwinski and Fahrig 2013). Relative fecundity was simply calculated from the average number of potential offspring per year whether the animals were oviparous or live-bearing. For egg-laying species, the number of

potential offspring was calculated by multiplying the average clutch size by the average number of clutches per year.

Individual mortality risk (1–100 points) was multiplied by the sum of these population-level factors (1–4 points) to calculate population-level road risk.

#### *Species-level road risk (1200 points possible)*

In comparison to population-level risk, we considered the overall risk of roads to species to be negatively associated with species range and conservation status. Although some populations may be at high risk, species with a wide distribution and many populations should be more resilient to localized declines and extirpations. Therefore, we assigned a range isolation score ranging from 0 to 1 that considered species distributions range-wide (North America) and within California (CA) (Table 4). Range-wide distribution varied from “CA only” to “widespread” (> 4 states). If the species range extended into Mexico and/or Canada, these countries were counted as another state for calculation of the index. California-wide distribution was calculated based upon the number of CA geographic regions occupied out of twelve regions defined by Hickman (1993) and used in Stebbins and

**Table 4** Species-level Road Risk (SRR): Score criteria for species-level road risk

$$\text{SRR}^a = \text{PRR} \times ((\text{Range isolation score} + \text{Conservation status score})/2)$$

(a) Range isolation score = (North America range + CA range)/2

North America range	Rank/score
CA only	1.00
2 states (very restricted distribution)	1.00
2 states (restricted)	0.67
2–3 states	0.33
Widespread (4 + states)	0.00
California range (No. of geographic regions occupied)	Rank/score
1	0.92
2	0.83
3	0.75
4	0.67
5	0.58
6	0.50
7	0.42
8	0.33
9	0.25
10	0.17
11	0.08
12	0.00

(b) Conservation status score

Conservation status	Rank/score <sup>a</sup>
CA or federal threatened/endangered	1.00
SSC priority 1	0.75
SSC priority 2	0.50
SSC priority 3	0.25
None	0.00

<sup>a</sup>Population-level risk > 80 only

McGinnis (2012). These two scores (Range-wide isolation, CA isolation) were summed and divided by two in order to normalize the overall range isolation score to a 0 to 1 scale.

At the species-level, we also incorporated conservation status (Table 4). Some species are declining and are at higher risk of extinction often due to multiple stressors. Federal and State Threatened and Endangered Species were given the highest score (1.0). In California, forty-five species are designated “Species of Special Concern (SSC)” with a ranking of 1, 2, or 3 based upon severity and immediacy of threats affecting each taxon (Thomson et al. 2016). SSC species were given a conservation status score ranging

from 0.25 to 0.75 based upon their SSC ranking. Population-level Road Risk (score range 1–400) was multiplied by (1 + Range Isolation Score + Conservation Status Score; score range 1–3) to calculate the final Species-level Road Risk.

Range and conservation status were only used as a multiplier for species-level road risk if the population-level road risk was greater than 80 (20% of possible population score). This helped to prevent false inflation of the road risk metrics for low road susceptible species.

Because all members of the genus *Batrachoseps* (slender salamanders) are similar in body size, range size and general life history characteristics, we scored

**Table 5** Species-level frequency distributions and road risk rankings

Percentile	Scores	Relative ranks
81–100	322–710	Very high
61–80	213–321	High
41–60	63–212	Medium
21–40	53–62	Low
1–20	0–52	Very Low

the genus as whole with the most conservative estimates and conservation status but included all 20 species in the final count and calculations.

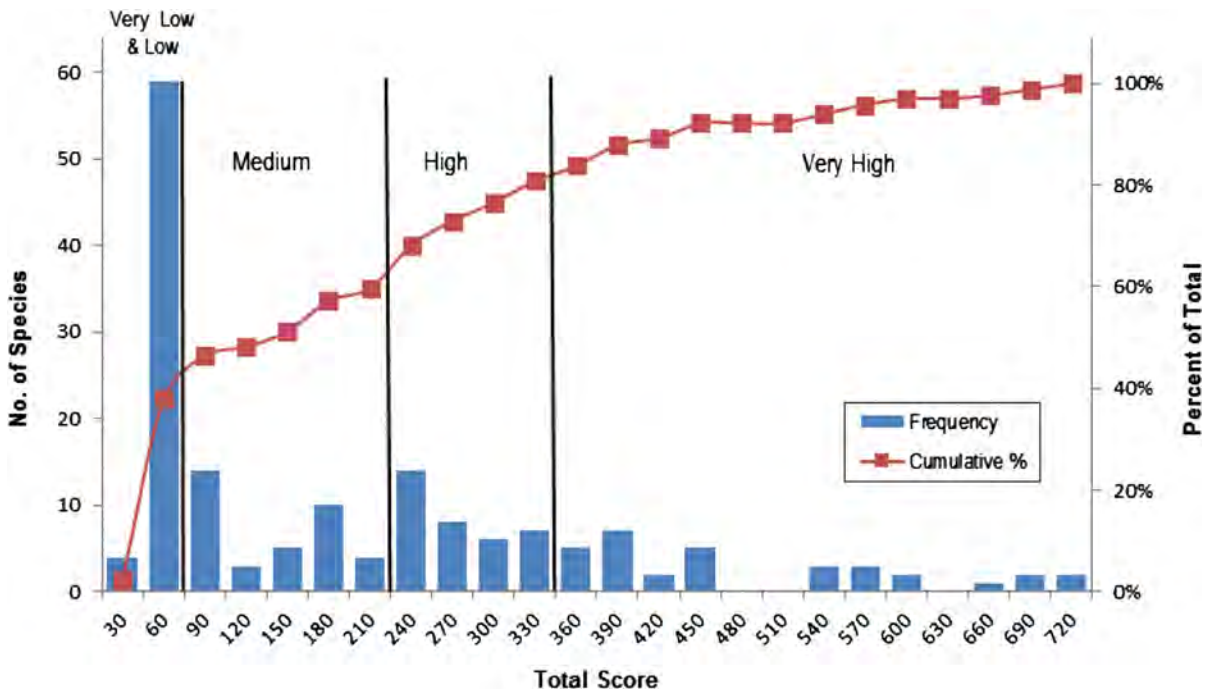
Once all 166 species (including subspecies with conservation status) were scored for species-level road risk within both terrestrial and aquatic habitats, we took the maximum score for each species and sorted them from the highest to lowest scores. We grouped species into categories of risk (Very high, high, medium, low, and very low) based upon ranges of values that represented frequency distributions in 20% increments of all species scores (Table 5, Fig. 2).

As a way to support the results of our ranking model with species literature, we focused on special status species. We reviewed recovery plans and 5-year reviews for federally listed species and state species accounts for California listed species and species of special concern (collectively referred to as special status species). For each rank group (i.e., “very low” to “very high”), we calculated the percentage of special status species where roads were specifically listed as a threat. Similarly, we tallied the number of species identified in a recent California preliminary road risk assessment (Levine 2013, Amy Golden pers. comm.) and compared the number of species that fell within each of our road risk categories.

**Results**

All chelonids, 72% of snakes, 50% of anurans, 18% of lizards and 17% of salamander species were ranked as high or very high risk from negative road impacts. (Table 6, Fig. 3).

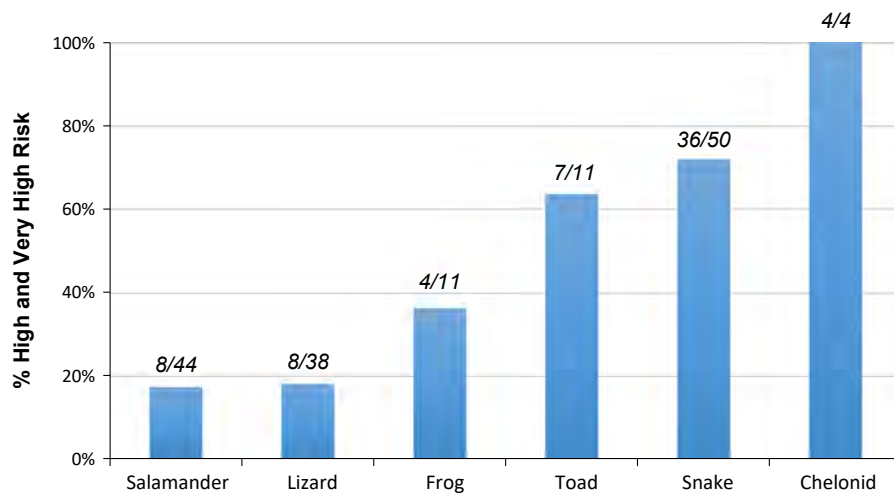
Review of species accounts, recovery plans, and 5-year reviews for all special status species showed



**Fig. 2** Histogram of species-level scores and approximate 20 percentile road risk categories

**Table 6** Numbers of species by taxa within each risk category

Species group	Species-level rankings				
	Very high	High	Med	Low	Very low
Salamander	4	4	3	26	9
Lizard	5	3	8	7	21
Anuran	5	6	6	4	1
Snake	15	21	13	0	1
Tortoise	1	0	0	0	0
Turtle	3	0	0	0	0

**Fig. 3** Percentages of species by taxa in high and very high road risk categories

that 94% (17/18) of species accounts that referenced roads as a threat to the species were ranked as “high” or “very high” in our risk assessment (Table 7). Of the special status species that ranked ‘high’ and ‘very high’, close to fifty percent (17/35) had road-related threats referenced in their listing literature. In comparison, only 4% (1/27) of ‘medium’ to ‘very low’ risk

special status species accounts mentioned roads as a potential threat. In addition, 79% (15/19) of species of concern recommended in a recent Caltrans preliminary road risk assessment scored as ‘high’ or ‘very high’ risk in our analysis (Levine 2013, Amy Golden pers. comm.).

**Table 7** Comparison of road risk results and number of special status species with roads listed as threat

Road risk level	Special status species			Caltrans PI <sup>a</sup>
	No. species in road risk level	No. species with roads listed as threat	% of Total	No. Spp in road risk level
Very high	25	14	56	11
High	11	3	27	4
Medium	5	1	20	3
Low	10	0	0	1
Very low	7	0	0	0

<sup>a</sup>Caltrans PI are Caltrans identified sensitive species

**Table 8** Amphibian and reptile road risk assessment: very high risk species (80–100% percentile), high risk species (60–80% percentile), medium risk species (40–60% percentile

range), low risk species (20–40% percentile) and very low risk species (0–20% percentile)

Risk Level-Species	Species			Road Risk Scores			Status		
	Group	Common Name	Scientific name	Maximum (Aquatic & Terrestrial) <sup>a</sup>	Terrestrial	Aquatic (Wetlands/ Rivers/ Streams, Perennial to Intermittent)	Federal or State Listing/ ARSSC Priority Rank (1-3) <sup>b</sup>	Roads Listed as Potential Threat in Listing? <sup>c</sup>	Caltrans Identified Sensitive Species? <sup>d</sup>
Very High	Snake	Giant Gartersnake	<i>Thamnophis gigas</i>	710	44	710	THR	Yes	Yes
	Turtle	Southern Western Pond Turtle	<i>Actinemys pallida</i>	707	283	707	1		Yes
	Snake	San Joaquin Coachwhip	<i>Masticophis flagellum ruddocki</i>	689	689	-	2	Yes	
	Snake	San Francisco Gartersnake	<i>Thamnophis sirtalis tetrataenia</i>	663	238	663	END		Yes
	Snake	Alameda Striped Racer	<i>Masticophis lateralis euryxanthus</i>	652	652	-	THR	Yes	
	Snake	California Red-sided Gartersnake	<i>Thamnophis sirtalis infernalis</i>	588	211	588	1		
	Tortoise	Mohave Desert Tortoise	<i>Gopherus agassizii</i>	580	580	-	THR	Yes	Yes
	Salamander	Red-bellied Newt	<i>Taricha rivularis</i>	561	561	72	2	Yes	Yes
	Turtle	Northern Western Pond Turtle	<i>Actinemys marmorata</i>	547	219	547	3		Yes
	Snake	Two-striped Gartersnake	<i>Thamnophis hammondi</i>	541	195	541	2		
	Snake	Baja California Coachwhip	<i>Masticophis fuliginosus</i>	534	534	-	3	Yes	
	Snake	Coast Patch-nosed Snake	<i>Salvadora hexalepis virgulata</i>	533	533	-	2	Yes	
	Salamander	California Newt	<i>Taricha torosa</i>	532	532	72	2	Yes	Yes
	Lizard	Banded Gila Monster	<i>Heloderma suspectum cinctum</i>	446	446	-			
	Salamander	California Tiger Salamander	<i>Ambystoma californiense</i>	437	437	-	THR	Yes	Yes
	Salamander	Sierra Newt	<i>Taricha sierrae</i>	437	437	72			
	Snake	Striped Whipsnake	<i>Masticophis taeniatus</i>	425	425	-			
	Lizard	Flat-tail Horned Lizard	<i>Phrynosoma mcallii</i>	425	425	-	2	Yes	
	Turtle	Sonoran Mud Turtle	<i>Kinosternon sonoriense</i>	399	37	399	1		
	Lizard	Blunt-nosed Leopard Lizard	<i>Gambelia sila</i>	393	393	-	END	Yes	Yes
	Snake	Baja California Ratsnake	<i>Bogertophis rosaliae</i>	387	387	-			
	Snake	Panamint Rattlesnake	<i>Crotalus stephensi</i>	387	387	-			
	Frog	California Red-legged Frog	<i>Rana draytonii</i>	380	380	300	THR	Yes	Yes
	Toad	Yosemite Toad	<i>Anaxyrus canorus</i>	379	379	284	THR	Yes	
	Toad	Black Toad	<i>Anaxyrus exsul</i>	379	379	284	THR		
	Lizard	Cope's Leopard Lizard	<i>Gambelia copeii</i>	372	372	-	2		
	Toad	Sonoran Desert Toad	<i>Incilius alvareus</i> (Possibly extinct in CA)	361	361	285	1		
	Lizard	Desert Horned Lizard	<i>Phrynosoma platyrhinos</i>	356	356	-			
	Snake	California Glossy Snake	<i>Arizona elegans occidentalis</i>	340	340	-	1		
	Snake	North American Racer	<i>Coluber constrictor</i>	334	334	-			
Snake	Coachwhip	<i>Masticophis flagellum</i>	333	333	-				
Toad	Arroyo Toad	<i>Anaxyrus californicus</i>	331	331	248	END	Yes	Yes	
Snake	Striped Racer	<i>Masticophis lateralis</i>	322	322	-				

<sup>a</sup> Maximum scores color-coded for toad risk type; terrestrial (gray), aquatic (blue), or both (gray/blue)  
<sup>b</sup> END=Endangered, THR= Threatened, 1-3= ARSSC Priority Ranking

<sup>c</sup> Federal Recovery plans, 5-year reviews, California species accounts for special status species  
<sup>d</sup> California Amphibian and Reptile Crossing Preliminary Investigation

Risk scores and relative rankings for California reptile and amphibian species in both terrestrial and aquatic habitats are presented in Tables 8. Terrestrial and Aquatic rankings are provided separately in Tables 9 and 10 and also include population-level risk scores, 95% population buffer distances, confidence levels, and identification of any surrogate species used for the distance calculations. Species scores for all ranking criteria and life history and movement references are provided in Appendices 1 and 2.

### Discussion

To our knowledge, this is the first attempt to objectively assess the relative risk of roads at a species level using a logical and scientifically based framework and apply it across a large array of species and habitats. We believe this approach could be useful for assessing and comparing susceptibility of species to negative road impacts within and among all taxonomic groups. To date, such risk assessments have been based largely upon expert opinion, limited information available on



Table 8 continued

Risk Level-Species	Species			Road Risk Scores			Status		
	Group	Common Name	Scientific name	Maximum (Aquatic & Terrestrial) <sup>a</sup>	Terrestrial	Aquatic (Wetlands/ Rivers/ Streams, Perennial to Intermittent)	Federal or State Listing/ ARSSC Priority Rank (1-3) <sup>b</sup>	Roads Listed as Potential Threat in Listing? <sup>c</sup>	Caltrans Identified Sensitive Species? <sup>d</sup>
High	Snake	Red Diamond Rattlesnake	<i>Crotalus ruber</i>	321	321	-	3	Yes	
	Snake	Speckled Rattlesnake	<i>Crotalus mitchelli</i>	317	317	-			
	Frog	Oregon Spotted Frog	<i>Rana pretiosa</i> (Possibly extinct in CA)	315	41	315	THR		
	Salamander	Santa Cruz Long-toed Salamander	<i>Ambystoma macrodactylum croceum</i>	308	308	-	END	Yes	Yes
	Salamander	Rough-skinned Newt	<i>Taricha granulosa</i>	304	304	72			
	Snake	Sierra Gartersnake	<i>Thamnophis couchii</i>	304	44	304			
	Snake	Regal Ring-necked Snake	<i>Diadophis punctatus regalis</i>	298	298	-	2		Yes
	Snake	California Lyresnake	<i>Trimorphodon lyrophanes</i>	293	293	-			
	Frog	Northern Red-legged Frog	<i>Rana aurora</i>	291	291	230	2		Yes
	Snake	Mojave Rattlesnake	<i>Crotalus scutulatus</i>	276	276	-			
	Snake	Western Patch-nosed Snake	<i>Salvadora hexalepis</i>	276	276	-			
	Snake	Common Gartersnake	<i>Thamnophis sirtalis</i>	271	165	271			
	Snake	Aquatic Gartersnake	<i>Thamnophis atratus</i>	266	40	266	0		
	Snake	Sidewinder	<i>Crotalus cerastes</i>	263	263	-			
	Salamander	California Giant Salamander	<i>Dicamptodon ensatus</i>	260	260	72	3	Yes	
	Snake	Sonoran Lyresnake	<i>Trimorphodon lambda</i>	260	260	-			
	Snake	Western Rattlesnake	<i>Crotalus oregonus</i>	250	250	-			
	Snake	Northwestern Gartersnake	<i>Thamnophis ordinoides</i>	245	138	245			
	Snake	Desert Nightsnake	<i>Hypsiglena chlorophaea</i>	241	241	-			
	Snake	Western Terrestrial Gartersnake	<i>Thamnophis elegans</i>	240	75	240			
	Lizard	Switak's Banded Gecko	<i>Coleonyx switaki</i>	236	236	-	THR		
	Toad	Western Spadefoot	<i>Spea hammondi</i>	234	234	-	1		Yes
	Snake	Coast Nightsnake	<i>Hypsiglena ochrorhyncha</i>	233	233	-			
	Lizard	Long-nosed Leopard Lizard	<i>Gambelia wislizenii</i>	226	226	-			
	Toad	Great Plains Toad	<i>Anaxyrus cognatus</i>	222	222	175			
	Toad	Woodhouse's Toad	<i>Anaxyrus woodhousii</i>	222	222	175			
	Lizard	Coastal Whiptail	<i>Aspidoscelis tigris stejnegeri</i>	219	219	-	2		
	Snake	Western Shovel-nosed Snake	<i>Chionactis occipitalis</i>	218	218	-			
	Snake	Spotted Leaf-nosed Snake	<i>Phyllorhynchus decurtatus</i>	218	218	-			
	Salamander	Southern Long-toed Salamander	<i>Ambystoma macrodactylum sigillatum</i>	217	217	-	2		
	Frog	Cascades Frog	<i>Rana cascadae</i>	217	217	72	2		
	Snake	Western Diamond-backed Rattlesnake	<i>Crotalus atrox</i>	214	214	-			
Snake	Western Groundsnake	<i>Sonora semiannulata</i>	212	212	-				

<sup>a</sup> Maximum scores color-coded for road risk type: terrestrial (gray), aquatic (blue), or both (gray/blue)

<sup>b</sup> END=Endangered, THR= Threatened, 1-3= ARSSC Priority Ranking

<sup>c</sup> Federal Recovery plans, 5-year reviews, California species accounts for special status species

<sup>d</sup> California Amphibian and Reptile Crossing Preliminary Investigation

road mortality, and even less information available on population or species-level road effects (Levine 2013; Rytwinski and Fahrig 2015).

Overall, this is meant to be a first step in highlighting reptile and amphibian species that may be at highest risk from roads transecting their habitat. These species may deserve consideration for further study and for implementing mitigation solutions to reduce mortality and to maintain or enhance connectivity. The risk assessment was done for both terrestrial and

aquatic habitats to further inform mitigation. Some aquatic species may greatly benefit from fish passages while others may better benefit from terrestrial barriers and wildlife crossings or both.

Although data are currently lacking to validate completely the scoring and results of the risk assessment, our review of species accounts, recovery plans, 5-year reviews for federal and state-listed species and California species of special concern show a strong association between elevated road risk from our



Table 8 continued

Risk Level-Species	Species			Road Risk Scores			Status		
	Group	Common Name	Scientific name	Maximum (Aquatic & Terrestrial) <sup>a</sup>	Terrestrial	Aquatic (Wetlands/ Rivers/ Streams, Perennial to Intermittent)	Federal or State Listing/ ARSSC Priority Rank (1-3) <sup>b</sup>	Roads Listed as Potential Threat in Listing? <sup>c</sup>	Caltrans Identified Sensitive Species? <sup>d</sup>
Medium	Snake	Checkered Gartersnake	<i>Thamnophis marcianus</i>	210	69	210			
	Lizard	Blainville's Horned Lizard	<i>Phrynosoma blainvillii</i>	209	209	-	2		Yes
	Frog	Foothill Yellow-legged Frog	<i>Rana boylei</i>	199	26	199	1		
	Snake	Gopher Snake	<i>Pituophis catenifer</i>	189	189	-			
	Snake	California Mountain Kingsnake	<i>Lampropeltis zonata</i>	184	184	-			Yes
	Snake	Glossy Snake	<i>Arizona elegans</i>	180	180	-			
	Lizard	Pygmy Short-horned Lizard	<i>Phrynosoma douglasii</i>	179	179	-			
	Toad	Couch's Spadefoot	<i>Scaphiopus couchii</i>	178	178	-	3		
	Snake	California Kingsnake	<i>Lampropeltis californiae</i>	175	175	-			
	Snake	Long-nosed Snake	<i>Rhinocheilus lecontei</i>	165	165	-			
	Toad	Western Toad	<i>Anaxyrus boreas</i>	165	165	130			
	Snake	Ring-necked Snake	<i>Diadophis punctatus</i>	164	164	-			Yes
	Lizard	San Diego Banded Gecko	<i>Coleonyx variegatus abbotti</i>	158	158	-	3	Yes	
	Salamander	Northwestern Salamander	<i>Ambystoma gracile</i>	152	152	-			
	Toad	Great Basin Spadefoot	<i>Spea intermontana</i>	152	152	-			
	Toad	Red-spotted Toad	<i>Anaxyrus punctatus</i>	147	147	72			
	Salamander	Long-toed Salamander	<i>Ambystoma macrodactylum</i>	143	143	-			
	Lizard	Orange-throated Whiptail	<i>Aspidoscelis hyperythra</i>	137	137	-			
	Snake	Smith's Black-headed Snake	<i>Tantilla hobartsmithi</i>	136	136	-			
	Snake	California Black-headed Snake	<i>Tantilla planiceps</i>	133	133	-			
	Lizard	Western Whiptail	<i>Aspidoscelis tigris</i>	118	118	-			
	Salamander	Coastal Giant Salamander	<i>Dicamptodon tenebrosus</i>	117	117	48			
	Lizard	Western Banded Gecko	<i>Coleonyx variegatus</i>	105	105	-			
	Lizard	Common Chuckwalla	<i>Sauromalus ater</i>	78	78	-			
	Snake	Northern Rubber Boa	<i>Charina bottae</i>	77	77	-			
	Snake	Southern Rubber Boa	<i>Charina umbratica</i>	77	77	-	THR		
	Snake	Northern Three-lined Boa	<i>Lichanura orcutti</i>	77	77	-			
	Lizard	Desert Iguana	<i>Dipsosaurus dorsalis</i>	72	72	-			
	Snake	Forest Sharp-tailed Snake	<i>Contia longicauda</i>	70	70	-			
	Snake	Common Sharp-tailed Snake	<i>Contia tenuis</i>	70	70	-			
	Frog	Pacific Treefrog	<i>Pseudacris regilla</i>	68	68	36			

<sup>a</sup> Maximum scores color-coded for road risk type: terrestrial (gray), aquatic (blue), or both (gray/blue)  
<sup>b</sup> END=Endangered, THR= Threatened, 1-3= ARSSC Priority Ranking

<sup>c</sup> Federal Recovery plans, 5-year reviews, California species accounts for special status species  
<sup>d</sup> California Amphibian and Reptile Crossing Preliminary Investigation

objective analysis and the probability that roads are listed as a potential threat to the species in the species listing literature.

Although more than 40% of special status species are semi-aquatic, roads were rarely considered a threat to aquatic connectivity in the species literature. This may be accurate if bridges or large culverts currently exist for water flow that also provide permeability to aquatic movement. Bridges are generally considered to be completely passable by all aquatic species. Bridges are more likely to be constructed adjacent to or over large water bodies and rivers, presumably

resulting in less risk to aquatic movement of populations that inhabit lake and river systems. However, culverts that are more commonly constructed under roads in streams and wetlands vary in passability depending on factors such as diameter, length, slope, outlet configuration, and other characteristics (Furniss et al. 1991; Clarkin et al. 2005; Kemp and O'Hanley 2010). In fact, Januchowski-Hartley et al. (2013) found that only 36% of road crossings were fully passable to fish in the Great Lakes basin. In addition, many low water crossings in arid regions of the state are simply a dip in the road that allows water to flow

Table 8 continued

Risk Level-Species	Species			Road Risk Scores			Status		
	Group	Common Name	Scientific name	Maximum (Aquatic & Terrestrial) <sup>a</sup>	Terrestrial	Aquatic (Wetlands/ Rivers/ Streams, Perennial to Intermittent)	Federal or State Listing/ ARSSC Priority Rank (1-3) <sup>b</sup>	Roads Listed as Potential Threat in Listing? <sup>c</sup>	Caltrans Identified Sensitive Species? <sup>d</sup>
Low	Salamander	Scott Bar Salamander	<i>Plethodon asupak</i>	62	62	-	THR		
	Salamander	Dunn's Salamander	<i>Plethodon dunni</i>	62	62	-			
	Salamander	Del Norte Salamander	<i>Plethodon elongatus</i>	62	62	-			
	Salamander	Siskiyou Mountains Salamander	<i>Plethodon stormi</i>	62	62	-	THR		
	Frog	California Treefrog	<i>Pseudacris cadaverina</i>	61	61	26			
	Salamander	Southern Torrent Salamander	<i>Rhyacotriton variegatus</i>	61	61	5	1		
	Lizard	Peninsula Leaf-toed Gecko	<i>Phyllodactylus nocticolus</i>	60	60	-			
	Lizard	Northern Alligator Lizard	<i>Elgaria coerulea</i>	60	60	-			
	Frog	Coastal Tailed Frog	<i>Ascaphus truei</i>	59	59	30	2		Yes
	Lizard	Common Side-blotched Lizard	<i>Uta stansburiana</i>	59	59	-			
	Lizard	Coachella Fringe-toed Lizard	<i>Uma inornata</i>	56	56	-	THR		
	Lizard	Colorado Desert Fringe-toed Lizard	<i>Uma notata</i>	56	56	-	2		
	Lizard	Mohave Fringe-toed Lizard	<i>Uma scoparia</i>	56	56	-	3		
	Frog	Lowland Leopard Frog	<i>Lithobates yavapaiensis</i> (Possibly extinct in CA)	54	31	54	1		
	Frog	Southern Mountain Yellow-legged Frog	<i>Rana muscosa</i>	54	26	54	END		
	Lizard	Zebra-tailed Lizard	<i>Callisaurus draconoides</i>	54	54	-			
Salamander	Wandering Salamander	<i>Aneides vagrans</i>	53	53	-				
Salamander	Slender Salamanders	<i>Batrachoseps</i> (genus; 20 spp.)	53	53	-	END <sup>e</sup>			
Very Low	Salamander	Ensatina	<i>Ensatina eschscholtzii</i>	51	51	-			
	Salamander	Yellow-blotched Ensatina	<i>Ensatina eschscholtzii croceater</i>	51	51	-			
	Salamander	Large-blotched Ensatina	<i>Ensatina eschscholtzii klauberi</i>	51	51	-			
	Lizard	Southern Alligator Lizard	<i>Elgaria multicarinata</i>	51	51	-			
	Lizard	Panamint Alligator Lizard	<i>Elgaria panamintina</i>	51	51	-	3		
	Frog	Sierra Nevada Yellow-legged Frog	<i>Rana sierrae</i>	51	51	36	THR		
	Lizard	Western Fence Lizard	<i>Sceloporus occidentalis</i>	49	49	-			
	Salamander	Limestone Salamander	<i>Hydromantes brunus</i>	48	48	-	THR		
	Salamander	Mount Lyell Salamander	<i>Hydromantes platycephalus</i>	48	48	-			
	Salamander	Clouded Salamander	<i>Aneides ferreus</i>	44	44	-			
	Salamander	Arboreal Salamander	<i>Aneides lugubris</i>	44	44	-			
	Lizard	Granite Spiny Lizard	<i>Sceloporus orcutti</i>	43	43	-			
	Snake	Western Blind Snake	<i>Rena humilis</i>	42	42	-			
	Lizard	Desert Spiny Lizard	<i>Sceloporus magister</i>	41	41	-			
	Lizard	Common Sagebrush Lizard	<i>Sceloporus graciosus</i>	39	41	-			
	Lizard	Gilbert's Skink	<i>Plestiodon gilberti</i>	39	39	-			
	Lizard	Western Skink	<i>Plestiodon skiltonianus</i>	39	39	-			
	Lizard	California Legless Lizard	<i>Anniella pulchra</i>	35	39	-	2		
	Salamander	Black Salamander	<i>Aneides flavipunctatus</i>	35	35	-			
	Salamander	Santa Cruz Black Salamander	<i>Aneides flavipunctatus niger</i>	35	35	-			
	Lizard	Baja California Collared Lizard	<i>Crotaphytus vestigium</i>	35	35	-			
	Lizard	Sandstone Night Lizard	<i>Xantusia gracilis</i>	33	33	-	3		
	Lizard	Granite Night Lizard	<i>Xantusia henshawi</i>	33	33	-			
	Lizard	Island Night Lizard	<i>Xantusia riversiana</i>	33	33	-	THR		
	Lizard	Sierra Night Lizard	<i>Xantusia sierrae</i>	33	33	-	1		
	Lizard	Desert Night Lizard	<i>Xantusia vigilis</i>	33	33	-			
	Lizard	Wiggins' Night Lizard	<i>Xantusia wigginsii</i>	33	33	-			
	Lizard	Long-tailed Brush Lizard	<i>Urosaurus graciosus</i>	27	27	-			
Lizard	Baja California Brush Lizard	<i>Urosaurus nigricaudus</i>	27	27	-				
Lizard	Ornate Tree Lizard	<i>Urosaurus ornatus</i>	27	27	-				
Lizard	Mearns' Rock Lizard	<i>Petrosaurus mearnsi</i>	21	21	-				

<sup>a</sup> Maximum scores color-coded for road risk type: terrestrial (gray), aquatic (blue), or both (gray/blue)

<sup>b</sup> END=Endangered, THR= Threatened, 1-3= ARSSC Priority Ranking

<sup>c</sup> Federal Recovery plans, 5-year reviews, California species accounts for special status species

<sup>d</sup> California Amphibian and Reptile Crossing Preliminary Investigation

<sup>e</sup> 4 Batrachoseps species with conservation status



**Table 9** Terrestrial risk ranking and population buffer distances

Risk Level (Terrestrial)		Species			Risk Scores (Terrestrial)		Movement Distances (Terrestrial)		
Species	Population	Group	Common Name	Scientific name	Road Risk: Species-Level	Road Risk: Population-Level	95% Population Movement Distance (m)	Confidence in Distance Estimate	Surrogate Used
Very High	Very High	Snake	San Joaquin Coachwhip	<i>Masticophis flagellum ruddocki</i>	689	285	1618	High	<i>M. fuliginosus</i>
	Very High	Snake	Alameda Striped Racer	<i>Masticophis lateralis euryxanthus</i>	652	221	631	Med/High	
	Very High	Tortoise	Mohave Desert Tortoise	<i>Gopherus agassizii</i>	580	240	1155	High	
	Very High	Salamander	Red-bellied Newt	<i>Taricha rivularis</i>	561	228	1600	High	
	Very High	Snake	Baja California Coachwhip	<i>Masticophis fuliginosus</i>	534	285	1904	High	
	Very High	Snake	Coast Patch-nosed Snake	<i>Salvadora hexalepis virgutea</i>	533	221	631	Low	<i>M. lateralis</i>
	Very High	Salamander	California Newt	<i>Taricha torosa</i>	532	228	2500	Med/High	
	Very High	Lizard	Banded Gila Monster	<i>Heloderma suspectum cinctum</i>	446	210	1250	High	
	High	Salamander	California Tiger Salamander	<i>Ambystoma californiense</i>	437	152	1849	Med/High	
	Very High	Salamander	Sierra Newt	<i>Taricha sierrae</i>	437	228	2050	Med	<i>T. torosa, T. rivularis</i>
	Very High	Snake	Striped Whipsnake	<i>Masticophis taeniatus</i>	425	300	2380	Med	
	Very High	Lizard	Flat-tail Horned Lizard	<i>Phrynosoma mcallii</i>	425	217	788	Med/High	
	High	Lizard	Blunt-nosed Leopard Lizard	<i>Gambelia sika</i>	393	133	510	High	
	Very High	Snake	Baja California Ratsnake	<i>Bogertophis rosaliae</i>	387	238	780	Low	<i>Elaphe obsoleta</i>
	Very High	Snake	Panamint Rattlesnake	<i>Crotalus ophelaps</i>	387	238	938	Med	<i>C. mitchelli</i>
	High	Frog	California Red-legged Frog	<i>Rana draytonii</i>	380	152	2360	High	
	High	Toad	Yosemite Toad	<i>Anaxyrus canorus</i>	379	128	1152	Med/High	
	High	Toad	Black Toad	<i>Anaxyrus exsul</i>	379	128	951	Low	<i>A. canorus, A. punctatus</i>
	High	Lizard	Cope's Leopard Lizard	<i>Gambelia copeii</i>	372	175	643	Low/Med	<i>G. wislizenii</i>
	High	Toad	Sonoran Desert Toad	<i>Inhailus alvanus (Possibly extinct in CA)</i>	361	152	1400	Low/Med	<i>A. cognatus</i>
	Very High	Lizard	Desert Horned Lizard	<i>Phrynosoma platyrhinos</i>	356	259	1308	Med/High	
	High	Snake	California Glossy Snake	<i>Arizona elegans occidentalis</i>	340	154	316	Low	<i>R. lecontei</i>
	Very High	Snake	North American Racer	<i>Coluber constrictor</i>	334	308	1800	Med	
	Very High	Snake	Coachwhip	<i>Masticophis flagellum</i>	333	285	1618	High	<i>M. fuliginosus</i>
	High	Toad	Arroyo Toad	<i>Anaxyrus californicus</i>	331	128	1082	Med/High	
	Very High	Snake	Striped Racer	<i>Masticophis lateralis</i>	322	221	631	Med	
	High	Snake	Red Diamond Rattlesnake	<i>Crotalus ruber</i>	321	175	853	High	
	Very High	Snake	Speckled Rattlesnake	<i>Crotalus mitchelli</i>	317	238	938	High	
Med	Salamander	Santa Cruz Long-toed Salamander	<i>Ambystoma macrodactylum croceum</i>	308	104	700	High		
Very High	Salamander	Rough-skinned Newt	<i>Taricha granulosa</i>	304	228	2050	Med	<i>T. torosa, T. rivularis</i>	
High	Snake	Regal Ring-necked Snake	<i>Diadophis punctatus regalis</i>	298	152	566	Low/Med		
Very High	Snake	California Lyresnake	<i>Trimorphodon lyrophanes</i>	293	195	800	Low		
High	Frog	Northern Red-legged Frog	<i>Rana aurora</i>	291	152	2360	Med	<i>R. draytonii</i>	
High	Turtle	Southern Western Pond Turtle	<i>Actinemys pallida</i>	283	128	309	Med/High		
High	Snake	Mojave Rattlesnake	<i>Crotalus scutulatus</i>	276	189	815	Med/High		
Very High	Snake	Western Patch-nosed Snake	<i>Salvadora hexalepis</i>	278	221	631	Low	<i>M. lateralis</i>	
High	Snake	Sidewinder	<i>Crotalus cerastes</i>	263	186	767	High		
Med	Salamander	California Giant Salamander	<i>Dicamptodon ensatus</i>	260	120	600	Low	<i>D. tenebrosus</i>	
Very High	Snake	Sonoran Lyresnake	<i>Trimorphodon lambda</i>	260	195	800	Low		
Very High	Snake	Western Rattlesnake	<i>Crotalus oregonus</i>	250	231	1096	Med/High		
High	Snake	Desert Nightsnake	<i>Hypsiglena chlorophaea</i>	241	175	566	Low	<i>D. punctatus</i>	
Med	Snake	San Francisco Gartersnake	<i>Thamnophis sirtalis tetrataenia</i>	238	81	300	Med		
Med	Lizard	Switek's Banded Gecko	<i>Coleonyx switaki</i>	236	90	200	Low	<i>C. variegatus (AZ)</i>	
Med	Toad	Western Spadefoot	<i>Spea hammondi</i>	234	104	670	Med		
High	Snake	Coast Nightsnake	<i>Hypsiglena ochrorhyncha</i>	233	175	566	Low	<i>D. punctatus</i>	
High	Lizard	Long-nosed Leopard Lizard	<i>Gambelia wislizenii</i>	226	175	643	Med/High		
High	Toad	Great Plains Toad	<i>Anaxyrus cognatus</i>	222	152	1400	Med/High		
High	Toad	Woodhouse's Toad	<i>Anaxyrus woodhousii</i>	222	152	1400	Low	<i>A. cognatus</i>	
Med	Lizard	Coastal Whiptail	<i>Aspidoscelis tigris stejnegeri</i>	219	105	300	Low	<i>A. hyperythra (multiplied by 2 for body size)</i>	
High	Turtle	Northern Western Pond Turtle	<i>Actinemys marmorata</i>	219	128	448	Med		
High	Snake	Western Shovel-nosed Snake	<i>Chionactis occipitalis</i>	218	154	400	Low		
High	Snake	Spotted Leaf-nosed Snake	<i>Phyllorhynchus decurtatus</i>	218	154	400	Low	<i>C. occipitalis, M. taeniatus</i>	
Med	Salamander	Southern Long-toed Salamander	<i>Ambystoma macrodactylum sigillatum</i>	217	104	700	Med		
Med	Frog	Cascades Frog	<i>Rana cascadae</i>	217	104	759	High		
High	Snake	Western Diamond-backed Rattlesnake	<i>Crotalus atrox</i>	214	147	484	Med		
High	Snake	Western Groundsnake	<i>Sonora semiannulata</i>	212	154	400	Low	<i>C. occipitalis</i>	
Med	Snake	California Red-sided Gartersnake	<i>Thamnophis sirtalis infernalis</i>	211	81	300	Low/Med	<i>T.s. tetrataenia</i>	

Table 9 continued

Risk Level (Terrestrial)		Species			Risk Scores (Terrestrial)		Movement Distances (Terrestrial)		
Species	Population	Group	Common Name	Scientific name	Road Risk: Species-Level	Road Risk: Population-Level	95% Population Movement Distance (m)	Confidence in Distance Estimate	Surrogate Used
Medium	Med.	Lizard	Blainville's Horned Lizard	<i>Phrynosoma blainvillii</i>	209	114	495	Med	
	Med	Snake	Two-striped Gartersnake	<i>Thamnophis hammondi</i>	195	81	239	Low/Med	
	High	Snake	Gopher Snake	<i>Pituophis catenifer</i>	189	189	820	Med/High	
	High	Snake	California Mountain Kingsnake	<i>Lampropeltis zonata</i>	184	147	501	Low/Med	<i>L. getulia</i> ; <i>L. triangulum</i>
	High	Snake	Glossy Snake	<i>Arizona elegans</i>	180	154	316	Low	<i>R. lecontei</i>
	Med	Lizard	Pygmy Short-horned Lizard	<i>Phrynosoma douglasii</i>	179	123	400	Low	<i>P. moccilli</i> (reduced 0.5 for body size)
	Med	Toad	Couch's Spadefoot	<i>Scaphiopus couchii</i>	178	104	670	Med	
	High	Snake	California Kingsnake	<i>Lampropeltis californiae</i>	175	175	501	Med/High	
	High	Snake	Long-nosed Snake	<i>Rhinocellus lecontei</i>	165	132	337	Low/Med	
	High	Snake	Common Gartersnake	<i>Thamnophis airtalis</i>	165	137	532	Low/Med	
	High	Toad	Western Toad	<i>Anaxyrus boreas</i>	165	152	2144	Med/High	
	High	Snake	Ring-necked Snake	<i>Diadophis punctatus</i>	164	136	566	Low/Med	
	Med	Lizard	San Diego Banded Gecko	<i>Coleonyx variegatus abotti</i>	158	84	200	Low/Med	<i>C. variegatus</i> (AZ)
	Med	Salamander	Northwestern Salamander	<i>Ambystoma gracile</i>	152	104	700	Low	<i>A. macrodactylum croceum</i>
	Med	Toad	Great Basin Spadefoot	<i>Spea infermontana</i>	152	104	670	Med	
	Med	Toad	Red-spotted Toad	<i>Anaxyrus punctatus</i>	147	104	750	Low	
	Med	Salamander	Long-toed Salamander	<i>Ambystoma macrodactylum</i>	143	104	700	Med	
	Med	Snake	Northwestern Gartersnake	<i>Thamnophis ordinoides</i>	138	95	239	Low	<i>T. hammondi</i>
	Med	Lizard	Orange-throated Whiptail	<i>Aspidoscelis tigris</i>	137	84	150	Low/Med	
	Med	Snake	Smith's Black-headed Snake	<i>Tantilla hobartsmithi</i>	136	105	150	Low	
	Med	Snake	California Black-headed Snake	<i>Tantilla planiceps</i>	133	84	150	Low	
	Med	Lizard	Western Whiptail	<i>Aspidoscelis tigris</i>	118	105	300	Low	<i>A. hyperythra</i> (multiplied by 2 for body size)
	Med	Salamander	Coastal Giant Salamander	<i>Dicamptodon tenebrosus</i>	117	80	600	Low/Med	
	Med	Lizard	Western Banded Gecko	<i>Coleonyx variegatus</i>	105	84	200	Low/Med	<i>C. variegatus</i> (AZ)
	Med	Lizard	Common Chuckwalla	<i>Sauromalus ater</i>	78	78	296	Med	
	Med	Snake	Northern Rubber Boa	<i>Charina bottae</i>	77	77	230	Low/Med	<i>L. trivirgata</i>
	Med	Snake	Southern Rubber Boa	<i>Charina umbratica</i>	77	77	230	Low/Med	<i>L. trivirgata</i>
	Med	Snake	Northern Three-lined Boa	<i>Lichanura orcutti</i>	77	77	230	Med/High	
	Med	Snake	Western Terrestrial Gartersnake	<i>Thamnophis elegans</i>	75	75	104	Low/Med	<i>T. gigas</i> (-40% for size diff)
	Med	Lizard	Desert Iguana	<i>Dipsosaurus dorsalis</i>	72	72	150	Low/Med	
Med	Snake	Forest Sharp-tailed Snake	<i>Contia longicauda</i>	70	70	150	Low		
Med	Snake	Common Sharp-tailed Snake	<i>Contia tenuis</i>	70	70	150	Low		
Med	Snake	Checkered Gartersnake	<i>Thamnophis marcianus</i>	69	69	239	Low	<i>T. hammondi</i>	
Med	Frog	Pacific Treefrog	<i>Pseudacris regilla</i>	68	68	400	Low/Med		
Low	Low	Salamander	Scott Bar Salamander	<i>Plethodon asupek</i>	62	62	92	Low	<i>P. glutinosus</i>
	Low	Salamander	Dunn's Salamander	<i>Plethodon dunni</i>	62	62	92	Low	<i>P. glutinosus</i>
	Low	Salamander	Del Norte Salamander	<i>Plethodon elongatus</i>	62	62	92	Low	<i>P. glutinosus</i>
	Low	Salamander	Siskiyou Mountains Salamander	<i>Plethodon stormi</i>	62	62	92	Low	<i>P. glutinosus</i>
	Low	Frog	California Treefrog	<i>Pseudacris cadaverina</i>	61	61	50	Low/Med	
	Low	Salamander	Southern Torrent Salamander	<i>Rhyacotriton variegatus</i>	61	61	50	Low	<i>R. cascadae</i>
	Low	Lizard	Peninsula Leaf-toed Gecko	<i>Phyllodactylus nocticolus</i>	60	60	200	Low	<i>C. variegatus</i> (AZ)
	Low	Lizard	Northern Alligator Lizard	<i>Elgaria coerulea</i>	60	60	106	Med	
	Low	Frog	Coastal Tailed Frog	<i>Ascaphus truei</i>	59	59	150	Med/High	
	Low	Lizard	Common Side-blotched Lizard	<i>Uta stansburiana</i>	59	59	152	Med/High	
	Low	Lizard	Coachella Fringe-toed Lizard	<i>Uma inornata</i>	56	56	52	Med/High	
	Low	Lizard	Colorado Desert Fringe-toed Lizard	<i>Uma notata</i>	56	56	75	Med/High	
	Low	Lizard	Mohave Fringe-toed Lizard	<i>Uma scoparia</i>	56	56	64	Med	<i>U. notata</i> <i>U. inornata</i>
	Low	Lizard	Zebra-tailed Lizard	<i>Callisaurus draconoides</i>	54	54	150	Med	
	Low	Salamander	Wandering Salamander	<i>Aneides vagrans</i>	53	53	39	Med/High	
	Low	Salamander	Slender Salamanders (20 species)	<i>Batrachoseps</i> (genus)	53	53	50	Low/Med	<i>B. pacificus</i>



Table 9 continued

Risk Level (Terrestrial)		Species			Risk Scores (Terrestrial)		Movement Distances (Terrestrial)		
Species	Population	Group	Common Name	Scientific name	Road Risk: Species-Level	Road Risk: Population-Level	95% Population Movement Distance (m)	Confidence in Distance Estimate	Surrogate Used
Very Low	Very Low	Salamander	Ensatina	<i>Ensatina eschscholtzii</i>	51	51	75	Med	
	Very Low	Salamander	Yellow-blotched Ensatina	<i>Ensatina eschscholtzii croceater</i>	51	51	75	Med	
	Very Low	Salamander	Large-blotched Ensatina	<i>Ensatina eschscholtzii klauberi</i>	51	51	75	Med	<i>E. eschscholtzii croceater</i>
	Very Low	Lizard	Southern Alligator Lizard	<i>Elgaria multicarinata</i>	51	51	106	Low/Med	<i>E. coerulea</i>
	Very Low	Lizard	Panamint Alligator Lizard	<i>Elgaria panamintina</i>	51	51	106	Low/Med	<i>E. coerulea</i>
	Very Low	Frog	Sierra Nevada Yellow-legged Frog	<i>Rana sierrae</i>	51	51	420	Med	
	Very Low	Lizard	Western Fence Lizard	<i>Sceloporus occidentalis</i>	49	49	160	Med	
	Very Low	Salamander	Limestone Salamander	<i>Hydromantes brunus</i>	48	48	80	Low	
	Very Low	Salamander	Mount Lyell Salamander	<i>Hydromantes platycephalus</i>	48	48	80	Low	
	Very Low	Salamander	Clouded Salamander	<i>Aneides ferreus</i>	44	44	39	Med	<i>A. vagrans</i>
	Very Low	Salamander	Arboreal Salamander	<i>Aneides lugubris</i>	44	44	39	Med	<i>A. vagrans</i>
	Very Low	Snake	Giant Gartersnake	<i>Thamnophis gigas</i>	44	44	174	High	
	Very Low	Snake	Sierra Gartersnake	<i>Thamnophis couchii</i>	44	44	115	Low/Med	<i>T. gigas</i> (-34% for size diff)
	Very Low	Lizard	Granite Spiny Lizard	<i>Sceloporus orcutti</i>	43	43	91	Low/Med	
	Very Low	Snake	Western Blind Snake	<i>Rena humilis</i>	42	42	50	Low	
	Very Low	Lizard	Desert Spiny Lizard	<i>Sceloporus magister</i>	41	41	91	Low	
	Very Low	Frog	Oregon Spotted Frog	<i>Rana pretiosa</i> (Possibly extinct in CA)	41	41	100	Low	
	Very Low	Lizard	Common Sagebrush Lizard	<i>Sceloporus graciosus</i>	41	41	41	Med/High	
	Very Low	Snake	Aquatic Gartersnake	<i>Thamnophis atratus</i>	40	40	99	Low/Med	<i>T. gigas</i> (-43% for size diff)
	Very Low	Lizard	Gilbert's Skink	<i>Plestiodon gilberti</i>	39	39	93	Low/Med	<i>P. skiltonianus</i> , <i>P. fasciatus</i> , <i>S. laterale</i>
	Very Low	Lizard	Western Skink	<i>Plestiodon skiltonianus</i>	39	39	93	Low/Med	
	Very Low	Lizard	California Legless Lizard	<i>Anniella pulchra</i>	39	39	15	High	
	Very Low	Turtle	Sonoran Mud Turtle	<i>Kinosternon sonoriense</i>	37	37	60	Med	
	Very Low	Salamander	Black Salamander	<i>Aneides flavipunctatus</i>	35	35	39	Med	<i>A. vagrans</i>
	Very Low	Salamander	Santa Cruz Black Salamander	<i>Aneides flavipunctatus niger</i>	35	35	39	Med	<i>A. vagrans</i>
	Very Low	Lizard	Great Basin Collared Lizard	<i>Crotaphytus bicinctores</i>	35	35	150	Low/Med	<i>C. collaris</i>
	Very Low	Lizard	Baja California Collared Lizard	<i>Crotaphytus vestigium</i>	35	35	150	Low/Med	<i>C. collaris</i>
	Very Low	Lizard	Sandstone Night Lizard	<i>Xantusia gracilis</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Lizard	Granite Night Lizard	<i>Xantusia henshawi</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Lizard	Island Night Lizard	<i>Xantusia riversiana</i>	33	33	14	High	
	Very Low	Lizard	Sierra Night Lizard	<i>Xantusia sierrae</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Lizard	Desert Night Lizard	<i>Xantusia vigilis</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Lizard	Wiggins' Night Lizard	<i>Xantusia wigginsi</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Frog	Lowland Leopard Frog	<i>Lithobates yavapaiensis</i> (Possibly extinct in CA)	31	31	100	Low	
	Very Low	Lizard	Long-tailed Brush Lizard	<i>Urosaurus graciosus</i>	27	27	130	Low/Med	<i>S. occidentalis</i> , <i>S. graciosus</i>
	Very Low	Lizard	Baja California Brush Lizard	<i>Urosaurus nigricaudus</i>	27	27	130	Low/Med	<i>S. occidentalis</i> , <i>S. graciosus</i>
	Very Low	Lizard	Ornate Tree Lizard	<i>Urosaurus ornatus</i>	27	27	130	Low/Med	<i>S. occidentalis</i> , <i>S. graciosus</i>
	Very Low	Frog	Foothill Yellow-legged Frog	<i>Rana boylei</i>	26	26	40	Med/High	
	Very Low	Frog	Southern Mountain Yellow-legged Frog	<i>Rana muscosa</i>	26	26	40	Med	<i>R. boylei</i>
	Very Low	Lizard	Mearns' Rock Lizard	<i>Petrosaurus mearnsi</i>	21	21	80	Low/Med	
Very Low	Lizard	Mearns' Rock Lizard	<i>Petrosaurus mearnsi</i>	21	21	80	Low/Med		

over the surface during high flow events. These may be used as road crossings by species traveling along ephemeral stream corridors with or without water flow. Given these potential vulnerabilities, we believe that road impacts to aquatic connectivity of herpetofauna deserve greater consideration.

Across broad taxonomic groups, chelonids (tortoises/turtles) and snakes had the greatest percentages of species at 'high' or 'very high' risk from roads. They are similar in that many move long distances (home

range and/or migratory), tend not to avoid roads (or are attracted to them for thermoregulation), are long lived, and have relatively low fecundity in comparison to other herpetofaunal groups. Because of these traits, chelonids and snakes have been identified elsewhere as being particularly susceptible to negative population effects from roads (Gibbs and Shriver 2002; Andrews et al. 2015b; Jackson et al. 2015).

There are only four species of chelonids in California, (desert tortoise (*Gopherus agassizii*),

Northwestern pond turtle (*Actinemys marmorata*), Southwestern pond turtle (*Actinemys pallida*), and the Sonoran mud turtle (*Kinosternon sonoriense*). There has been a high level of attention to road impacts on the desert tortoise (*Gopherus agassizii*) as numerous studies have documented not only high road mortality, but measurable road effect zones, and mostly positive responses to barriers and underpasses (e.g., Boarman and Sazaki 1996, 2006; Peaden et al. 2016; but see Peadon et al. 2017). Although not listed as a primary threat to pond turtle populations in California (Thomson et al. 2016), road mortality is a major concern for western pond turtle populations in Oregon (Rosenberg et al. 2009). Pond turtles travel kilometers within perennial waters and from pool to pool in intermittent aquatic habitats to forage and find mates (Goodman and Stewart 2000). In addition, females nest and lay eggs in terrestrial habitats up to 0.5 km away from water which make roads that parallel aquatic habitat a threat to both females and hatchlings (Reese and Welsh 1997; Rathbun et al. 2002; Pilliod et al. 2013). In fact, road mortality of females has been identified as a cause for male-biased sex ratios in some populations of pond turtles and other freshwater turtle species (Steen et al. 2006; Rosenberg et al. 2009; Reid and Peery 2014). Therefore, this species requires consideration of both aquatic and terrestrial connectivity to satisfy their annual resource requirements. Sonoran mud turtles also travel long distances within intermittent streams and thus may be at risk of roads that transect their aquatic habitat (Hensley et al. 2010).

Larger colubrid snakes (Family Colubridae; many genera) and rattlesnakes (genus *Crotalus*) were ranked among the highest risk from negative road effects. In addition to being attracted to paved road surfaces for thermoregulation, many large snakes have wide home-ranges or may move large distances between winter hibernacula and summer foraging areas. In contrast to smaller species, larger snakes are also less likely to avoid roads (Rosen and Lowe 1994; Andrews and Gibbons 2005; Andrews et al. 2008; Siers et al. 2016). High road mortality (e.g., Klauber 1931; Rosen and Lowe 1994; Jones et al. 2011), reduced abundance near roads (Rudolph et al. 1999; Jones et al. 2011), increased extinction risk (Row et al. 2007), and decreased genetic diversity (Clark et al. 2010; Hermann et al. 2017) have been documented for numerous snake species; as have positive responses to barriers

and underpasses (Dodd et al. 2004; Colley et al. 2017). In our statewide risk analysis, coachwhips (genus *Masticophis/Coluber*) were amongst the highest risk groups at both the population and species-levels. These are particularly wide-ranging and very active foragers in comparison to other snake genera (Stebbins and McGinnis 2012). The coachwhip (*Masticophis flagellum*) was found to be ninefold more likely to be extirpated from habitats that were fragmented by roads and urbanization, contributing to their decline throughout California (Case and Fisher 2001; Mitrovich 2006). Similarly, habitat fragmentation from roads and urbanization were identified as primary threats to the Alameda whipsnake (*Masticophis lateralis euryxanthus* USFWS 2011). Although road use and mortality have been documented for many other terrestrial California snake species on road-riding surveys (e.g., Klauber 1931; Jones et al. 2011; Shilling and Waetjen 2017), there is a paucity of studies examining population-level effects of roads on California snake species. We could find only one such study, where presence of a highway was shown to reduce gene flow in the Western diamond-backed rattlesnake (*Crotalus atrox*) in the Sonoran Desert, AZ (Hermann et al. 2017).

Long foraging movements within aquatic habitats also contributed to the majority of garter snakes (genus: *Thamnophis*) falling within the highest road risk categories. Maintaining aquatic and wetland connectivity is of primary concern for these species. Garter snakes also use terrestrial habitats for overwintering, reproduction, and for moving among wetland or aquatic patches. Some migrate long distances to winter hibernacula, making them also susceptible to roads within adjacent terrestrial habitats (Roe et al. 2006; Jackson et al. 2015). The highly aquatic giant garter snake (*Thamnophis gigas*) had the highest aquatic road risk score. Because it moves only short distances on land (Halstead et al. 2015), mitigation may best focus on functional aquatic passages with lengths of adjacent road barriers based upon their terrestrial movement distances.

Toads were the third highest ranking group with 64% ranked in the highest risk categories. In particular, Bufonid toads (family Bufonidae) may move large distances (> 1 km) in both aquatic and terrestrial habitats to satisfy their annual resource requirements; thus 5 of 7 bufonid species ranked high or very high risk from roads. Consistent with our risk assessment



**Table 10** Aquatic risk ranking and population buffer distances

Risk Level (Aquatic)		Species			Risk Scores (Aquatic)		Movement Distances (Aquatic)		
Species	Population	Group	Common Name	Scientific name	Road Risk: Species-Level	Road Risk: Population-Level	95% Population Movement Distance (m)	Confidence in Distance Estimate	Surrogate Used
Very High	Very High	Snake	Giant Gartersnake	<i>Thamnophis gigas</i>	710	240	1556	Med/High	
	Very High	Turtle	Southern Western Pond Turtle	<i>Actinemys pallida</i>	707	320	3145	High	
	Very High	Snake	San Francisco Gartersnake	<i>Thamnophis sirtalis tetrataenia</i>	663	224	1146	Med	<i>T. sirtalis</i>
	Very High	Snake	California Red-sided Gartersnake	<i>Thamnophis sirtalis infernalis</i>	588	224	1146	Med	<i>T. sirtalis</i>
	Very High	Turtle	Northern Western Pond Turtle	<i>Actinemys marmorata</i>	547	320	3145	High	<i>A. pallida</i>
	Very High	Snake	Two-striped Gartersnake	<i>Thamnophis hammondi</i>	541	224	979	Low	<i>T. gigas</i> (-37% for size diff)
High	Turtle	Sonoran Mud Turtle	<i>Kinosternon sonoriense</i>	399	168	1000	Med		
High	Med	Frog	Oregon Spotted Frog	<i>Rana pretiosa</i> (Possibly extinct in CA)	315	120	1300	Low	
	Very High	Snake	Sierra Gartersnake	<i>Thamnophis couchii</i>	304	192	1021	Low	<i>T. gigas</i> (-34% for size diff)
	Med	Frog	California Red-legged Frog	<i>Rana draytonii</i>	300	120	1864	High	
	Med	Toad	Sonoran Desert Toad	<i>Inhailus alvarius</i> (Possibly extinct in CA)	285	120	1400	Low/Med	<i>A. cognatus</i>
	Med	Toad	Yosemite Toad	<i>Anaxyrus canorus</i>	284	96	1152	Med/High	
	Med	Toad	Black Toad	<i>Anaxyrus exsul</i>	284	96	951	Low/Med	<i>A. canorus</i> , <i>A. punctatus</i>
	Very High	Snake	Common Gartersnake	<i>Thamnophis sirtalis</i>	271	224	1146	Med	
	High	Snake	Aquatic Gartersnake	<i>Thamnophis atratus</i>	266	168	889	Low	<i>T. gigas</i> (-43% for size diff)
	Med	Toad	Arroyo Toad	<i>Anaxyrus californicus</i>	248	96	1000	Med/High	
	High	Snake	Northwestern Gartersnake	<i>Thamnophis ordinoides</i>	245	168	775	Low	<i>T. gigas</i> (-50% for size diff)
	Very High	Snake	Western Terrestrial Gartersnake	<i>Thamnophis elegans</i>	240	192	931	Low	<i>T. gigas</i> (-40% for size diff)
	Medium	Med	Frog	Northern Red-legged Frog	<i>Rana aurora</i>	230	120	1864	Med
High		Snake	Checkered Gartersnake	<i>Thamnophis marciarius</i>	210	144	835	Low	<i>T. gigas</i> (-46% for size diff)
Med		Frog	Foothill Yellow-legged Frog	<i>Rana boylei</i>	199	90	2420	Med/High	
Med		Toad	Great Plains Toad	<i>Anaxyrus cognatus</i>	175	120	1400	Med/High	
Med		Toad	Woodhouse's Toad	<i>Anaxyrus woodhousii</i>	175	120	1400	Low/Med	<i>A. cognatus</i>
Med		Toad	Western Toad	<i>Anaxyrus boreas</i>	130	120	1274	Low/Med	
Med		Salamander	Red-bellied Newt	<i>Taricha rivularis</i>	72	72	600	High	
Med		Salamander	California Newt	<i>Taricha torosa</i>	72	72	600	Med/High	<i>T. rivularis</i>
Med		Salamander	Sierra Newt	<i>Taricha sierrae</i>	72	72	600	Med	<i>T. rivularis</i>
Med		Salamander	Rough-skinned Newt	<i>Taricha granulosa</i>	72	72	600	Med	<i>T. rivularis</i>
Med		Salamander	California Giant Salamander	<i>Dicamptodon ensatus</i>	72	72	600	Low	Educated guess
Low		Med	Frog	Cascades Frog	<i>Rana cascadae</i>	72	72	759	High
	Med	Toad	Red-spotted Toad	<i>Anaxyrus punctatus</i>	72	72	750	Med	
	Low	Frog	Lowland Leopard Frog	<i>Lithobates yavapaiensis</i> (Possibly extinct in CA)	54	54	900	Low	
Very Low	Low	Frog	Southern Mountain Yellow-legged Frog	<i>Rana muscosa</i>	54	54	665	Med	
	Very Low	Salamander	Coastal Giant Salamander	<i>Dicamptodon tenebrosus</i>	48	48	600	Low	Educated guess
	Very Low	Frog	Pacific Treefrog	<i>Pseudacris regilla</i>	36	36	400	Low	Educated guess
	Very Low	Frog	Sierra Nevada Yellow-legged Frog	<i>Rana sierrae</i>	36	36	525	Med/High	
	Very Low	Frog	Coastal Tailed Frog	<i>Ascaphus truei</i>	30	30	266	Med/High	
	Very Low	Frog	California Treefrog	<i>Pseudacris cadaverina</i>	26	26	200	Low/Med	
Very Low	Salamander	Southern Torrent Salamander	<i>Rhyacotriton variegatus</i>	5	5	50	Low/Med	<i>R. cascadae</i>	

results, there is evidence that bufonid toads are particularly susceptible to negative impacts from roads elsewhere (Trenham et al. 2003; Orłowski 2007; Eigenbrod et al. 2008).

Roads and traffic have been associated with reduced abundance and species richness of frog populations (e.g., Fahrig et al. 1995; Houlahan and Findlay 2003). However, approximately half of California species are small, primarily aquatic, highly

fecund, with relatively limited movements and thus ranked low for road impacts. Four of 11 species ranked within the highest risk groupings; California red-legged frog (*Rana draytonii*), Oregon spotted frog (*R. pretiosa*), Northern red-legged frog (*R. aurora*), and Cascades frog (*R. cascadae*). The Oregon spotted frog (*R. pretiosa*) is known to move large distances within aquatic habitats (Bourque 2008; USFWS 2009). Construction of a highway that bisected the

Yellowstone population of Oregon spotted frogs was one important factor that reduced the population dramatically in the 1950s (see discussion in Watson et al. 2003). Although portions of the populations show high site fidelity, California red-legged frog and Northern red-legged frog migrants can move large distances (> 1 km) across both aquatic and terrestrial habitats (Bulger et al. 2003; Fellers and Kleeman 2007; Hayes et al. 2007). Road mortality or habitat fragmentation from roads and urbanization were listed as primary threats to these species elsewhere (USFWS 2002; COSEWIC 2015).

Lizards had relatively low percentages of species in the high risk groupings. Many lizard species are small, non-migratory, territorial, have small home ranges and are thus at low risk of negative road effects. Similar to snakes, lizards can also be attracted to road surfaces for thermoregulation. A few wide ranging species scored in the highest risk categories including the Gila monster (*Heloderma suspectum*), leopard lizards (genus *Gambelia*) and two horned lizard species (genus *Phrynosoma*). The Gila monster has been negatively associated with urbanization, where larger home ranges and greater movement rates result in higher mortality for males (Kwiatkowski et al. 2008). Sensitive to habitat fragmentation, the blunt-nosed leopard lizard (*Gambelia sila*) was found to be largely absent from habitat patches less than 250 ha (Bailey and Germano 2015). Flat-tailed horned lizards (*Phrynosoma mcallii*) are also susceptible to habitat fragmentation with very large home ranges for their size, particularly in wet years (Young and Young 2000). In fact, road mortality is a well-known threat for this species (see review by CDFW 2016b). Horned lizards are also particularly vulnerable to being killed on roads due to their tendency to flatten and remain motionless while being approached (Young and Young 2000).

Salamanders also had relatively low percentages of species in the high risk grouping. Over 75% (35/46) of the California salamanders are lungless salamanders (Plethodontidae) and Torrent salamanders (Rhyacotritonidae). These species are mostly small, sedentary, non-migratory, closed habitat specialists with limited movement distances and these traits have resulted in a high level of speciation. This is exemplified by there being at least 20 species of slender salamanders (genus *Batrachoseps*) in California alone (Martinez-Solano et al. 2007; Vences and Wake 2007). However, within the salamander group, newts and several other

migratory salamander species were ranked within the highest risk categories from negative road effects. There is substantial evidence that habitat fragmentation and mortality due to roads negatively affect many of these species. For instance, newts regularly migrate long distances over land from and to breeding ponds, and to terrestrial foraging habitats (> 2 km; Trenham 1998). Large numbers are found dead on roads during dispersal periods and newt species are often the first to disappear in fragmented landscapes (Gibbs 1998; Trenham 1998, Shields pers. comm.). Similarly, road mortality and habitat fragmentation are primary threats to the California tiger salamander and other Ambystomid salamanders because terrestrial habitat is used for interpond migration and overwintering (Semlitsch 1998; Trenham et al. 2001; Bolster 2010).

Because this assessment covers a wide array of species and habitats, the risk to particular species populations must be re-assessed on a local level. This includes consideration of the locations, types, and densities of roads in relation to population and species ranges along with goals for functional, meta-population, and genetic connectivity (e.g., Marsh and Jaeger 2015). Due to very low road densities in their limited ranges, some species and populations may be at lower risk. For instance the Gila monster, Oregon spotted frog, Sonoran mud turtle, Sonoran desert toad (*Incilius alvarius*) and Yosemite toad (*Anaxyrus canorus*) scored high due to life history and space-use characteristics, however their limited ranges are largely in protected or low road density areas in the state. Thus roads may not be a significant threat to these species in California. In contrast, high road densities may increase the risk for species within coastal regions such as remaining populations of Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*), Alameda striped racer (*Masticophis lateralis euryxanthus*), and San Francisco garter snake (*Thamnophis sirtalis tetrataenia*). However, most species consist of numerous populations with a myriad of differing road-related threat levels. Although detailed species ranges and occupancy within ranges are well known for some species with very limited ranges, for most species range-wide surveys have not been conducted. Therefore, only general range boundaries are available that encompass large portions of the state and availability of species distribution models of habitat suitability and occupancy within their ranges is rare. This lack of detailed spatial information on species distribution

further limits the potential to incorporate road locations, types, and densities in a state and species-wide assessment.

We also note that relative risk to negative road impacts is provided for both populations and species. Risk was elevated for species with small and isolated ranges and that are facing a myriad of other threats. Because of this, a few common widespread species scored high at the population-level but not at the species-level. This included gopher snakes (*Pituophis catenifer*) and western toads (*Anaxyrus boreas*) where road mortality has been identified as a threat to the persistence of local populations (e.g., COSEWIC 2012; Jochimsen et al. 2014).

To potentially aid in local assessments, we have provided distance estimates or “buffer zones” that contain estimates for 95% of population-level movements for all species (e.g., Semlitsch and Bodie 2003). We provide all references evaluated for distance estimates in Appendix 2. Meta-population movements can be very important to the stability of pond-breeding amphibians (e.g., Semlitsch 2008; Jackson et al. 2015) and are included in many of the buffer zone calculations. However, we note that buffer zones may not include meta-population-level movements if the rate of these dispersal movements was less than 5% in the studies we used for our analyses.

This should be considered an initial assessment of susceptibility to negative road impacts in a hierarchical framework (e.g., see Level 2; Hobday et al. 2011). Therefore, as previously stated it will be important to re-assess the risk of specific populations to roads within their habitat and to evaluate and compare alternatives at the local scale (e.g., Suter 2016). This may include more detailed information on specific road attributes (e.g., density, type, location), as well as species behavior (Jaeger et al. 2005; Rouse et al. 2011; Rytwinski and Fahrig 2013; Jacobson et al. 2016). Age structured and spatially explicit population viability models are valuable tools to predict long-term population responses to roads and to compare outcomes of multiple mitigation scenarios (e.g., Gibbs and Shriver 2005; Borda-de-Água et al. 2014; Polak et al. 2014; Crawford 2015). Need and placement of mitigation structures can be guided by local population or meta-population dynamics, landscape attributes, movement routes, and road mortality hot spots (e.g., Bissonette and Adair 2008; Langen et al. 2009, 2015b; D’Amico et al. 2016; Loraamm and Downs 2016).

The quantity and quality of life history information, particularly movement data, are highly variable among species (see confidence levels; Tables 9 and 10). Therefore it is important to re-assess risk as new information becomes available. Finally, this is a structured assessment of comparative risk across a range of target species; therefore specific values for high risk have not been established. The ranking or assessment methodology should be adaptive and updated with advancements of road ecology science (e.g., Linkov et al. 2006).

## Conclusion

Although roads are a significant cause of mortality and habitat fragmentation for many wildlife populations, road-related risk rankings have been based largely on expert opinion due to a scarcity of literature on road effects for most species. Therefore, we developed an objective and scientifically-based comparative risk approach to assess the potential threat from negative road impacts using species life history and movement data. After applying it to over 160 herpetofaunal species (and subspecies) in the state of California, the results are consistent with road ecology literature in identifying known high risk species, and call attention to some species not previously identified. Overall, we found that snakes and chelonids had the largest proportion of species at high risk for negative road impacts due to longer movement distances (home range and/or migratory), lack of road avoidance, and relatively low fecundity in comparison to other herpetofaunal groups. Results also indicated that consideration of aquatic connectivity appears to be under-represented for semi-aquatic herpetofauna that use both terrestrial and stream, riverine, or wetland habitats.

In addition to informing transportation planning and mitigation considerations for California herpetofauna, we believe this approach may be useful for comparing the risk of road-related fragmentation and mortality for species elsewhere and for other taxonomic groups. The results can help to inform multi-criteria threat assessments for special status species or those in consideration for listing. Finally, this serves to highlight species that may deserve further study and consideration for aquatic and terrestrial road mitigation to reduce mortality and to maintain population-level connectivity.

This risk assessment approach compares the susceptibility of species to negative road impacts. Commonly, there are numerous populations within a species range that occupy areas with greatly differing road pressures. Therefore, the actual risk to specific species populations will depend upon local road densities, road-types, traffic, and road locations in relation to species habitat and movement corridors.

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# Research to Inform Caltrans Best Management Practices for Reptile and Amphibian Road Crossings



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Cheryl S. Brehme and Robert N. Fisher

U.S. GEOLOGICAL SURVEY, WESTERN ECOLOGICAL RESEARCH CENTER

In collaboration with:

Tom E.S. Langton<sup>1</sup> and Anthony P. Clevenger<sup>2</sup>

<sup>1</sup>TRANSPORT ECOLOGY SERVICES (HCI LTD.), SUFFOLK, UNITED KINGDOM

<sup>2</sup>WESTERN TRANSPORTATION INSTITUTE. MONTANA STATE UNIVERSITY - BOZEMAN.

---

## Contributing Authors:

Esther Adelsheim, Stanford University (Chapter 4)

Stephanie Barnes, USDA Forest Service (Chapter 5)

Tristan Edgarian, U.S Geological Survey (Chapters 6 and 7)

Stacie Hathaway, U.S Geological Survey (Chapter 2)

Michael Hobbs, Hobbs Ecology (Chapter 4)

Brittany Idrizaj, U.S Geological Survey (Chapters 4 and 5)

Jennifer Kingston, U.S Geological Survey (Chapters 6 and 7)

Alan Launer, Stanford University (Chapter 4)

Tritia Matsuda, U.S Geological Survey (Chapter 4)

Jeremy Sebes, U.S Geological Survey (Chapters 6 and 7)

Jeff Tracey, U.S Geological Survey (Chapters 4, 5, 6, and 7)

Cassie Vaughan, USDA Forest Service (Chapter 5)

Elise Watson, U.S Geological Survey (Chapter 3)

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San Diego Field Station

USGS Western Ecological Research Center

4165 Spruance Road, Suite 200

San Diego, CA 92101

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# **Chapter 1. Executive Summary**

## **Introduction**

In October of 2014, the U.S. Geological Survey (USGS) began a 5-year project to conduct research to inform Best Management Practices (BMPs) for amphibian and reptile crossing and barrier systems in California. To inform future conservation and transportation planning, this project involved identification of species at highest risk of negative road impacts, creation of geodatabase and spatial mapping tools that crosswalk with California Essential Habitat Connectivity Planning, and field research to address information gaps in the efficacy of reptile and amphibian passage and barrier systems.

Per the agreement with California Department of Transportation (Caltrans; agreement 65A0553), this project was part of a broader collaborative effort between the Western Transportation Institute (WTI) of Montana State University and USGS Western Ecological Research Center (WERC). As part of this broader project, WTI conducted a worldwide literature review and gap analysis and produced a BMP manual for herpetofauna in California (Langton and Clevenger 2020). WTI and USGS were contracted separately although we worked closely together throughout this broader effort and each brought particular expertise to the project. WTI has expertise in highways, the attributes of the highway environment, and broad international experience with road ecology and herpetofauna connectivity systems worldwide. USGS WERC has expertise with California amphibian and reptile species and their ecology, study design and implementation, and landscape connectivity and road ecology.

## **Overall Program Objectives and Tasks**

To meet the objectives in the contract, the project was composed of six major tasks:

1) Meet with Caltrans and other California herpetologists to establish collaborative networks with California herpetologists and inform them about the Caltrans amphibian and reptile highway crossing design project.

2) Perform a risk analysis based on an evaluation of California amphibian and reptile species ranges, life histories, population locations, habitat needs, and movement patterns to identify road sensitive species and/or confirm road sensitive species previously identified by Caltrans.

3) Create spatial data and maps to crosswalk with the California Essential Connectivity Map (Caltrans/California Department of Fish and Wildlife (CDFW) / U.S. Department of Transportation (DOT)) and Amphibian and Reptile Species of Special Concern Maps (CDFW) for species evaluated in Task 2 and identify primary roadways that transect habitats for these sensitive species. This was done in consultation with the WTI research team, Caltrans, wildlife agencies (U.S. Fish and Wildlife Service (USFWS) and CDFW) and species experts.

4) Assist WTI in the synthesis of the state of the practice in reptile and amphibian highway crossings by compiling and reviewing literature on amphibians and reptiles and mitigation measures to reduce road impacts, including identifying research gaps and future research needs.

5) Using expertise from within WERC and input on roadways and animal crossings from WTI, develop and design a plan for field research to evaluate key design and environmental attributes of functional passage structures for select amphibian and reptile species. Select sensitive amphibian and reptile species from the prioritized list developed in Task 2. Conduct field studies at existing (and new if possible) crossing structures to determine effective means for enhancing the ability of the selected species to cross highways. Give preference to multiple replicated sites that allow for simple experimental manipulations.

6) Provide expertise on California amphibians and reptiles to the WTI research team for the preparation of the Best Management Practices (BMPs) manual. Prepare report of Tasks 1-5 and a manuscript for presentation and/or publication.

### **Establishing Collaborative Networks (Task 1)**

We began the first task by holding a special session at the California-Nevada Amphibian Populations Task Force (APTF) in Calabasas, CA on January 8-10, 2015. The session was entitled “Amphibian (and Amphibious Reptile) Road Ecology” and hosted by USGS with guest speakers Tony Clevenger (WTI), Tom Langton (Herpetofauna C I Ltd), Sally Brown (USFWS), Michael Westphal (U.S. Bureau of Land Management), Michael Hobbs (San Jose State University) and Chris Brown (USGS). We used this venue to highlight the project and to begin collaborative networking. Collaborations continued throughout the contract period through many meetings and communications with WTI, California scientists and herpetologists, Caltrans state and district biologists, USFWS, CDFW, U.S. Forest Service (USFS), and other scientists and herpetologists throughout the state. We also attended and presented at multiple conferences and meetings such as the Desert Tortoise Council Symposium (2016), annual APTF meetings (2015-16, 2018-2019), Western Section of the Wildlife Society (2019), USGS Amphibian Research Monitoring Initiative (ARMI 2015-2019), and the International Conference of Ecology and Transportation (2015, 2019).

Tasks 2 through 5 are individually summarized in the following subsections of Chapter 1 of this report along with summaries of findings, relevance of findings to informing the BMPs, and suggestions for future studies. Individual comprehensive reports for the risk analysis (task 2), geodatabase (task 3), and field research (task 5) are presented in subsequent Chapters.

## Risk Assessment (Task 2)

Caltrans considers the need for barrier structures and safe wildlife road-crossings important to maintain the long-term viability of wildlife populations (Caltrans 2019). To prioritize these efforts for herpetofauna, we identified species that are most at risk of extirpation from road-related impacts. With over 160 California species and a lack of species-specific research data, we developed an objective risk assessment method based upon road ecology science. Risk scores were based upon a suite of life history, movement, and space-use characteristics associated with negative road effects that were applied in a hierarchical manner from individuals to species (Figure 1). Considerations included movement distances, movement frequency, speed, habitat preferences, movement behavior (territorial, non-territorial, vs. migratory), fecundity, range size and conservation status. All California herpetofauna species (and some subspecies) were ranked into five relative categories of road-related risk to both aquatic and terrestrial connectivity (very-high to very-low) based upon 20% increments of all species scores.

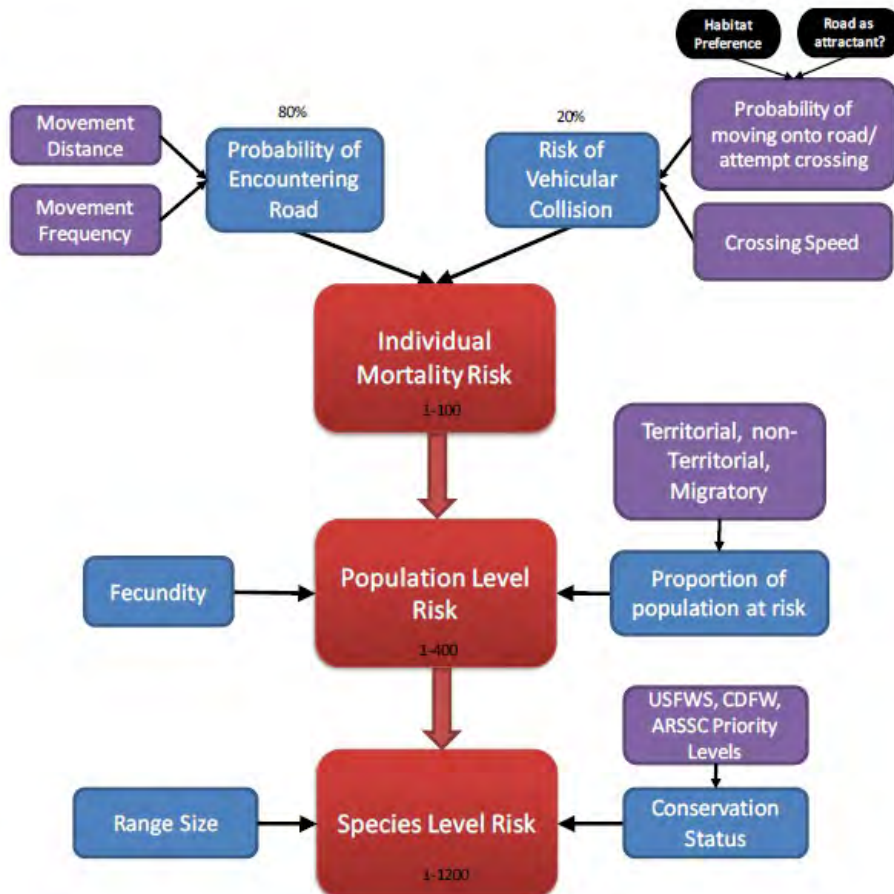


Figure 1. California Reptile and Amphibian Road Risk Assessment Conceptual Model.



All chelonids, 72% of snakes, 50% of anurans, 18% of lizards and 17% of salamander species in California were ranked at high or very-high risk from negative road impacts. Results were largely consistent with local and global scientific literature in identifying high risk species and groups.

Overall, snakes and chelonids had the largest proportion of species at high risk for negative road impacts due to longer movement distances (home range and/or migratory), lack of road avoidance, and relatively low fecundity in comparison to other herpetofaunal groups. This includes the desert tortoise, that has been shown to suffer from high road mortality negatively affecting population abundance in the Mojave Desert, and pond turtles, that travel kilometers within perennial waters and intermittent aquatic habitats to forage and find mates. In addition, female pond turtles migrate from their aquatic habitat to terrestrial habitats to nest and lay eggs, which make roads that parallel aquatic habitat a threat to both females and hatchlings.

Many large colubrid snakes and rattlesnakes ranked high. They are not only attracted to paved road surfaces for thermoregulation but have wide home ranges or move large distances between winter hibernacula and summer foraging areas. Long foraging movements within aquatic habitats also contributed to many garter snakes falling within the highest road risk categories.

Approximately half of California anuran species were ranked at high risk of negative road effects. These include Bufonid toads and red-legged frogs that may move large distances in both aquatic and terrestrial habitats to satisfy their annual resource requirements. Newts and several Ambystomid salamander species whose populations annually migrate between aquatic and upland habitats also ranked as high risk. Only a few wide-ranging lizard species scored in the highest risk categories including the Gila monster, leopard lizards, and two horned lizard species.

This risk assessment approach compared the susceptibility of species to negative road impacts. Commonly, there are numerous populations that occupy areas with greatly differing road pressures within a single species range. The actual risk to specific populations will depend upon local road densities, road types, traffic, and road locations in relation to species habitat and movement corridors. Therefore, it will be important to reassess the risk of roads to specific populations and to evaluate and compare alternatives at the local scale.

To help inform transportation planning and for evaluating the suitability of different best management practices, the risk of roads to both terrestrial and aquatic connectivity was assessed. Thus, semi-aquatic species have two risk scores. Some scored high in both habitats, while others scored high in only one. This is important when evaluating the need for underpasses and other terrestrial crossings versus bridges and fish passages. For example, underpasses, barriers and other structures may be suitable for species with high terrestrial risk scores; such as tortoises, colubrid snakes, rattlesnakes, and Ambystomid salamanders. Conversely, the use of fish passages and bridges could also be considered for species with high aquatic risk scores; such as the giant gartersnake, California red-sided gartersnake, two-striped gartersnake, and Sonoran mud turtle. Both terrestrial and aquatic passages may be needed for species groups that ranked high in both categories; such as pond turtles, Bufonid toads, newts and red-legged frogs. Along with this, buffer distances for terrestrial and aquatic habitats were calculated to encompass 95% of population level movements of all species. This provides information to agencies deciding whether a population is

close enough to a road (within buffer distance) to warrant mitigation, the need for a barrier, and whether a goal should be to provide population-level connectivity or allow for occasional dispersal to provide long-term genetic connectivity.

A simplified list of high and very-high risk species is provided in Table 1. This work has been published (Brehme et al. 2018). The journal article with all California species rankings and buffer distances is included as Chapter 2 and is available at <https://link.springer.com/article/10.1007/s10980-018-0640-1>.

Table 1. California Amphibians and Reptiles Ranked at High and Very-high Risk of Negative Road-related Impacts.

<b>GROUP</b>	<b>VERY-HIGH RISK</b>	<b>HIGH RISK</b>
Terrestrial Snakes	Alameda Striped Racer Baja California Coachwhip Baja California Ratsnake California Glossy Snake Coachwhip Coast Patch-nosed Snake North American Racer Panamint Rattlesnake San Joaquin Coachwhip Striped Racer	California Lyresnake Desert Nightsnake Mojave Rattlesnake Nightsnake Red Diamond Rattlesnake Regal Ring-necked Snake Sidewinder Sonoran Lyresnake Speckled Rattlesnake Spotted Leaf-nosed Snake Western Groundsnake Western Diamond-backed Rattlesnake Western Patch-nosed Snake Western Shovel-nosed Snake Western Rattlesnake
Aquatic Snakes	California Red-sided Gartersnake Giant Gartersnake San Francisco Gartersnake Two-striped Gartersnake	Aquatic Gartersnake Common Gartersnake Northwestern Gartersnake Sierra Gartersnake Western Terrestrial Gartersnake
Freshwater Turtles	Northern Western Pond Turtle Southern Western Pond Turtle Sonora Mud Turtle	
Tortoises	Mohave Desert Tortoise	
Toads	Arroyo Toad Black Toad Sonoran Desert Toad Yosemite Toad	Great Plains Toad Western Spadefoot Woodhouse's Toad
Frogs	California Red-legged Frog	Cascades Frog Northern Red-legged Frog Oregon Spotted Frog
Lizards	Banded Gila Monster Blunt-nosed Leopard Lizard Cope's Leopard Lizard Desert Horned Lizard Flat-tailed Horned Lizard	Long-nosed Leopard Lizard San Diegan Tiger Whiptail Switak's Banded Gecko
Salamanders	California Newt Callifornia Tiger Salamander Red-bellied Newt Sierra Newt	California Giant Salamander Rough-skinned Newt Santa-Cruz Long-toed Salamander Southern Long-toed Salamander

### Spatial Mapping (Task 3)

Caltrans and CDFW commissioned the California Essential Habitat Connectivity (CEHC) Project because they consider a functional network of connected wildlands essential to the continued support of California's diverse natural communities in the face of human development and climate change (Spencer et al. 2010). CEHC maps and spatial layers depict large, relatively natural habitat blocks greater than 809 ha (2000 acres) that support native biodiversity and areas deemed essential for regional scale animal and plant connectivity. These maps were intended to make transportation and land-use planning more efficient and less costly, while helping to reduce wildlife-vehicle collisions. They are available on the CDFW Biogeographic Information and Observation System (BIOS) website <https://wildlife.ca.gov/Data/BIOS>.

Essential Connectivity Areas (ECA), Natural Landscape Blocks (NLB), and Natural Areas\_small (NA) from the Essential Connectivity Map geodatabase were provided by CDFW. Although habitat blocks greater than 809 ha are appropriate for planning connectivity for large mammals, small animals can persist on smaller size patches. Therefore, we merged ECA, NLB, and NA areas 10 ha or greater. The resulting layer was then dissolved into a single polygon feature class with a buffer of 100 meters added to it. This connected many of the smaller polygons and better represented natural areas large enough to support sensitive amphibian and reptile populations. We then prepared a spatial geodatabase that intersects the modified CEHC map, State Highways and high-risk species ranges from the California amphibian and reptile road risk assessment (Brehme et al. 2018). This geodatabase was designed to be a useful planning tool for Caltrans to quickly identify road segments which may warrant planning for increased connectivity of high-risk amphibian and reptile species.

The spatial geodatabase (CalTrans\_SpeciesRoadRisk\_Map.mpk) includes:

- 1) CEHC lands merged with smaller habitat blocks (>10 ha).
- 2) Ranges of high and very-high risk amphibian and reptile species.
- 3) California highway segments that intersect habitat ranges of high and very-high risk amphibian and reptile species.
- 3) California highway segments that intersect habitat ranges of high and very-high risk amphibian and reptile species and CEHC lands.
- 4) The total number of high and very-high risk species habitat ranges that intersect the highway segments and CEHC lands.

Here we show an example of a high-risk species density map for the state (Figure 2) and an individual species map (Figure 3), where the species habitat range intersects CEHC lands and state highway systems. Note that the accuracy of each species road risk map is dependent upon the accuracy of its most recent range map, which varies by species (see Chapter 3 for sources). Because many species are patchily distributed throughout their ranges, species may not be

occupying habitat along all intersecting highway segments. Therefore, highlighted road segments indicate the possibility of species occupancy as well as known occupancy.

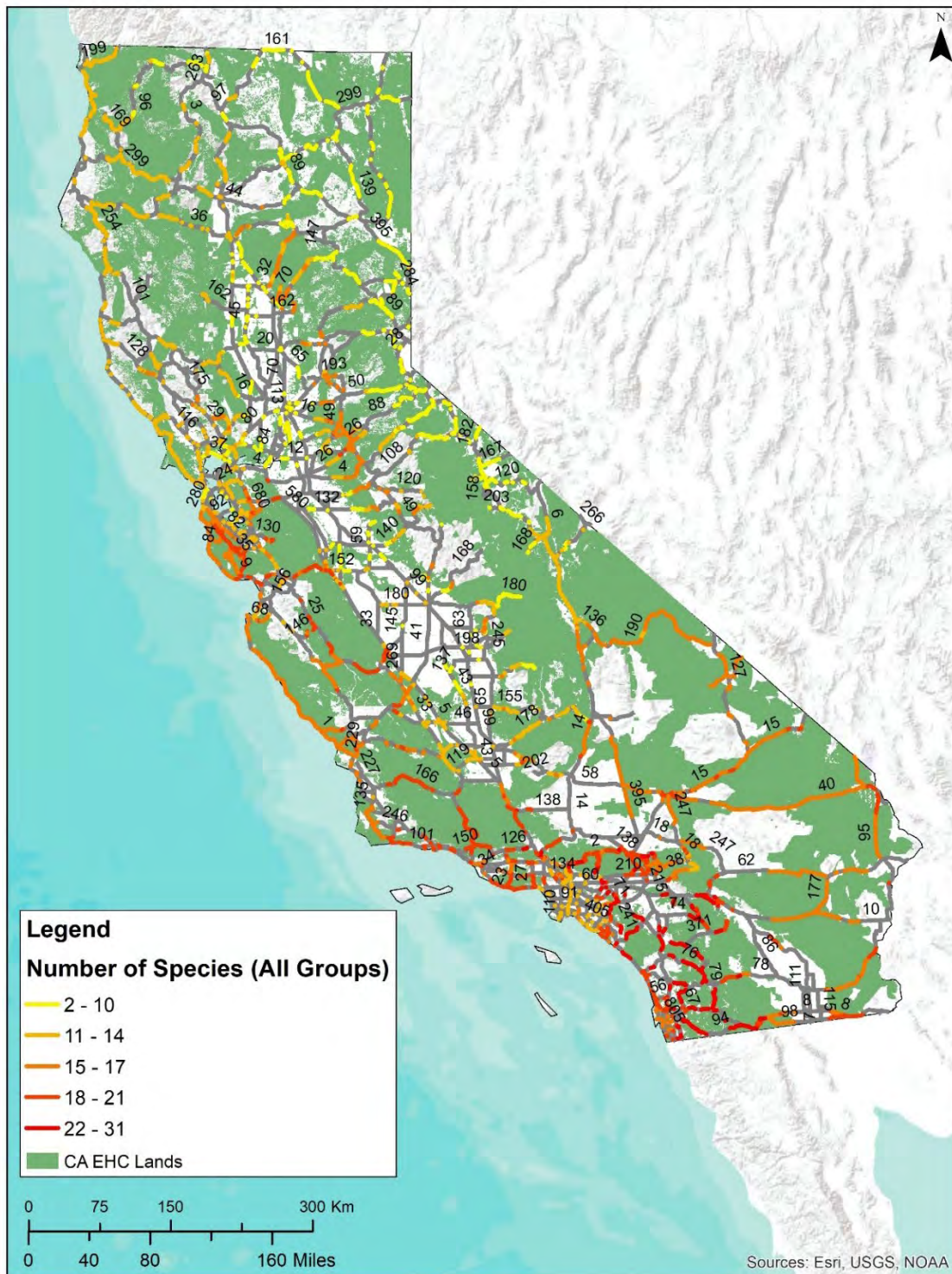


Figure 2. Density of High and Very-High Risk Reptile and Amphibian Species across the State Highway System (Elise Watson, USGS). Note: California Highway Numbers are in Black.



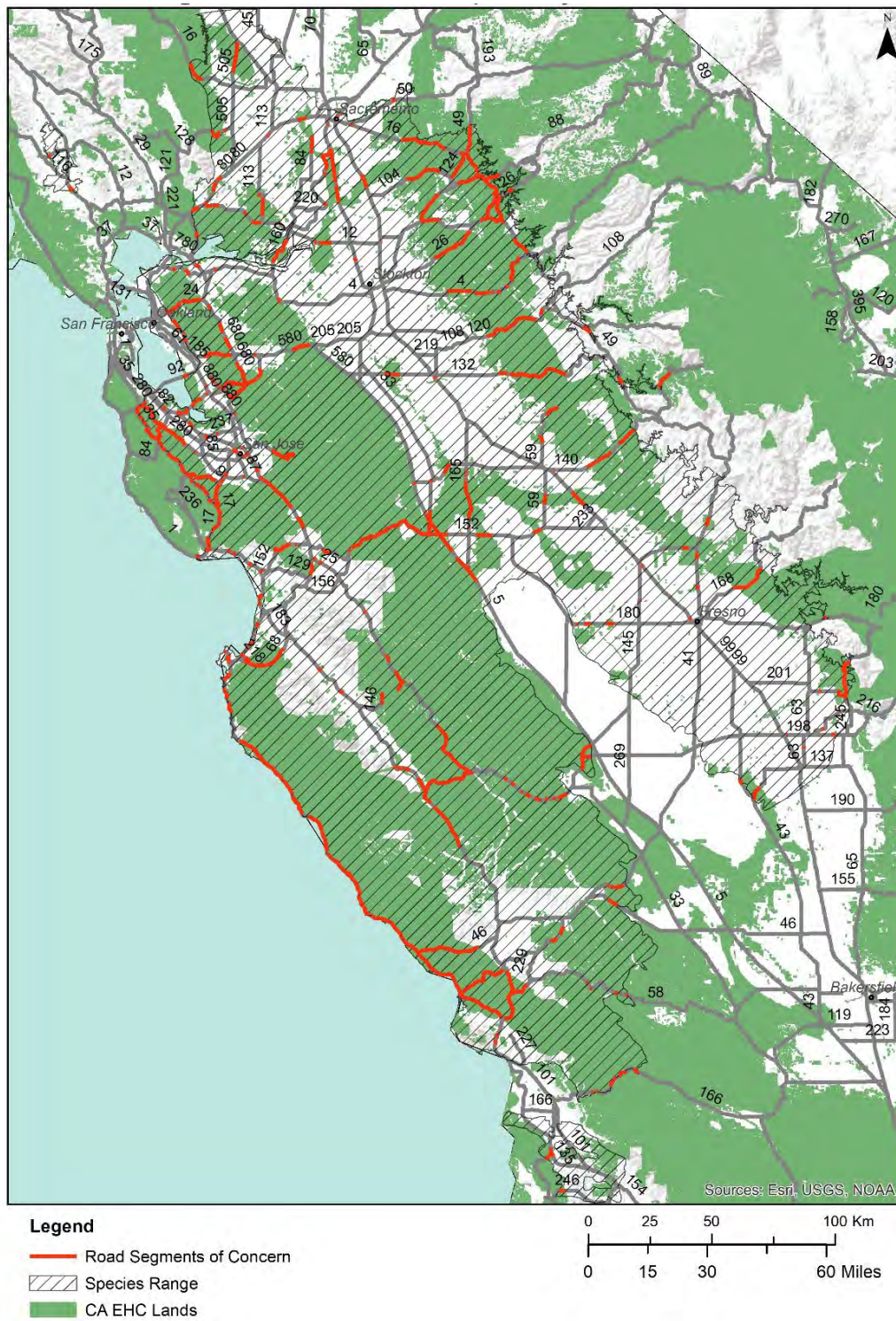


Figure 3. Overlay of Single Very-High Risk Species Range (*Ambystoma californiense*), CEHC Lands and the State Highway System (Elise Watson, USGS). Note: California Highway Numbers are in Black.

## Literature Review and Gap Analysis (Task 4)

To synthesize what was currently known about reptile and amphibian crossing systems in California and throughout the world and to identify primary information gaps in scientific and practical knowledge to inform these crossing systems, WTI conducted a detailed literature review and synthesis with input from USGS (Langton and Clevenger 2017). The authors reviewed 52 studies on crossing systems with 125 individual taxa (75 reptile and 50 amphibian species or sub-species) throughout Europe, North America, South America and Australasia. Of these, 45% were for reptiles and 55% amphibians. Information from each paper was summarized into three study or 'knowledge area' categories: passage construction and use, passage environmental variables and barrier construction and use.

Langton and Clevenger (2017) concluded that in most cases road mitigation was installed primarily to reduce road mortality versus to maintain connectivity. However, large passages tended to be more permeable to amphibian and reptile crossings than smaller passages. They determined that the literature reflected a widely spread and low-inference scientific knowledge base regarding the efficacy of amphibian and reptile passages and barrier systems, although the body of literature has been growing in recent years with specific species and systems. They also found little information on the role of existing infrastructure and drainage culverts in helping to maintain genetic and population connectivity for herpetofauna.

Therefore, Langton and Clevenger (2017) concluded there was a need for more properly designed studies to evaluate the effectiveness of purpose-built (engineered) and non-engineered passages and barriers. Research studies (controlled experimental or field settings) were needed to directly measure, test and compare results among mitigation structures, their structural and environmental characteristics, and permeability to species and species groups. Information and knowledge gaps identified from this analysis included the following:

- Use of existing highway structures by herpetofauna.
- Relative permeability of most commonly built structures to different herpetofauna groups.
- Relationship between use and openness ratio and length and width of passage.
- Whether populations could benefit from addition of barrier fencing to existing structures.
- The most effective ways to simulate natural and artificial light, temperature and moisture within underpasses.
- The influence of fence material and opacity on barrier effectiveness and passage use.
- Effectiveness of turnarounds at fence ends.
- The best designs to extend barriers along road access points.

This review and synthesis, along with the risk assessment, was used to help guide field research and for developing California Best Management Practices (BMPs) for sensitive amphibian and reptile highway crossings (Langton and Clevenger 2020).



## Research Questions and Field Studies (Task 5)

Based on the literature review and gap analysis, we devised a list of 9 research studies along with research objectives, target species/groups, general study designs, relative costs, and how each of these studies would inform Best Management Practices (BMPs) for Caltrans reptile and amphibian crossings. Representatives from Caltrans (Simon Bisrat, James Henke, Amy Golden, Amy Bailey), Western Transportation Institute (Tony Clevenger, Tom Langton), and USGS (Robert Fisher, Cheryl Brehme) met in September of 2017 to review the study options and select the studies that would be pursued as part of this project.

After reviewing and discussing each of the studies, the following studies were identified as being the most cost effective while providing valuable information for the BMPs. Below are the primary research questions, target species and locations chosen for these studies.

1. What is the maximum distance between passages to maintain permeability for migratory herpetofauna (pond breeding amphibians)?
  - a. Target Species/Groups: California tiger salamander, Yosemite toad
  - b. Locations: Stanford, Sierra National Forest.
2. How does fence material (transparency) influence species movement along barriers?
  - a. Target Species/Groups: reptiles and amphibians, California tiger salamander, Yosemite toad
  - b. Locations: San Diego, Stanford, Sierra National Forest
3. Fence ends: How effective are fence-end turnarounds?
  - a. Target Species/Groups: reptiles and amphibians
  - b. Location: San Diego, Stanford, Sierra National Forest
4. What designs of jump-outs are effective for herpetofauna and other small animals?
  - a. Target Species/Groups: reptiles and amphibians
  - b. Location: San Diego

Additionally, we included two extra questions in our studies as they developed.

5. What is the relative permeability of a special built passage system for California tiger salamanders (Type 5: Micro-underpass)?
  - a. Target Species/Groups: California tiger salamander
  - b. Location: Stanford
6. Is there an alternative to the tunnel passage system design for migratory amphibians and other high risk herpetofauna? Evaluation of a novel elevated road segment passage.
  - a. Target Species/Groups: Yosemite toad
  - b. Location: Sierra National Forest.

Individual reports of all field studies are provided in Chapters 4 through 7.

## **Summary of Research Findings and Relevance to Caltrans BMP's (Task 6)**

The results of our field studies inform the Caltrans Best Management Practices for amphibian and reptile crossing systems regarding passage spacing for migratory amphibians, barrier fencing materials, and the effectiveness of turnarounds and jump-outs. We also evaluated the permeability of an existing amphibian tunnel system and a novel pilot elevated road segment passage.

### **Movement Distances along Barriers to Inform Passage Spacing for Migratory Amphibians** *(Question 1 above)*

Our results from studies of California tiger salamanders (CTS) in Stanford, CA and Yosemite toads in the Sierra National Forest showed that many of these amphibians migrating between wetland and upland habitats were unlikely to reach the road passage systems if they encountered the barrier fencing away from the passage. CTS moved an average distance of 40 m and Yosemite toads moved an average distance of 52 m along barrier fencing before “giving up,” and their probability of making it to a crossing decreased rapidly with increasing distance. In addition to distance moved, the direction the salamanders and toads turned when reaching the barrier fencing was a factor in whether they reached a passage. Individuals that reached the barrier fencing and then travelled in the wrong direction (away from the passage) were significantly less likely to reach the crossing than those that made the correct initial direction choice. The average distance moved by these amphibians indicates that approximately half of the individuals moved greater distances and half moved shorter distances before “giving up.” We estimated a distance between passages of less than 12.5 m (CTS) and 20 m (Yosemite toads) would be needed along migratory pathways to maintain a high level of permeability.

Therefore, the likelihood by distance that animals reach a passage can inform the planning and spacing of crossing systems for migratory amphibians and other migratory species. Without considering this, amphibian road crossing systems composed of barrier fencing and underpasses have the potential to become a greater barrier to movement. This is particularly relevant when high connectivity is important for the sustainability of the population, such as for migratory amphibian species that must make population level movements between upland and breeding habitats. With non-migratory species, less frequent cross-road movements could be acceptable if roads do not transect seasonal habitats or vital resources. In these cases, occasional crossings to enable reproductive and genetic connectivity may be sufficient to maintain long term population persistence.

### **Barrier Fencing Materials** *(Question 2 above)*

Three of our studies were relevant to herpetofaunal responses to fencing materials of various transparencies. One was the fence trial behavioral study of reptiles in Rancho Jamul, one was our CTS study at Stanford, and the third was our Yosemite toad study in the Sierra Nevada.

The results from our behavioral studies show that herpetofauna are more likely to interact with the transparent and semi-transparent fences by poking at them with their noses, pacing back and forth, and attempting to climb. The transparent (hardware cloth) and semi-transparent fencing (polymer matrix “mesh”) used in our studies were not only see-through, but permeable to the movement of air in comparison to plastic solid fencing. Because sight and chemoreception senses are typically well developed in reptiles, it is not clear to what extent these different senses are driving fence interaction behaviors. However, it is clear from our observations that animals exhibiting these behaviors appeared to be trying to find a way through the fence to the other side.

Although fence interaction behaviors have been documented elsewhere in comparing hardware cloth and solid fencing (Ruby et al. 1994, Milburn-Rodríguez et al. 2016), our trial behavioral studies showed a clear gradation of response from solid to semi-transparent to transparent fencing in all taxa studied. In addition, our studies showed that these behavioral responses typically resulted in animals moving slower, or spending more time, along transparent/permeable fencing in comparison to solid fencing. This may not be a large concern when the purpose of the fence is primarily to exclude animals. However, it may be an important consideration when a dual objective is to lead species toward a road crossing structure, particularly when high permeability and population connectivity across the structure is desired.

In our migratory amphibian studies, the transparency of fencing (mesh vs. solid) did not significantly affect the movement distances of CTS or Yosemite toads or their probability of making it to the underpass system, although the estimated probabilities of reaching underpasses were slightly lower for the semi-transparent fencing. With preliminary data, the speed and time of travel for Yosemite toads were not significantly different by fence type. However, for CTS, the speed and time of travel varied significantly by fence type. CTS moving along solid fencing moved at almost twice the average speed and were 3 times less likely to turn around and repeatedly move back and forth. Therefore, CTS moving along fencing that they could see through resulted in them expending a higher amount of time and energy to make it to the crossing.

There are many reasons why different fencing types (hardware cloth, mesh, or solid) may be used in particular landscapes, habitats, and climates with considerations that include heat, rain and wind, permeability, durability, and aesthetics (see Langton and Clevenger 2020). Our behavioral study was the first to show that addition of a simple visual barrier (6 in./153 mm in our study) from the ground upwards, at the base of transparent and semi-transparent fencing, can reduce fence interaction behaviors and increase rates of movement. In fact, for most measures, herpetofauna responses to mesh and hardware cloth fencing with a visual barrier were not significantly different than to the solid barrier. This could allow for more flexibility in the decision-making and planning processes for barrier systems for herpetofauna.

### Turnarounds (Question 3 above)

Three studies were relevant to the efficacy of turnarounds. One was done in Rancho Jamul, one was our CTS study at Stanford, and the third was our Yosemite toad study in the Sierra Nevada. A general graphic of the turn-around design used is depicted in Figure 4.

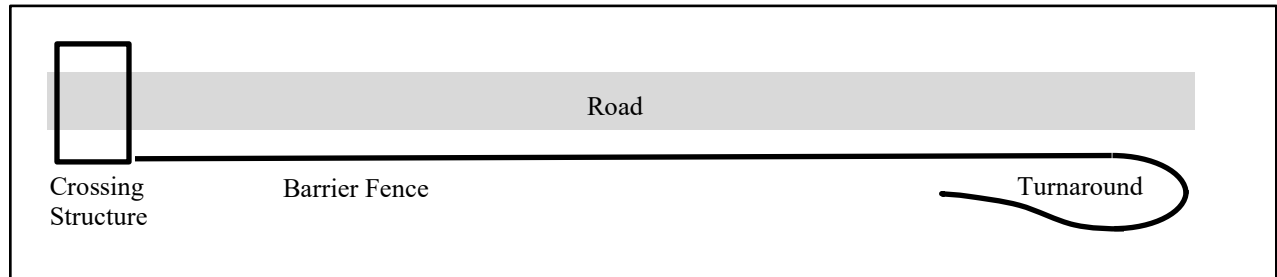


Figure 4. Diagram of Turn-around at Barrier Fence End

Our Rancho Jamul study was the first to show that small turnarounds at fence ends can be effective in changing the trajectory of movement for herpetofauna and small mammals. The turnarounds in our studies were approximately 1.5 m long and 1 m wide at the widest point with the turnaround ending approximately 0.4 m from the original fence line and extending another 0.4 m parallel to the fence. Turnarounds at fence ends were made of hardware cloth, mesh, or solid fencing (2 each). We documented that over 90% of herpetofauna (lizards, snakes and toads) and 69% of small mammals changed course after leaving a turnaround. Of those that changed their trajectory, 67% of herpetofauna and 43% of small mammals moved back along the original fence line while the remainder turned away from the fence line toward the habitat. We previously observed that animals spend more time interacting (e.g. poking, back and forth movements, climbing) with fencing that they can see and smell through (Question 2, Chapter 6). Animals also generally spent increased amounts of time in transparent/permeable and semi-transparent/permeable turnarounds than solid impermeable turnarounds.

Our results also suggest the use of transparent or semi-transparent fencing for turnarounds may increase their effectiveness for some species groups (Chapter 7). These results could be related to animals interacting with the fencing and spending more time in transparent turnarounds, so that they were less likely to remember and continue on their original trajectory. The results may also be related to the different types of spatial learning and memory used for navigation when animals are subjected to solid barriers (egocentric) in comparison to transparent barriers (allocentric) as has been shown in maze-food trials with rodents (Violle et al. 2009, Vorhees and Williams 2014). Validation of these findings in other locations and possibly more specific research studies addressing spatial learning and movement responses in reptiles, amphibians, and small mammals in their natural environments would be needed to further our understanding of these results.

We did not compare different sizes or shapes of turnarounds in our study; however, we hypothesize that having the end of the turnaround close to the original fence line may help to steer

animals back along the original barrier in the direction of original origin. Longer or larger turnarounds encompassing smaller turnarounds have been proposed to increase the probability that animals do not go out onto the roadways if they turn away from the fence and into habitat on leaving the turn around (Langton and Clevenger 2020).

In this study, we only documented animal movement for up to 1 m (3.4 feet) after leaving the turnaround. It is entirely possible that animals changed course again after they left the field of view of the video camera. In our Stanford and Sierra movement studies (Chapters 3 and 4), two out of three CTS that presumably reached a turnaround at the fence end were subsequently documented on another camera 25-125 m away moving back along the fence line. Preliminary results suggest seven out of 10 Yosemite toads changed course at a turnaround, while three continued in the direction past the fence ends. Of the seven toads that changed course, four were subsequently documented on another camera 40-80 m away moving back along the fence line toward the passage. Further studies using more cameras and/or tracking methods are needed to better understand how turnarounds affect movement of animals over a longer distances and time frames. Higher mortality of herpetofauna has been well documented at fence ends even with turnarounds (Gunson et al. 2014, Langton and Clevenger 2017, Helldin and Petrovan 2019). However, the high proportion of herpetofauna that changed directions in our study supports the use of turnarounds in attempts to reduce the chances that small animals go out onto the roadway at fence ends and potentially to help ‘steer’ them back toward to a crossing structure.

#### **Jump-outs** (*Question 4 above*)

Animals can get trapped within the roadway if they get through an opening in the fencing or overshoot the end of the fencing. Jump-outs provide a way for animals that get trapped within a roadway surrounded by vertical barrier fencing to safely get back into the habitat on the other side of the fence. Although jump-outs are commonly built structures along wildlife fencing for large mammals, they have not been incorporated into transportation planning for reptile and amphibian barriers. However, short curved or sloped fencing has been designed for amphibians that angles toward the habitat to allow movement over the top in one direction.

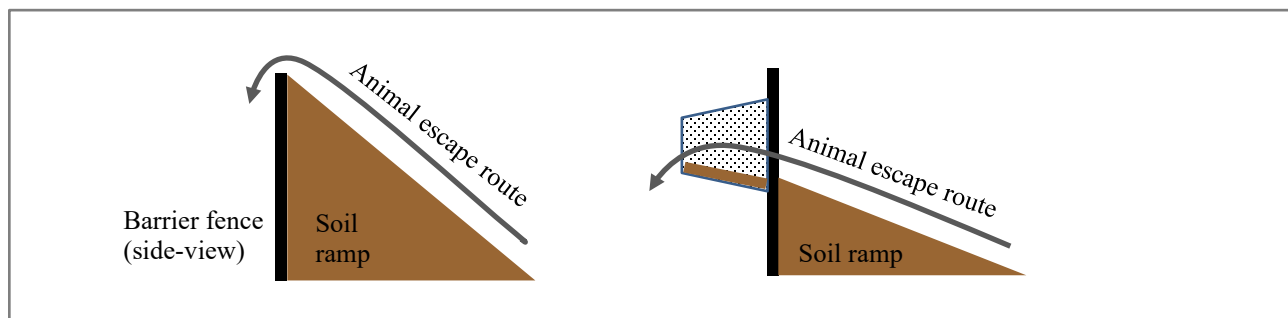


Figure 5. Diagram of Jump-out Configurations a) Over Fence and b) Through Fence.

Our experimental behavioral study showed that two jump-out configurations (Figure 5) were largely effective in allowing animals trapped on the ‘wrong’ side of a vertical fence to escape back into the habitat. One was simply a soil ramp to the top of the exclusion fencing (Figure 5a: 50 cm. in height) and the other was a polymer box funnel placed at a height of 25 cm above the ground within the exclusion fencing with a small soil ramp leading up to it (Figure 5b). A total of 75% of lizards, 95% of snakes, and 1 of 2 toads used a jump-out to escape the enclosure. There was little difference between the use of the high ramp and low funnel jump-outs by lizards or snakes. We observed that lizards often sat on top of the 50 cm high ramp for long periods of time before jumping to the ground, whereas there was little hesitation with the lower 25 cm jump-outs.

We suggest jump-outs be provided at regular intervals along vertical barriers in the form of a ramp leading to the top of the barrier or leading to a funnel type structure that opens to the habitat. It is also important that any jump-out design for herpetofauna consider the safety of other wildlife. This includes minimizing the size difference of the entrance and exit of box funnel designs so that larger animals do not get stuck in the funnel. Rectangular or cylindrical shapes with the same entry and exit size could be considered. For short barrier fencing, most other wildlife can simply step, climb, or jump over the barrier. For taller barrier fences, escape routes may include jump-outs of several sizes to accommodate a wider variety of species.

### **Effectiveness of Crossing Structures: Amphibian Tunnels and a Novel Elevated Road Segment** (*Questions 5 and 6 above*)

Many small animals, especially amphibian populations that must migrate between aquatic and terrestrial habitats, are susceptible to negative impacts from roads within their habitat (e.g. Hamer et al. 2008, Semlitsch 2008, Brehme et al. 2018). In the winter breeding seasons of 2018 and 2019, we studied the movement of CTS across three existing micro-passage amphibian tunnels spaced approximately 5 m apart from one another along Junipero Serra Blvd in Stanford, CA. The road bisects a historic CTS breeding pond and upland CTS habitat. CTS that did reach the opening of the passage system had a very high probability (87%) of making a complete crossing to the other side. The passages are made of inert materials (polymer concrete) and incorporate a slotted ceiling at the road surface to allow natural light, moisture and rainfall to permeate the length of the passage. These passages have been shown to be permeable to amphibian movement in North America and Europe (Jackson and Tynning 1989, Pagnucco et al. 2012, Langton and Clevenger 2017). Although they have not been used for amphibian passage on the state highway system to date, these results are promising for possible use of these and/or similarly designed passages by Caltrans.

Although micro-passage tunnels are a standard mitigation solution to reduce amphibian road mortality, there is evidence that these systems may filter movements of populations that disperse over large areas, particularly if passages are placed too far apart from one another across the migratory pathways (e.g. Allaback and Laabs 2002, Pagnucco et al. 2012, Ottburg and van der Grift 2019). In 2018 we tested a new and novel passage elevated road segment (ERS) prototype, an eight-in. high elevated road segment using road mats designed for use by heavy equipment at



construction sites. The ERS was installed on top of a USFS road along a Yosemite toad mortality “hotspot” with directional barrier fencing. The ERS provides a safe crossing nearly 100 ft wide while allowing both light and rain to pass through. We monitored Yosemite toad and other herpetofaunal activity along fencing and under the passage using specialized cameras. Initial results show that toads and other herpetofauna as well as small mammals used the passage and mortality was greatly reduced. Although the prototype was a 100-ft wide passage, theoretically they could be made to any length. This ERS prototype offers a new concept design to increase permeability of roads to migratory amphibians and other species. There is currently an effort underway by DOT and other transportation engineers to adapt this concept design to more permanent highway applications.

## **Considerations for Future Studies**

To further inform the design of effective barrier and passage systems for herpetofauna, we suggest consideration of the following research:

1. Continue study of Yosemite toads in Sierra National Forest to increase sample size and confidence in model predictions on passage spacing, fence opacity, and the permeability of the ERS crossing system.
2. Include one or more new study locations and species to better predict underpass spacing needs for high-risk migratory amphibian species. This would address the question of whether movement distances along barrier fencing are predictable among species groups and size classes.
3. Continue California tiger salamander and Yosemite toad studies to explore modifications to increase effectiveness of passages. Address the following questions:
  - a. Will affixing a visual barrier to transparent or semi-transparent fencing change CTS behavior so that it more closely resembles the reaction to solid fencing? This is useful because in some areas, mesh fencing may be preferred for water/wind permeability, etc.
  - b. Would more turnarounds along the length of barrier fencing help to increase the probability of success for animals that start out moving away from tunnels?
4. Continue research to assess the effectiveness of fence end treatments by studying the effect of turnaround length, materials and configuration on amphibian and reptile turnaround rates. Monitor animal movements over longer distances after exiting turnaround.

5. Work with engineers familiar with Caltrans materials and specifications to design (and test if possible) new options to add to existing BMP elements for increasing effectiveness of road crossings for herpetofauna such as:
  - a. Elevated road segment (ERS) concept designs for primary roadways.
  - b. Artificial lighting in tunnels that best simulates natural lighting for diurnal species. This is mainly for long underpasses where grated skylights in the shoulders and median are not feasible or sufficient to illuminate a passage .
  - c. Drip or other drainage systems that deposit a path of moisture in otherwise dry underpasses during rain events.
  - d. Design modifications to decrease the temperature differential between tunnel interiors and the surrounding environment.
  - e. Design modifications to incorporate cover and ledges for herpetofauna within larger passages.
  
6. Design and implement studies to better understand if herpetofauna use existing passages and culverts for movement across roads.
  - a. If so, what is the relative permeability of the most commonly built structures to different herpetofauna groups?
  - b. Is the probability of use related to size of passage? If so, for which species groups?
  - c. How is use of passages related to length and openness ratio?
  - d. Would barrier fencing increase the use of non-engineered structures (i.e. culverts)?

These proposed studies will allow Caltrans to better evaluate the effectiveness of existing barrier and road crossing systems, to increase the ‘toolbox’ of innovative solutions, to increase the effectiveness of crossing systems for reptiles and amphibians in California, and to make more informed decisions on underpass spacing for high-risk migratory species.

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*Note: more extensive citations are included in individual study chapters*

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## Chapter 2. California Road Risk Analysis for Herpetofauna (Reprinted with permission)

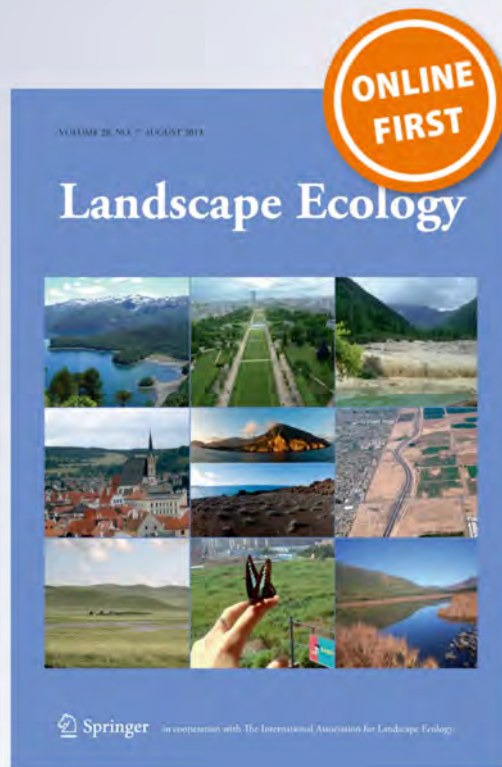
*An objective road risk assessment method  
for multiple species: ranking 166 reptiles  
and amphibians in California*

**Cheryl S. Brehme, Stacie A. Hathaway &  
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**Landscape Ecology**

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# An objective road risk assessment method for multiple species: ranking 166 reptiles and amphibians in California

Cheryl S. Brehme  · Stacie A. Hathaway  · Robert N. Fisher 

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## Abstract

**Context** Transportation and wildlife agencies may consider the need for barrier structures and safe wildlife road-crossings to maintain the long-term viability of wildlife populations. In order to prioritize these efforts, it is important to identify species that are most at risk of extirpation from road-related impacts.

**Purpose** Our goal was to identify reptiles and amphibians in California most susceptible to road mortality and fragmentation. With over 160 species and a lack of species-specific research data, we developed an objective risk assessment method based upon road ecology science.

**Methods** Risk scoring was based upon a suite of life history and space-use characteristics associated with negative road effects applied in a hierarchical manner from individuals to species. We evaluated risk to both aquatic and terrestrial connectivity and calculated buffer distances to encompass 95% of population-level movements. We ranked species into five relative categories of road-related risk (very-high to very-low) based upon 20% increments of all species scores.

**Results** All chelonids, 72% of snakes, 50% of anurans, 18% of lizards and 17% of salamander species in California were ranked at high or very-high risk from negative road impacts. Results were largely consistent with local and global scientific literature in identifying high risk species and groups.

**Conclusions** This comparative risk assessment method provides a science-based framework to identify species most susceptible to negative road impacts. The results can inform regional-scale road mitigation planning and prioritization efforts and threat assessments for special-status species. We believe this approach is applicable to numerous landscapes and taxonomic groups.

**Keywords** Reptile · Amphibian · Road mortality · Habitat fragmentation · Road ecology · Risk assessment · Road

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C. S. Brehme (✉) · S. A. Hathaway · R. N. Fisher  
U.S. Geological Survey, Western Ecological Research  
Center, San Diego, CA, USA  
e-mail: cbrehme@usgs.gov

## Introduction

There have been many attempts to better characterize and quantify threat criteria in order to classify species at higher risk of extinction at state, national, and global levels (Congress 1973 (U.S. Endangered Species Act); Mace et al. 2008; Hobday et al. 2011; Thomson et al. 2016; IUCN 2017). Roads are a significant threat to wildlife populations (e.g., Forman et al. 2003;



Andrews et al. 2015a; van der Ree et al. 2015), causing both barrier (habitat fragmentation) and depletion (road mortality) effects. Barrier effects occur when animals avoid crossing roads, in which case roads essentially fragment species habitat. Barrier effects include reduced size and quality of available habitat, reduced effective population size, reduced ability to find mates and resources, increased genetic structuring, and increased probability of local extirpation (e.g., Forman et al. 2003; Fahrig and Rytwinski 2009; D'Amico et al. 2016). Depletion effects occur when animals attempt to cross roads and are killed by vehicles. Depletion effects include all of the risks from barrier effects as well as reduced survivorship, making high road mortality an even greater concern (Jackson and Fahrig 2011). Among other stressors, such as habitat loss and fragmentation, invasive species, pesticide use, changing climate, and disease, the negative impacts from roads may independently or cumulatively threaten the persistence of populations and even species.

Amphibians and reptiles have been identified as being particularly susceptible to the negative effects of roads within their habitat (e.g., Klauber 1931; Forman et al. 2003; Rytwinski and Fahrig 2012; Andrews et al. 2015a, b; D'Amico et al. 2015). Many are slow moving, do not avoid roads, and are simply too small for drivers to see and avoid. During rains many amphibians make long linear terrestrial movements regardless of the presence of intersecting roadways (Glista et al. 2008), and because paved roads typically absorb and retain more heat than the surrounding habitat, snakes and lizards are often attracted to roads for thermoregulation (Case and Fisher 2001; Jochimsen et al. 2004). In fact, road surveys are one of the most common methods for surveying these reptiles (e.g., Sullivan 2012). Many herpetofauna species utilize both aquatic and terrestrial habitat for breeding, development, foraging, and overwintering and therefore require connectivity within and between both aquatic and terrestrial habitats to support basic life history requirements.

The primary goal of this study was to provide information to transportation and other planning agencies in California to assist them in prioritizing road mitigation efforts for amphibian and reptile species. Although there is still a lot to learn about the effectiveness of different designs of road mitigation

systems, the use of barrier systems, underpasses, and overpasses can reduce road mortality and help to maintain connectivity and safe passage across roads for herpetofauna and other wildlife (Jochimsen et al. 2004; Colino-Rabanal and Lizana 2012; Langton 2015; Langen et al. 2015b). Because it is currently unrealistic and cost prohibitive to mitigate all roadways for all species, it is vital to identify species most susceptible to road-related impacts. Within species ranges, risks to populations and need for mitigation can then be evaluated based upon local road densities and matrix, road-types, traffic, and road locations in relation to species habitat and movement corridors (e.g., Jaeger 2000; Litvaitis and Tash 2008; Langen et al. 2015b; Zimmermann Teixeira et al. 2017).

Here we describe a road risk assessment methodology applied to native amphibian and reptile species in California, a global biodiversity hotspot (Myers et al. 2000). We also included analysis of subspecies if they had special federal or state protection status. This includes 166 species and subspecies of frogs, toads, salamanders, snakes, lizards, turtles, and tortoise. Rankings and prioritizations such as these can be very subjective. In order to avoid including low risk species that may be favored by the assessors or to unintentionally overlook species that are at high risk, it was important for this be done in an objective manner informed by current road ecology literature.

Very few quantitative data are available on the impact of roads on population persistence. Jaeger et al. (2005) were the first to develop a relative ranking system to compare the impact of roads on wildlife populations. Their ranking system was largely based upon behavioral responses of animal species to the road surface, road size, traffic noise, and vehicles with varying road sizes and traffic volumes. However, knowledge of these detailed behavioral responses to ranges in road and traffic characteristics is rarely found in literature and the link between individual behavior and population-level effects has not been clearly established (Rytwinski and Fahrig 2012, 2013).

Rytwinski and Fahrig (2012) performed a meta-analysis of wildlife groups to test whether certain life history characteristics were related to negative responses to roads. High reproductive rate (fecundity) was negatively associated with the magnitude of population-level effects for amphibians. No associations were significant in reptiles, although there were

few studies to inform this analysis. However, a strong link was shown between body size, greater mobility, lower reproductive rates and the magnitude of negative road effects in mammals, the most studied wildlife group. Conversely, simulations predicted populations of species with small home ranges and high reproductive rates were the least likely to be affected by roads (Rytwinski and Fahrig 2013).

We used these findings as a basis for creating a multi-tiered system to rank and identify reptile and amphibian species that may be most susceptible to road impacts. We based our ranking upon a suite of species life history and space-use characteristics associated with negative road effects, as well as including species distribution and conservation status. We evaluated risk to both aquatic and terrestrial connectivity and include buffer distances that were calculated to encompass 95% of population movements. Relative confidence in these distances is given for each species based upon the amount of support from scientific studies. We solely focused on the direct effects of roads as barriers and sources of road mortality and not impacts from road construction and maintenance or indirect effects from increased human use of the landscape once a road is in place (see review by Langen et al. 2015a).

Because we based the risk assessment solely upon space-use and life history characteristics, this represents a species relative susceptibility to road impacts. It is understood that circumstances associated with particular populations (e.g., local road types, locations, densities) may elevate or reduce the risk for certain populations and species.

## Methods

### Road risk assessment (overview)

We assessed the relative risk of California herpetofauna species to negative road-related impacts at three scales in a hierarchical fashion. We first assessed risk at the scale of an individual animal and then expanded the risk to the population and then to species (Fig. 1).

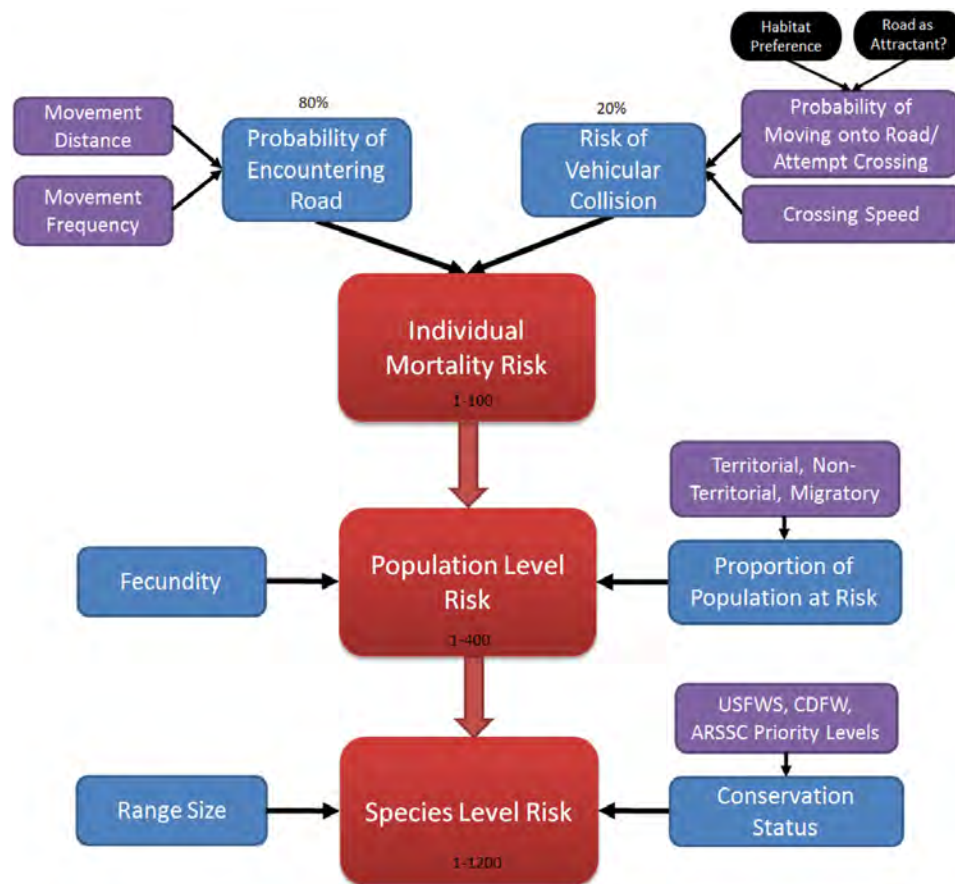
At the individual-level, we based road risk primarily upon the likelihood that an individual would encounter one or more roads. We considered this a product of movement distance (home range, seasonal migrations) and movement frequency (e.g., active

foragers, seasonal migrants, sit-and-wait predators vs. sedentary species) (e.g., Bonnet et al. 1999; Carr and Fahrig 2001). Because many species are semi-aquatic, movement distance and frequency were scored separately for both aquatic and terrestrial habitats.

There is a theorized higher risk associated with depletion effects (i.e., road mortality) in comparison to barrier effects (Fahrig and Rytwinski 2009; Jackson and Fahrig 2011). Therefore, we gave additional weight to those species more likely to go out onto a road surface and be killed by vehicular traffic. For this we considered factors of habitat preference (e.g., open vs. closed), roads as potential attractants (e.g., for basking), and movement speed (e.g., slow vs. fast). However, individuals within and among species may respond differently to roads (attraction vs. avoidance) based upon local landscape features, road width, traffic volume, and perceived danger (Forman et al. 2003; Andrews 2005; Brehme et al. 2013; Jacobson et al. 2016). Because a state-wide analysis encompasses extreme variation in landscape and road characteristics, the extent to which roads act as barriers or sources of direct mortality within a species range is unknown. The risk disparity between depletion and barrier effects could also be highly variable. Therefore, we limited the additional weight for potential depletion effects to twenty percent of the individual risk score.

We assessed population-level road risk by multiplying individual risk with scores representing: (1) the relative proportion of the population at risk; and (2) the species ability to sustain higher rates of mortality. For instance, the proportion of the population at risk was expected to be higher for migratory species than for territorial species. Highly fecund species were expected to better withstand (or more quickly recover from) higher mortality in comparison to those with few annual offspring.

Finally, we assessed species-level road risk by multiplying population road risk with scores for range size (both within and outside of California) and conservation status according to the U.S. Fish and Wildlife Service (USFWS 2016) and the California Department of Fish and Wildlife (CDFW 2016a; Thomson et al. 2016). Species with smaller ranges typically have fewer populations and are thus less resilient to population-level stressors. Endangered, threatened, and special concern species have already been designated at risk of extirpation, often due to



**Fig. 1** California reptile and amphibian road risk assessment conceptual model (ARSSC Amphibian and Reptile Species of Special Concern (Thomson et al. 2016))

multiple stressors, and are thus thought to be less likely to be resilient to additional road impacts.

Although we present both aquatic and terrestrial risk scores for semi-aquatic species, we used the higher of the two scores for the overall risk ranking.

#### Literature review

Species life history data were primarily taken from and cross-checked among the following species account review sources;

1. U.S. Fish and Wildlife Service (USFWS) Recovery Plans and 5-year Reviews <https://www.fws.gov/endangered/>.
2. California Amphibian and Reptile Species of Special Concern (ARSSC; Thomson et al. 2016).
3. A Field Guide to Amphibians and Reptiles of California (Stebbins and McGinnis 2012)
4. Amphibian declines: the conservation status of United States species (Lannoo 2005).
5. Conservation Status of Amphibians and Reptiles on USDA National Forests, Pacific Southwest Region, 2012 (Evelyn and Sweet 2012).
6. Natureserve Explorer (natureserve.org): Species Accounts largely authored by G. Hammerson (2003–2016).

When these reviews were lacking life history information needed for the road risk assessment, we then searched for supplementary peer-reviewed literature using the Google Scholar search engine. Because movement distances (terrestrial, aquatic, home range, migratory) were so important for the risk assessment, we acquired referenced articles from the species accounts and independently searched the literature to acquire these data. Search terms included the species common name, scientific name, or genus and terms such as “movement”, “home-range”, “spatial”, and “telemetry”. We also reviewed articles for citations of other studies to find more recent information on movement. This literature included published articles,

book chapters, M.S. Theses, Ph.D. dissertations, agency reports, and consultant reports. In the case that specific life history or movement information was not found for a species, we chose a surrogate species based upon phylogeny, habitat, and body size. We first looked for the closest related species within the genus or family and chose a closely related surrogate based upon similar habitat and body size. If surrogates were used, these are clearly reported.

#### Road risk metrics

The following section describes in detail the rank scoring used for Individual-level Road Risk, Population-level Road Risk, and Species-level Road Risk. All rank values are meant to represent the relative contribution of each attribute to either additive or multiplicative road risk.

#### *Individual-level risk (100 points possible)*

Out of a total of 100 points for individual road mortality risk, we attributed up to 80 points (80%) to the risk of encountering a road and up to 20 points (20%) for the risk of an individual moving onto a road and being killed by a motor vehicle.

The risk of encountering a road was based on a combination of movement distance and general movement frequency. Movement distance was ranked 1–40 based upon home range movement distances (diameter) for non-migrants or migration distances for seasonal migrants that spanned from 0 to > 1200 m (Table 1). The scores are linearly correlated with increasing movement distance.

For species that use both terrestrial and wetland/stream/riverine habitats, such as frogs, toads, aquatic snakes and turtles, we scored aquatic and terrestrial movement distances and frequencies separately. This was necessary as some species move much larger distances and at different frequencies in one habitat versus the other. This also informs the type(s) of mitigation structures that may be warranted based upon habitat type, buffer distances and risk scores for each species. Aquatic movement distances were not calculated for pond-breeding amphibians. Ponds are typically small ephemeral bodies of water and terrestrial movements of amphibians to and among ponds

**Table 1** Individual-level Road Risk (IRR): Score criteria for risk of individuals encountering a road

Risk of individuals encountering a road = Movement distance × frequency			
Movement distance (m)	Score	Frequency	Score
> 1200	40	Active throughout home range	2
901–1200	32	Migratory (2–4 × per year)/ non-migratory sit and wait foragers	1.5
601–900	24	Sedentary, confined to specialized habitat	1
451–600	16		
301–450	12		
201–300	8		
101–200	5		
51–100	3		
0–50	1		

account for the majority of movement for these species.

The calculations and rankings for movement distances were well considered and deserve further explanation. Our original thinking was that maximum distances should reflect relative movement distances across species and these data were commonly reported in species accounts. However, it became increasingly difficult to determine whether maximum distances reported were seasonal migration movements, home range movements or rarer dispersal events. We believed this assessment should reflect annual movement distances and not rare dispersal events. We considered using average/median movement distances; however, these often underestimate the movement of seasonal migrants because in many cases a sizeable portion of the population may remain close to a breeding site, while another sizable portion make longer distance migrations causing an average or median to be uninformative. Therefore, we decided to use a buffer distance that incorporates the movement distances of 95% of the population studied. A 95% population movement distance is commonly accepted for the delineation of terrestrial buffer zones for amphibians (i.e., Semlitsch 1998; Semlitsch and Bodie 2003) and we believe it was the most biologically

meaningful and useful measure for this study. This measure, which we will refer to as Maximum Population Movement Distance (MPMD), should include almost all population movements, such as seasonal migration distances and annual home ranges (diameter), but not rare dispersal events. The MPMD should also be useful for local risk assessments as these distances can be used to aide in mapping and mitigation decisions.

The calculation we used for MPMD is commonly known as the 95% upper tolerance interval (Vangel 2015). A tolerance interval is an interval that is meant to contain a specified percentage of individual population measurements. This should not be confused with a confidence interval, which is an interval that is meant to contain the population mean. We chose a 50% confidence level for the upper 95% confidence limit of movement distances which is equal to the 95% prediction interval for future observations and is the mean +  $1.645 \times$  standard deviation. In cases where a standard deviation was not reported, we back calculated standard deviation from the standard error and sample size, calculated it from the individual data, or estimated it based on the methods recommended by Hozo et al. (2005). Although non-parametric tolerance intervals would be more appropriate for non-normally distributed movement data, the data required to calculate these is rarely reported in the published literature. In the case of non-normally distributed data where medians, sample sizes and ranges are reported, Hozo et al. (2005) methods allow for approximation of means and standard deviations with no assumption of the underlying data distribution. We found the resulting MPMDs to be reasonable in excluding large outliers but including multiple long distance movements below the maximum movement distance.

We recognize that for any species there can be substantial variability in movement distances that depend upon varying local, landscape, and climatic factors. This was often reflected in studies with sometimes widely varying estimates of home range and migration distances. We attempted to be conservative by using the study data for calculation of MPMD in which the largest population movement distances were observed. For studies where movement distance significantly varied between females and males, we used the information from the wider ranging sex. For migratory distances, we did not use distances from extreme environments, such as Canada, where

suitable overwintering sites are typically much farther away from breeding and summer activity areas than in milder California climates (e.g., Gregory 1984). We did use study data from adjacent states or lower estimates of migration distances from those reported in Midwestern states. In some cases where little information was available, we made an educated guess based upon limited study data and/or closely related species and noted these in the tables. For all MPMDs, we report a relative confidence level based upon the number and quality of studies, sample sizes, and locations in or adjacent to California. It is intended that the scores be adjusted as new information becomes available.

To compute the risk of encountering a road, the MPMD was multiplied by a relative index of the expected frequency of longer distance movements (1–2 points; Table 1). We defined three frequency categories largely based upon annual migratory movements or foraging strategies for non-migratory species. The highest category included actively foraging predators which are characterized by frequent wandering movements throughout their home range (Pianka 1966). Less frequent movers included seasonal migrants traveling among breeding, summer foraging, and/or overwintering sites and non-migratory ‘sit-and-wait’ predators that remain still for long periods of time to ambush prey (Pianka 1966). Finally, low frequency included highly sedentary species with high site fidelity, particularly specialized rock, crevice, soil, or tree dwellers that may rarely traverse terrestrial or aquatic habitats.

The risk of an individual moving onto a road and being killed by a moving vehicle was ranked by attributes of habitat preference, road use, and movement speed (Table 2). Habitat preference represents the degree to which an individual is expected to go out onto or avoid an open road as predicted from their habitat and microhabitat preferences. Open habitat specialists and generalists were expected to more readily move onto a road than species that prefer cover (e.g., Forman et al. 2003; Brehme et al. 2013). Although many amphibians are closed habitat specialists, most readily move through open habitats during rain events, when most overland migratory movements tend to occur (Glista et al. 2008). Therefore, amphibians were considered open habitat specialists for this ranking. An additional factor that may increase road use is for thermoregulation for lizards



**Table 2** Individual-level Road Risk (IRR): Score criteria for risk of road mortality

Risk of road mortality = Habitat preference + road use + movement speed					
Habitat preference	Score	Road use	Score	Movement speed	Score
Open habitat specialist/amphibians	10	Thermoregulation (snakes/lizards)	4	Slow (< 0.6 m/s)	6
Generalist	8	Other	0	Medium (0.6–2.0 m/s)	3
Edge specialist	4			Fast (> 2.0 m/s)	0
Closed habitat or aquatic specialist	0				

**Table 3** Population-level Road Risk (PRR): Score criteria for population level road risk

PRR = IRR × (Fecundity + Proportion of population at risk)					
Fecundity	Ave. potential offspring/year	Score	Proportion of population at risk	Score	
Low	0–10	2	Seasonal migrants (Migratory)	2	
Med	11–25	1.5	Wandering	1.5	
High	26–100	1	Territorial	1	
Very high	> 100	0			

and snakes, as roads often retain more heat than the surrounding environment (Colino-Rabanal and Lizana 2012; Mccardle and Fontenot 2016). Finally, there is an increased risk of road mortality for slow versus fast moving species (see Andrews and Gibbons 2005; Mazerolle et al. 2005; Andrews et al. 2015b).

#### *Population-level Road Risk (400 points possible)*

To assess the risk of negative road impacts on the persistence of a population we incorporated scores for population-level movement behavior and fecundity (Table 3). For the proportion of a population expected to encounter a road, we scored the greatest risk to species that seasonally migrate to overwintering and breeding areas (Jackson et al. 2015). For those that do not migrate, we expected higher proportions of non-territorial or loosely territorial species (“wandering”) to encounter roads than species that defend distinct territories.

Species with low fecundity are less resilient to road mortality impacts than highly fecund species (Rytwin-ski and Fahrig 2013). Relative fecundity was simply calculated from the average number of potential offspring per year whether the animals were oviparous or live-bearing. For egg-laying species, the number of

potential offspring was calculated by multiplying the average clutch size by the average number of clutches per year.

Individual mortality risk (1–100 points) was multiplied by the sum of these population-level factors (1–4 points) to calculate population-level road risk.

#### *Species-level road risk (1200 points possible)*

In comparison to population-level risk, we considered the overall risk of roads to species to be negatively associated with species range and conservation status. Although some populations may be at high risk, species with a wide distribution and many populations should be more resilient to localized declines and extirpations. Therefore, we assigned a range isolation score ranging from 0 to 1 that considered species distributions range-wide (North America) and within California (CA) (Table 4). Range-wide distribution varied from “CA only” to “widespread” (> 4 states). If the species range extended into Mexico and/or Canada, these countries were counted as another state for calculation of the index. California-wide distribution was calculated based upon the number of CA geographic regions occupied out of twelve regions defined by Hickman (1993) and used in Stebbins and



**Table 4** Species-level Road Risk (SRR): Score criteria for species-level road risk

$$\text{SRR}^a = \text{PRR} \times ((\text{Range isolation score} + \text{Conservation status score})/2)$$

(a) Range isolation score = (North America range + CA range)/2

North America range	Rank/score
CA only	1.00
2 states (very restricted distribution)	1.00
2 states (restricted)	0.67
2–3 states	0.33
Widespread (4 + states)	0.00
California range (No. of geographic regions occupied)	Rank/score
1	0.92
2	0.83
3	0.75
4	0.67
5	0.58
6	0.50
7	0.42
8	0.33
9	0.25
10	0.17
11	0.08
12	0.00

(b) Conservation status score

Conservation status	Rank/score <sup>a</sup>
CA or federal threatened/endangered	1.00
SSC priority 1	0.75
SSC priority 2	0.50
SSC priority 3	0.25
None	0.00

<sup>a</sup>Population-level risk > 80 only

McGinnis (2012). These two scores (Range-wide isolation, CA isolation) were summed and divided by two in order to normalize the overall range isolation score to a 0 to 1 scale.

At the species-level, we also incorporated conservation status (Table 4). Some species are declining and are at higher risk of extinction often due to multiple stressors. Federal and State Threatened and Endangered Species were given the highest score (1.0). In California, forty-five species are designated “Species of Special Concern (SSC)” with a ranking of 1, 2, or 3 based upon severity and immediacy of threats affecting each taxon (Thomson et al. 2016). SSC species were given a conservation status score ranging

from 0.25 to 0.75 based upon their SSC ranking. Population-level Road Risk (score range 1–400) was multiplied by (1 + Range Isolation Score + Conservation Status Score; score range 1–3) to calculate the final Species-level Road Risk.

Range and conservation status were only used as a multiplier for species-level road risk if the population-level road risk was greater than 80 (20% of possible population score). This helped to prevent false inflation of the road risk metrics for low road susceptible species.

Because all members of the genus *Batrachoseps* (slender salamanders) are similar in body size, range size and general life history characteristics, we scored

**Table 5** Species-level frequency distributions and road risk rankings

Percentile	Scores	Relative ranks
81–100	322–710	Very high
61–80	213–321	High
41–60	63–212	Medium
21–40	53–62	Low
1–20	0–52	Very Low

the genus as whole with the most conservative estimates and conservation status but included all 20 species in the final count and calculations.

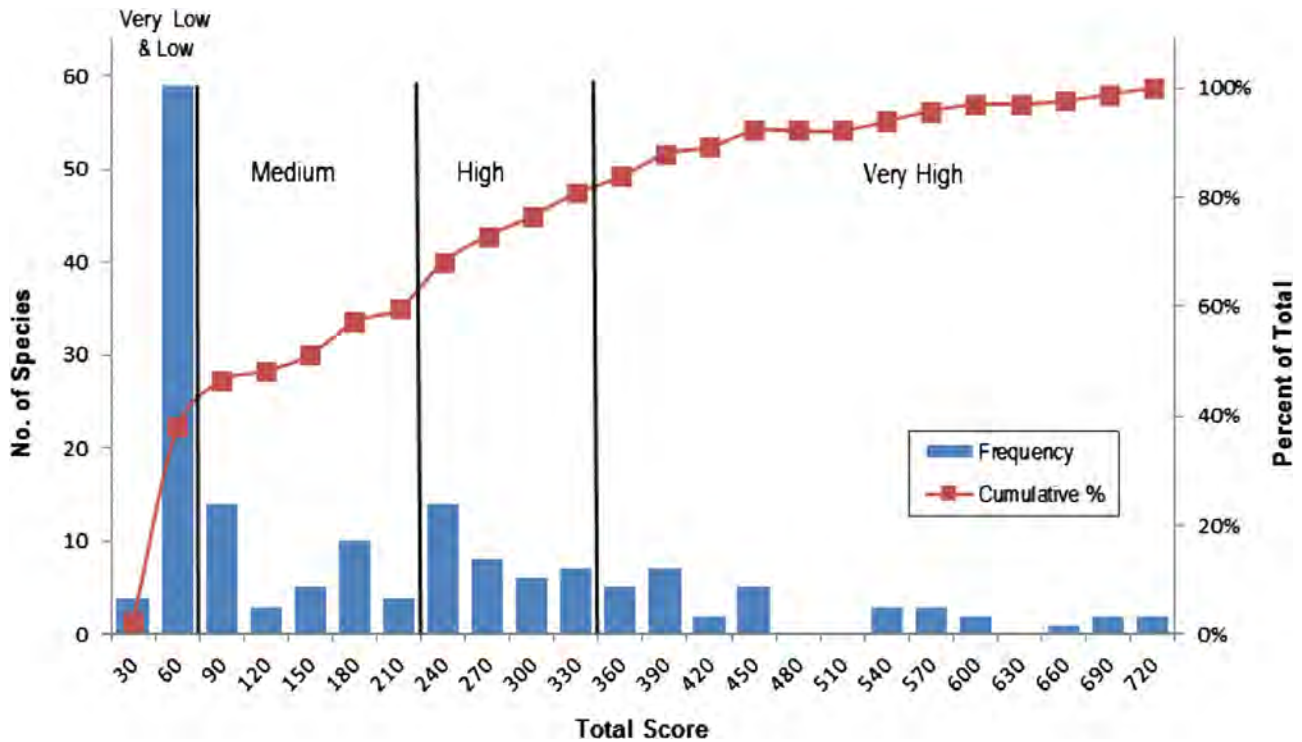
Once all 166 species (including subspecies with conservation status) were scored for species-level road risk within both terrestrial and aquatic habitats, we took the maximum score for each species and sorted them from the highest to lowest scores. We grouped species into categories of risk (Very high, high, medium, low, and very low) based upon ranges of values that represented frequency distributions in 20% increments of all species scores (Table 5, Fig. 2).

As a way to support the results of our ranking model with species literature, we focused on special status species. We reviewed recovery plans and 5-year reviews for federally listed species and state species accounts for California listed species and species of special concern (collectively referred to as special status species). For each rank group (i.e., “very low” to “very high”), we calculated the percentage of special status species where roads were specifically listed as a threat. Similarly, we tallied the number of species identified in a recent California preliminary road risk assessment (Levine 2013, Amy Golden pers. comm.) and compared the number of species that fell within each of our road risk categories.

**Results**

All chelonids, 72% of snakes, 50% of anurans, 18% of lizards and 17% of salamander species were ranked as high or very high risk from negative road impacts. (Table 6, Fig. 3).

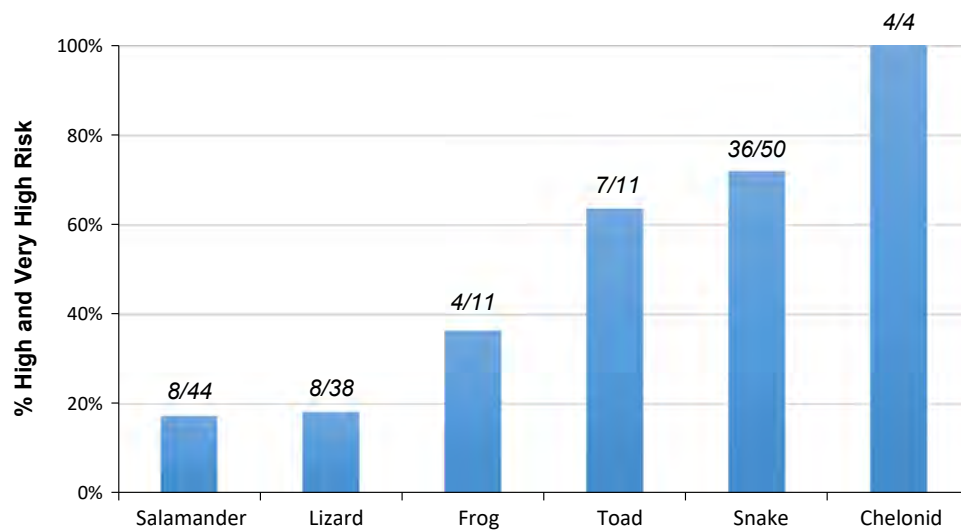
Review of species accounts, recovery plans, and 5-year reviews for all special status species showed



**Fig. 2** Histogram of species-level scores and approximate 20 percentile road risk categories

**Table 6** Numbers of species by taxa within each risk category

Species group	Species-level rankings				
	Very high	High	Med	Low	Very low
Salamander	4	4	3	26	9
Lizard	5	3	8	7	21
Anuran	5	6	6	4	1
Snake	15	21	13	0	1
Tortoise	1	0	0	0	0
Turtle	3	0	0	0	0

**Fig. 3** Percentages of species by taxa in high and very high road risk categories

that 94% (17/18) of species accounts that referenced roads as a threat to the species were ranked as “high” or “very high” in our risk assessment (Table 7). Of the special status species that ranked ‘high’ and ‘very high’, close to fifty percent (17/35) had road-related threats referenced in their listing literature. In comparison, only 4% (1/27) of ‘medium’ to ‘very low’ risk

special status species accounts mentioned roads as a potential threat. In addition, 79% (15/19) of species of concern recommended in a recent Caltrans preliminary road risk assessment scored as ‘high’ or ‘very high’ risk in our analysis (Levine 2013, Amy Golden pers. comm.).

**Table 7** Comparison of road risk results and number of special status species with roads listed as threat

Road risk level	Special status species			Caltrans PI <sup>a</sup>
	No. species in road risk level	No. species with roads listed as threat	% of Total	No. Spp in road risk level
Very high	25	14	56	11
High	11	3	27	4
Medium	5	1	20	3
Low	10	0	0	1
Very low	7	0	0	0

<sup>a</sup>Caltrans PI are Caltrans identified sensitive species

**Table 8** Amphibian and reptile road risk assessment: very high risk species (80–100% percentile), high risk species (60–80% percentile), medium risk species (40–60% percentile

range), low risk species (20–40% percentile) and very low risk species (0–20% percentile)

Risk Level-Species	Species			Road Risk Scores			Status		
	Group	Common Name	Scientific name	Maximum (Aquatic & Terrestrial) <sup>a</sup>	Terrestrial	Aquatic (Wetlands/ Rivers/ Streams, Perennial to Intermittent)	Federal or State Listing/ ARSSC Priority Rank (1-3) <sup>b</sup>	Roads Listed as Potential Threat in Listing? <sup>c</sup>	Caltrans Identified Sensitive Species? <sup>d</sup>
Very High	Snake	Giant Gartersnake	<i>Thamnophis gigas</i>	710	44	710	THR	Yes	Yes
	Turtle	Southern Western Pond Turtle	<i>Actinemys pallida</i>	707	283	707	1		Yes
	Snake	San Joaquin Coachwhip	<i>Masticophis flagellum ruddocki</i>	689	689	-	2	Yes	
	Snake	San Francisco Gartersnake	<i>Thamnophis sirtalis tetrataenia</i>	663	238	663	END		Yes
	Snake	Alameda Striped Racer	<i>Masticophis lateralis euryxanthus</i>	652	652	-	THR	Yes	
	Snake	California Red-sided Gartersnake	<i>Thamnophis sirtalis infernalis</i>	588	211	588	1		
	Tortoise	Mohave Desert Tortoise	<i>Gopherus agassizii</i>	580	580	-	THR	Yes	Yes
	Salamander	Red-bellied Newt	<i>Taricha rivularis</i>	561	561	72	2	Yes	Yes
	Turtle	Northern Western Pond Turtle	<i>Actinemys marmorata</i>	547	219	547	3		Yes
	Snake	Two-striped Gartersnake	<i>Thamnophis hammondi</i>	541	195	541	2		
	Snake	Baja California Coachwhip	<i>Masticophis fuliginosus</i>	534	534	-	3	Yes	
	Snake	Coast Patch-nosed Snake	<i>Salvadora hexalepis virgulata</i>	533	533	-	2	Yes	
	Salamander	California Newt	<i>Taricha torosa</i>	532	532	72	2	Yes	Yes
	Lizard	Banded Gila Monster	<i>Heloderma suspectum cinctum</i>	446	446	-			
	Salamander	California Tiger Salamander	<i>Ambystoma californiense</i>	437	437	-	THR	Yes	Yes
	Salamander	Sierra Newt	<i>Taricha sierrae</i>	437	437	72			
	Snake	Striped Whipsnake	<i>Masticophis taeniatus</i>	425	425	-			
	Lizard	Fiat-tail Horned Lizard	<i>Phrynosoma mcallii</i>	425	425	-	2	Yes	
	Turtle	Sonoran Mud Turtle	<i>Kinosternon sonoriense</i>	399	37	399	1		
	Lizard	Blunt-nosed Leopard Lizard	<i>Gambelia sila</i>	393	393	-	END	Yes	Yes
	Snake	Baja California Ratsnake	<i>Bogertophis rosaliae</i>	387	387	-			
	Snake	Panamint Rattlesnake	<i>Crotalus stephensi</i>	387	387	-			
	Frog	California Red-legged Frog	<i>Rana draytonii</i>	380	380	300	THR	Yes	Yes
	Toad	Yosemite Toad	<i>Anaxyrus canorus</i>	379	379	284	THR	Yes	
	Toad	Black Toad	<i>Anaxyrus exsul</i>	379	379	284	THR		
	Lizard	Cope's Leopard Lizard	<i>Gambelia copeii</i>	372	372	-	2		
	Toad	Sonoran Desert Toad	<i>Inciilius alvarius (Possibly extinct in CA)</i>	361	361	285	1		
	Lizard	Desert Horned Lizard	<i>Phrynosoma platyrhinos</i>	356	356	-			
	Snake	California Glossy Snake	<i>Arizona elegans occidentalis</i>	340	340	-	1		
	Snake	North American Racer	<i>Coluber constrictor</i>	334	334	-			
	Snake	Coachwhip	<i>Masticophis flagellum</i>	333	333	-			
	Toad	Arroyo Toad	<i>Anaxyrus californicus</i>	331	331	248	END	Yes	Yes
Snake	Striped Racer	<i>Masticophis lateralis</i>	322	322	-				

<sup>a</sup> Maximum scores color-coded for toad risk type: terrestrial (gray), aquatic (blue), or both (gray/blue)

<sup>b</sup> END=Endangered, THR= Threatened, 1-3= ARSSC Priority Ranking

<sup>c</sup> Federal Recovery plans, 5-year reviews, California species accounts for special status species

<sup>d</sup> California Amphibian and Reptile Crossing Preliminary Investigation

Risk scores and relative rankings for California reptile and amphibian species in both terrestrial and aquatic habitats are presented in Tables 8. Terrestrial and Aquatic rankings are provided separately in Tables 9 and 10 and also include population-level risk scores, 95% population buffer distances, confidence levels, and identification of any surrogate species used for the distance calculations. Species scores for all ranking criteria and life history and movement references are provided in Appendices 1 and 2.

### Discussion

To our knowledge, this is the first attempt to objectively assess the relative risk of roads at a species level using a logical and scientifically based framework and apply it across a large array of species and habitats. We believe this approach could be useful for assessing and comparing susceptibility of species to negative road impacts within and among all taxonomic groups. To date, such risk assessments have been based largely upon expert opinion, limited information available on



Table 8 continued

Risk Level-Species	Species			Road Risk Scores			Status		
	Group	Common Name	Scientific name	Maximum (Aquatic & Terrestrial) <sup>a</sup>	Terrestrial	Aquatic (Wetlands/ Rivers/ Streams, Perennial to Intermittent)	Federal or State Listing/ ARSSC Priority Rank (1-3) <sup>b</sup>	Roads Listed as Potential Threat in Listing? <sup>c</sup>	Caltrans Identified Sensitive Species? <sup>d</sup>
High	Snake	Red Diamond Rattlesnake	<i>Crotalus ruber</i>	321	321	-	3	Yes	
	Snake	Speckled Rattlesnake	<i>Crotalus mitchellii</i>	317	317	-			
	Frog	Oregon Spotted Frog	<i>Rana pretiosa</i> (Possibly extinct in CA)	315	41	315	THR		
	Salamander	Santa Cruz Long-toed Salamander	<i>Ambystoma macrodactylum croceum</i>	308	308	-	END	Yes	Yes
	Salamander	Rough-skinned Newt	<i>Taricha granulosa</i>	304	304	72			
	Snake	Sierra Gartersnake	<i>Thamnophis couchii</i>	304	44	304			
	Snake	Regal Ring-necked Snake	<i>Diadophis punctatus regalis</i>	298	298	-	2		Yes
	Snake	California Lyresnake	<i>Trimorphodon lyrophanes</i>	293	293	-			
	Frog	Northern Red-legged Frog	<i>Rana aurora</i>	291	291	230	2		Yes
	Snake	Mojave Rattlesnake	<i>Crotalus scutulatus</i>	276	276	-			
	Snake	Western Patch-nosed Snake	<i>Salvadora hexalepis</i>	276	276	-			
	Snake	Common Gartersnake	<i>Thamnophis sirtalis</i>	271	165	271			
	Snake	Aquatic Gartersnake	<i>Thamnophis atratus</i>	266	40	266	0		
	Snake	Sidewinder	<i>Crotalus cerastes</i>	263	263	-			
	Salamander	California Giant Salamander	<i>Dicamptodon ensatus</i>	260	260	72	3	Yes	
	Snake	Sonoran Lyresnake	<i>Trimorphodon lambda</i>	260	260	-			
	Snake	Western Rattlesnake	<i>Crotalus oreganus</i>	250	250	-			
	Snake	Northwestern Gartersnake	<i>Thamnophis ordinoides</i>	245	138	245			
	Snake	Desert Nightsnake	<i>Hypsiglena chlorophaea</i>	241	241	-			
	Snake	Western Terrestrial Gartersnake	<i>Thamnophis elegans</i>	240	75	240			
	Lizard	Switak's Banded Gecko	<i>Coleonyx switaki</i>	236	236	-	THR		
	Toad	Western Spadefoot	<i>Spea hammondi</i>	234	234	-	1		Yes
	Snake	Coast Nightsnake	<i>Hypsiglena ochrorhyncha</i>	233	233	-			
	Lizard	Long-nosed Leopard Lizard	<i>Gambella wislizenii</i>	226	226	-			
	Toad	Great Plains Toad	<i>Anaxyrus cognatus</i>	222	222	175			
	Toad	Woodhouse's Toad	<i>Anaxyrus woodhousii</i>	222	222	175			
	Lizard	Coastal Whiptail	<i>Aspidoscelis tigris stejnegeri</i>	219	219	-	2		
	Snake	Western Shovel-nosed Snake	<i>Chionactis occipitalis</i>	218	218	-			
	Snake	Spotted Leaf-nosed Snake	<i>Phyllorhynchus decurtatus</i>	218	218	-			
	Salamander	Southern Long-toed Salamander	<i>Ambystoma macrodactylum sigillatum</i>	217	217	-	2		
Frog	Cascades Frog	<i>Rana cascadae</i>	217	217	72	2			
Snake	Western Diamond-backed Rattlesnake	<i>Crotalus atrox</i>	214	214	-				
Snake	Western Groundsnake	<i>Sonora semiannulata</i>	212	212	-				

<sup>a</sup> Maximum scores color-coded for road risk type: terrestrial (gray), aquatic (blue), or both (gray/blue)

<sup>b</sup> END=Endangered, THR= Threatened, 1-3= ARSSC Priority Ranking

<sup>c</sup> Federal Recovery plans, 5-year reviews, California species accounts for special status species

<sup>d</sup> California Amphibian and Reptile Crossing Preliminary Investigation

road mortality, and even less information available on population or species-level road effects (Levine 2013; Rytwinski and Fahrge 2015).

Overall, this is meant to be a first step in highlighting reptile and amphibian species that may be at highest risk from roads transecting their habitat. These species may deserve consideration for further study and for implementing mitigation solutions to reduce mortality and to maintain or enhance connectivity. The risk assessment was done for both terrestrial and

aquatic habitats to further inform mitigation. Some aquatic species may greatly benefit from fish passages while others may better benefit from terrestrial barriers and wildlife crossings or both.

Although data are currently lacking to validate completely the scoring and results of the risk assessment, our review of species accounts, recovery plans, 5-year reviews for federal and state-listed species and California species of special concern show a strong association between elevated road risk from our

Table 8 continued

Risk Level-Species	Species			Road Risk Scores			Status		
	Group	Common Name	Scientific name	Maximum (Aquatic & Terrestrial) <sup>a</sup>	Terrestrial	Aquatic (Wetlands/ Rivers/ Streams, Perennial to Intermittent)	Federal or State Listing/ ARSSC Priority Rank (1-3) <sup>b</sup>	Roads Listed as Potential Threat in Listing? <sup>c</sup>	Caltrans Identified Sensitive Species? <sup>d</sup>
Medium	Snake	Checkered Gartersnake	<i>Thamnophis marcianus</i>	210	69	210			
	Lizard	Blainville's Horned Lizard	<i>Phrynosoma blainvillii</i>	209	209	-	2		Yes
	Frog	Foothill Yellow-legged Frog	<i>Rana boylei</i>	199	26	199	1		
	Snake	Gopher Snake	<i>Pituophis catenifer</i>	189	189	-			
	Snake	California Mountain Kingsnake	<i>Lampropeltis zonata</i>	184	184	-			Yes
	Snake	Glossy Snake	<i>Arizona elegans</i>	180	180	-			
	Lizard	Pygmy Short-horned Lizard	<i>Phrynosoma douglasii</i>	179	179	-			
	Toad	Couch's Spadefoot	<i>Scaphiopus couchii</i>	178	178	-	3		
	Snake	California Kingsnake	<i>Lampropeltis californiae</i>	175	175	-			
	Snake	Long-nosed Snake	<i>Rhinocheilus lecontei</i>	165	165	-			
	Toad	Western Toad	<i>Anaxyrus boreas</i>	165	165	130			
	Snake	Ring-necked Snake	<i>Diadophis punctatus</i>	164	164	-			Yes
	Lizard	San Diego Banded Gecko	<i>Coleonyx variegatus abbotti</i>	158	158	-	3	Yes	
	Salamander	Northwestern Salamander	<i>Ambystoma gracile</i>	152	152	-			
	Toad	Great Basin Spadefoot	<i>Spea intermontana</i>	152	152	-			
	Toad	Red-spotted Toad	<i>Anaxyrus punctatus</i>	147	147	72			
	Salamander	Long-toed Salamander	<i>Ambystoma macrodactylum</i>	143	143	-			
	Lizard	Orange-throated Whiptail	<i>Aspidoscelis hyperythra</i>	137	137	-			
	Snake	Smith's Black-headed Snake	<i>Tantilla hobartsmithi</i>	136	136	-			
	Snake	California Black-headed Snake	<i>Tantilla planiceps</i>	133	133	-			
	Lizard	Western Whiptail	<i>Aspidoscelis tigris</i>	118	118	-			
	Salamander	Coastal Giant Salamander	<i>Dicamptodon tenebrosus</i>	117	117	48			
	Lizard	Western Banded Gecko	<i>Coleonyx variegatus</i>	105	105	-			
	Lizard	Common Chuckwalla	<i>Sauromalus ater</i>	78	78	-			
	Snake	Northern Rubber Boa	<i>Charina bottae</i>	77	77	-			
	Snake	Southern Rubber Boa	<i>Charina umbratica</i>	77	77	-	THR		
	Snake	Northern Three-lined Boa	<i>Lichanura orcutti</i>	77	77	-			
	Lizard	Desert Iguana	<i>Dipsosaurus dorsalis</i>	72	72	-			
	Snake	Forest Sharp-tailed Snake	<i>Contia longicauda</i>	70	70	-			
	Snake	Common Sharp-tailed Snake	<i>Contia tenuis</i>	70	70	-			
Frog	Pacific Treefrog	<i>Pseudacris regilla</i>	68	68	36				

<sup>a</sup> Maximum scores color-coded for toad risk type; terrestrial (gray), aquatic (blue), or both (gray/blue)  
<sup>b</sup> END=Endangered, THR= Threatened, 1-3= ARSSC Priority Ranking

<sup>c</sup> Federal Recovery plans, 5-year reviews, California species accounts for special status species  
<sup>d</sup> California Amphibian and Reptile Crossing Preliminary Investigation

objective analysis and the probability that roads are listed as a potential threat to the species in the species listing literature.

Although more than 40% of special status species are semi-aquatic, roads were rarely considered a threat to aquatic connectivity in the species literature. This may be accurate if bridges or large culverts currently exist for water flow that also provide permeability to aquatic movement. Bridges are generally considered to be completely passable by all aquatic species. Bridges are more likely to be constructed adjacent to or over large water bodies and rivers, presumably

resulting in less risk to aquatic movement of populations that inhabit lake and river systems. However, culverts that are more commonly constructed under roads in streams and wetlands vary in passability depending on factors such as diameter, length, slope, outlet configuration, and other characteristics (Furniss et al. 1991; Clarkin et al. 2005; Kemp and O'Hanley 2010). In fact, Januchowski-Hartley et al. (2013) found that only 36% of road crossings were fully passable to fish in the Great Lakes basin. In addition, many low water crossings in arid regions of the state are simply a dip in the road that allows water to flow



Table 8 continued

Risk Level-Species	Species			Road Risk Scores			Status		
	Group	Common Name	Scientific name	Maximum (Aquatic & Terrestrial) <sup>a</sup>	Terrestrial	Aquatic (Wetlands/ Rivers/ Streams, Perennial to Intermittent)	Federal or State Listing/ ARSSC Priority Rank (1-3) <sup>b</sup>	Roads Listed as Potential Threat in Listing? <sup>c</sup>	Caltrans Identified Sensitive Species? <sup>d</sup>
Low	Salamander	Scott Bar Salamander	<i>Plethodon asupak</i>	62	62	-	THR		
	Salamander	Dunn's Salamander	<i>Plethodon dunni</i>	62	62	-			
	Salamander	Del Norte Salamander	<i>Plethodon elongatus</i>	62	62	-			
	Salamander	Siskiyou Mountains Salamander	<i>Plethodon stormi</i>	62	62	-	THR		
	Frog	California Treefrog	<i>Pseudacris cadaverina</i>	61	61	26			
	Salamander	Southern Torrent Salamander	<i>Rhyacotriton variegatus</i>	61	61	5	1		
	Lizard	Peninsula Leaf-toed Gecko	<i>Phyllodactylus nocticolus</i>	60	60	-			
	Lizard	Northern Alligator Lizard	<i>Elgaria coerulea</i>	60	60	-			
	Frog	Coastal Tailed Frog	<i>Ascaphus truei</i>	59	59	30	2		Yes
	Lizard	Common Side-blotched Lizard	<i>Uta stansburiana</i>	59	59	-			
	Lizard	Coachella Fringe-toed Lizard	<i>Uma inornata</i>	56	56	-	THR		
	Lizard	Colorado Desert Fringe-toed Lizard	<i>Uma notata</i>	56	56	-	2		
	Lizard	Mohave Fringe-toed Lizard	<i>Uma scoparia</i>	56	56	-	3		
	Frog	Lowland Leopard Frog	<i>Lithobates yavapaiensis</i> (Possibly extinct in CA)	54	31	54	1		
	Frog	Southern Mountain Yellow-legged Frog	<i>Rana muscosa</i>	54	26	54	END		
	Lizard	Zebra-tailed Lizard	<i>Callisaurus draconoides</i>	54	54	-			
	Salamander	Wandering Salamander	<i>Aneides vagrans</i>	53	53	-			
	Salamander	Slender Salamanders	<i>Batrachoseps</i> (genus: 20 spp.)	53	53	-	END <sup>e</sup>		
Very Low	Salamander	Ensatina	<i>Ensatina eschscholtzii</i>	51	51	-			
	Salamander	Yellow-blotched Ensatina	<i>Ensatina eschscholtzii croceater</i>	51	51	-			
	Salamander	Large-blotched Ensatina	<i>Ensatina eschscholtzii klauberi</i>	51	51	-			
	Lizard	Southern Alligator Lizard	<i>Elgaria multicarinata</i>	51	51	-			
	Lizard	Panamint Alligator Lizard	<i>Elgaria panamintina</i>	51	51	-	3		
	Frog	Sierra Nevada Yellow-legged Frog	<i>Rana sierrae</i>	51	51	36	THR		
	Lizard	Western Fence Lizard	<i>Sceloporus occidentalis</i>	49	49	-			
	Salamander	Limestone Salamander	<i>Hydromantes brunus</i>	48	48	-	THR		
	Salamander	Mount Lyell Salamander	<i>Hydromantes platycephalus</i>	48	48	-			
	Salamander	Clouded Salamander	<i>Aneides ferreus</i>	44	44	-			
	Salamander	Arboreal Salamander	<i>Aneides lugubris</i>	44	44	-			
	Lizard	Granite Spiny Lizard	<i>Sceloporus orcutti</i>	43	43	-			
	Snake	Western Blind Snake	<i>Rena humilis</i>	42	42	-			
	Lizard	Desert Spiny Lizard	<i>Sceloporus magister</i>	41	41	-			
	Lizard	Common Sagebrush Lizard	<i>Sceloporus graciosus</i>	39	41	-			
	Lizard	Gilbert's Skink	<i>Plestiodon gilberti</i>	39	39	-			
	Lizard	Western Skink	<i>Plestiodon skiltonianus</i>	39	39	-			
	Lizard	California Legless Lizard	<i>Anniella pulchra</i>	35	39	-	2		
	Salamander	Black Salamander	<i>Aneides flavipunctatus</i>	35	35	-			
	Salamander	Santa Cruz Black Salamander	<i>Aneides flavipunctatus niger</i>	35	35	-			
	Lizard	Baja California Collared Lizard	<i>Crotaphytus vestigium</i>	35	35	-			
	Lizard	Sandstone Night Lizard	<i>Xantusia gracilis</i>	33	33	-	3		
	Lizard	Granite Night Lizard	<i>Xantusia henshawi</i>	33	33	-			
	Lizard	Island Night Lizard	<i>Xantusia riversiana</i>	33	33	-	THR		
Lizard	Sierra Night Lizard	<i>Xantusia sierrae</i>	33	33	-	1			
Lizard	Desert Night Lizard	<i>Xantusia vigilis</i>	33	33	-				
Lizard	Wiggins' Night Lizard	<i>Xantusia wigginsi</i>	33	33	-				
Lizard	Long-tailed Brush Lizard	<i>Urosaurus graciosus</i>	27	27	-				
Lizard	Baja California Brush Lizard	<i>Urosaurus nigricaudus</i>	27	27	-				
Lizard	Ornate Tree Lizard	<i>Urosaurus ornatus</i>	27	27	-				
Lizard	Mearns' Rock Lizard	<i>Petrosaurus mearnsi</i>	21	21	-				

<sup>a</sup> Maximum scores color-coded for toad risk type: terrestrial (gray), aquatic (blue), or both (gray/blue)

<sup>b</sup> END=Endangered, THR= Threatened, 1-3= ARSSC Priority Ranking

<sup>c</sup> Federal Recovery plans, 5-year reviews, California species accounts for special status species

<sup>d</sup> California Amphibian and Reptile Crossing Preliminary Investigation

<sup>e</sup> 4 *Batrachoseps* species with conservation status

**Table 9** Terrestrial risk ranking and population buffer distances

Risk Level (Terrestrial)		Species			Risk Scores (Terrestrial)		Movement Distances (Terrestrial)		
Species	Population	Group	Common Name	Scientific name	Road Risk: Species- Level	Road Risk: Population- Level	95% Population Movement Distance (m)	Confidence in Distance Estimate	Surrogate Used
Very High	Very High	Snake	San Joaquin Coachwhip	<i>Masticophis flagellum ruddocki</i>	689	285	1618	High	<i>M. fuliginosus</i>
	Very High	Snake	Alameda Striped Racer	<i>Masticophis lateralis euryxanthus</i>	652	221	631	Med/High	
	Very High	Tortoise	Mohave Desert Tortoise	<i>Gopherus agassizii</i>	580	240	1155	High	
	Very High	Salamander	Red-bellied Newt	<i>Taricha rivularis</i>	561	228	1600	High	
	Very High	Snake	Baja California Coachwhip	<i>Masticophis fuliginosus</i>	534	285	1904	High	
	Very High	Snake	Coast Patch-nosed Snake	<i>Salvadora hexalepis virgulata</i>	533	221	631	Low	<i>M. lateralis</i>
	Very High	Salamander	California Newt	<i>Taricha torosa</i>	532	228	2500	Med/High	
	Very High	Lizard	Banded Gila Monster	<i>Heloderma suspectum cinctum</i>	448	210	1250	High	
	High	Salamander	California Tiger Salamander	<i>Ambystoma californiense</i>	437	152	1849	Med/High	
	Very High	Salamander	Sierra Newt	<i>Taricha sierrae</i>	437	228	2050	Med	<i>T. torosa, T. rivularis</i>
	Very High	Snake	Striped Whipsnake	<i>Masticophis taeniatus</i>	425	300	2380	Med	
	Very High	Lizard	Flat-tail Horned Lizard	<i>Phrynosoma mcallii</i>	425	217	788	Med/High	
	High	Lizard	Blunt-nosed Leopard Lizard	<i>Gambelia sile</i>	393	133	510	High	
	Very High	Snake	Baja California Ratsnake	<i>Bogertophis rosaliae</i>	387	238	780	Low	<i>Elaphe obsoleta</i>
	Very High	Snake	Panamint Rattlesnake	<i>Crotalus stephensi</i>	387	238	938	Med	<i>C. mitchelli</i>
	High	Frog	California Red-legged Frog	<i>Rana draytonii</i>	380	152	2360	High	
	High	Toad	Yosemite Toad	<i>Anaxyrus canorus</i>	379	128	1152	Med/High	
	High	Toad	Black Toad	<i>Anaxyrus exsul</i>	379	128	951	Low	<i>A. canorus, A. punctatus</i>
	High	Lizard	Cope's Leopard Lizard	<i>Gambelia copeii</i>	372	175	643	Low/Med	<i>G. wislizenii</i>
	High	Toad	Sonoran Desert Toad	<i>Irridillus alvarius (Possibly extinct in CA)</i>	361	152	1400	Low/Med	<i>A. cognatus</i>
	Very High	Lizard	Desert Horned Lizard	<i>Phrynosoma platyrhinos</i>	356	259	1308	Med/High	
	High	Snake	California Glossy Snake	<i>Arizona elegans occidentalis</i>	340	154	316	Low	<i>R. lecontei</i>
	Very High	Snake	North American Racer	<i>Coluber constrictor</i>	334	308	1800	Med	
	Very High	Snake	Coachwhip	<i>Masticophis flagellum</i>	333	285	1618	High	<i>M. fuliginosus</i>
High	Toad	Arroyo Toad	<i>Anaxyrus californicus</i>	331	128	1082	Med/High		
Very High	Snake	Striped Racer	<i>Masticophis lateralis</i>	322	221	631	Med		
High	High	Snake	Red Diamond Rattlesnake	<i>Crotalus ruber</i>	321	175	853	High	
	Very High	Snake	Speckled Rattlesnake	<i>Crotalus mitchelli</i>	317	238	938	High	
	Med	Salamander	Santa Cruz Long-toed Salamander	<i>Ambystoma macrodactylum croceum</i>	308	104	700	High	
	Very High	Salamander	Rough-skinned Newt	<i>Taricha granulosa</i>	304	228	2050	Med	<i>T. torosa, T. rivularis</i>
	High	Snake	Regal Ring-necked Snake	<i>Diadophis punctulatus regalis</i>	298	152	566	Low/Med	
	Very High	Snake	California Lyresnake	<i>Trimorphodon lyrophanes</i>	293	195	800	Low	
	High	Frog	Northern Red-legged Frog	<i>Rana aurora</i>	291	152	2360	Med	<i>R. draytonii</i>
	High	Turtle	Southern Western Pond Turtle	<i>Actinemys pallida</i>	283	128	309	Med-High	
	High	Snake	Mojoze Rattlesnake	<i>Crotalus scutulatus</i>	276	189	815	Med/High	
	Very High	Snake	Western Patch-nosed Snake	<i>Salvadora hexalepis</i>	276	221	631	Low	<i>M. lateralis</i>
	High	Snake	Sidewinder	<i>Crotalus cerastes</i>	263	188	767	High	
	Med	Salamander	California Giant Salamander	<i>Dicamptodon ensatus</i>	260	120	600	Low	<i>D. tenebrosus</i>
	Very High	Snake	Sonoran Lyresnake	<i>Trimorphodon lambda</i>	260	195	800	Low	
	Very High	Snake	Western Rattlesnake	<i>Crotalus oreganus</i>	250	231	1096	Med/High	
	High	Snake	Desert Nightsnake	<i>Hypsiglena chlorophaea</i>	241	175	566	Low	<i>D. punctatus</i>
	Med	Snake	San Francisco Gartersnake	<i>Thamnophis sirtalis tetrataenia</i>	238	81	300	Med	
	Med	Lizard	Switak's Banded Gecko	<i>Coleonyx switaki</i>	236	90	200	Low	<i>C. variegatus (AZ)</i>
	Med	Toad	Western Spadefoot	<i>Spea hammondi</i>	234	104	670	Med	
	High	Snake	Coast Nightsnake	<i>Hypsiglena ochrorhyncha</i>	233	175	566	Low	<i>D. punctatus</i>
	High	Lizard	Long-nosed Leopard Lizard	<i>Gambelia wislizenii</i>	228	175	643	Med/High	
	High	Toad	Great Plains Toad	<i>Anaxyrus cognatus</i>	222	152	1400	Med/High	
	High	Toad	Woodhouse's Toad	<i>Anaxyrus woodhousii</i>	222	152	1400	Low	<i>A. cognatus</i>
	Med	Lizard	Coastal Whiptail	<i>Aspidoscelis tigris storeri</i>	219	105	300	Low	<i>A. hyperythra (multiplied by 2 for body size)</i>
	High	Turtle	Northern Western Pond Turtle	<i>Actinemys marmorata</i>	219	128	448	Med	
High	Snake	Western Shovel-nosed Snake	<i>Chionactis occipitalis</i>	218	154	400	Low		
High	Snake	Spotted Leaf-nosed Snake	<i>Phyllorhynchus decurtatus</i>	218	154	400	Low	<i>C. occipitalis, M. taeniatus</i>	
Med	Salamander	Southern Long-toed Salamander	<i>Ambystoma macrodactylum sigillatum</i>	217	104	700	Med		
Med	Frog	Cascades Frog	<i>Rana cascadae</i>	217	104	759	High		
High	Snake	Western Diamond-backed Rattlesnake	<i>Crotalus atrox</i>	214	147	484	Med		
High	Snake	Western Groundsnake	<i>Sonora semiannulata</i>	212	154	400	Low	<i>C. occipitalis</i>	
Med	Snake	California Red-sided Gartersnake	<i>Thamnophis sirtalis infernalis</i>	211	81	300	Low/Med	<i>T.s. tetrataenia</i>	



Table 9 continued

Risk Level (Terrestrial)		Species			Risk Scores (Terrestrial)		Movement Distances (Terrestrial)		
Species	Population	Group	Common Name	Scientific name	Road Risk: Species- Level	Road Risk: Population- Level	95% Population Movement Distance (m)	Confidence in Distance Estimate	Surrogate Used
Medium	Med	Lizard	Blainville's Horned Lizard	<i>Phrynosoma blainvillii</i>	209	114	495	Med	
	Med	Snake	Two-striped Gartersnake	<i>Thamnophis hammondi</i>	195	81	239	Low/Med	
	High	Snake	Gopher Snake	<i>Pituophis catenifer</i>	189	189	820	Med/High	
	High	Snake	California Mountain Kingsnake	<i>Lampropeltis zonata</i>	184	147	501	Low/Med	<i>L. getula</i> , <i>L. triangulum</i>
	High	Snake	Glossy Snake	<i>Arizona elegans</i>	180	154	316	Low	<i>R. lecontei</i>
	Med	Lizard	Pygmy Short-horned Lizard	<i>Phrynosoma douglasii</i>	179	123	400	Low	<i>P. mcallii</i> (reduced 0.5 for body size)
	Med	Toad	Couch's Spadefoot	<i>Scaphiopus couchii</i>	178	104	670	Med	
	High	Snake	California Kingsnake	<i>Lampropeltis californiae</i>	175	175	501	Med/High	
	High	Snake	Long-nosed Snake	<i>Rhinocellus lecontei</i>	165	132	337	Low/Med	
	High	Snake	Common Gartersnake	<i>Thamnophis sirtalis</i>	165	137	532	Low/Med	
	High	Toad	Western Toad	<i>Anaxyrus boreas</i>	165	152	2144	Med/High	
	High	Snake	Ring-necked Snake	<i>Diadophis punctatus</i>	164	136	566	Low/Med	
	Med	Lizard	San Diego Banded Gecko	<i>Coleonyx variegatus abboti</i>	158	84	200	Low/Med	<i>C. variegatus</i> (AZ)
	Med	Salamander	Northwestern Salamander	<i>Ambystoma gracile</i>	152	104	700	Low	<i>A. macrodactylum croceum</i>
	Med	Toad	Great Basin Spadefoot	<i>Spea intermontana</i>	152	104	670	Med	
	Med	Toad	Red-spotted Toad	<i>Anaxyrus punctatus</i>	147	104	750	Low	
	Med	Salamander	Long-toed Salamander	<i>Ambystoma macrodactylum</i>	143	104	700	Med	
	Med	Snake	Northwestern Gartersnake	<i>Thamnophis ordinoides</i>	138	95	239	Low	<i>T. hammondi</i>
	Med	Lizard	Orange-throated Whiptail	<i>Aspidoscelis hyperythra</i>	137	84	150	Low/Med	
	Med	Snake	Smith's Black-headed Snake	<i>Tantilla hobartsmithi</i>	136	105	150	Low	
	Med	Snake	California Black-headed Snake	<i>Tantilla planiceps</i>	133	84	150	Low	
	Med	Lizard	Western Whiptail	<i>Aspidoscelis tigris</i>	118	105	300	Low	<i>A. hyperythra</i> (multiplied by 2 for body size)
	Med	Salamander	Coastal Giant Salamander	<i>Dicamptodon tenebrosus</i>	117	80	600	Low/Med	
	Med	Lizard	Western Banded Gecko	<i>Coleonyx variegatus</i>	105	84	200	Low/Med	<i>C. variegatus</i> (AZ)
	Med	Lizard	Common Chuckwalla	<i>Sauromalus ater</i>	78	78	296	Med	
	Med	Snake	Northern Rubber Boa	<i>Charina bottae</i>	77	77	230	Low/Med	<i>L. trivirgata</i>
	Med	Snake	Southern Rubber Boa	<i>Charina umbratica</i>	77	77	230	Low/Med	<i>L. trivirgata</i>
	Med	Snake	Northern Three-lined Boa	<i>Lichanura orcutti</i>	77	77	230	Med/High	
	Med	Snake	Western Terrestrial Gartersnake	<i>Thamnophis elegans</i>	75	75	104	Low/Med	<i>T. gigas</i> (-40% for size diff)
	Med	Lizard	Desert Iguana	<i>Dipsosaurus dorsalis</i>	72	72	150	Low/Med	
	Med	Snake	Forest Sharp-tailed Snake	<i>Contia longicauda</i>	70	70	150	Low	
	Med	Snake	Common Sharp-tailed Snake	<i>Contia tenuis</i>	70	70	150	Low	
Med	Snake	Checkered Gartersnake	<i>Thamnophis marcianus</i>	69	69	239	Low	<i>T. hammondi</i>	
Med	Frog	Pacific Treefrog	<i>Pseudacris regilla</i>	68	88	400	Low/Med		
Low	Low	Salamander	Scott Bar Salamander	<i>Plethodon asupak</i>	62	62	92	Low	<i>P. glutinosus</i>
	Low	Salamander	Dunn's Salamander	<i>Plethodon dunnii</i>	62	62	92	Low	<i>P. glutinosus</i>
	Low	Salamander	Del Norte Salamander	<i>Plethodon elongatus</i>	62	62	92	Low	<i>P. glutinosus</i>
	Low	Salamander	Siskiyou Mountains Salamander	<i>Plethodon stormi</i>	62	62	92	Low	<i>P. glutinosus</i>
	Low	Frog	California Treefrog	<i>Pseudacris cadaverina</i>	61	61	50	Low/Med	
	Low	Salamander	Southern Torrent Salamander	<i>Rhyacotriton variegatus</i>	61	61	50	Low	<i>R. cascadae</i>
	Low	Lizard	Peninsula Leaf-toed Gecko	<i>Phyllodactylus nocticolus</i>	60	60	200	Low	<i>C. variegatus</i> (AZ)
	Low	Lizard	Northern Alligator Lizard	<i>Elgaria coerulea</i>	60	80	106	Med	
	Low	Frog	Coastal Tailed Frog	<i>Ascaphus truei</i>	59	59	150	Med/High	
	Low	Lizard	Common Side-blotched Lizard	<i>Uta stansburiana</i>	59	59	152	Med/High	
	Low	Lizard	Coachella Fringe-toed Lizard	<i>Uma inornata</i>	56	56	52	Med/High	
	Low	Lizard	Colorado Desert Fringe-toed Lizard	<i>Uma notata</i>	56	56	75	Med/High	
	Low	Lizard	Mohave Fringe-toed Lizard	<i>Uma scoparia</i>	56	56	64	Med	<i>U. notata</i> , <i>U. inornata</i>
	Low	Lizard	Zebra-tailed Lizard	<i>Callisaurus draconoides</i>	54	54	150	Med	
	Low	Salamander	Wandering Salamander	<i>Aneides vagrans</i>	53	53	39	Med/High	
	Low	Salamander	Slender Salamanders (20 species)	<i>Batrachoseps</i> (genus)	53	53	50	Low/Med	<i>B. pacificus</i>

Table 9 continued

Risk Level (Terrestrial)		Species			Risk Scores (Terrestrial)		Movement Distances (Terrestrial)		
Species	Population	Group	Common Name	Scientific name	Road Risk: Species- Level	Road Risk: Population- Level	95% Population Movement Distance (m)	Confidence in Distance Estimate	Surrogate Used
Very Low	Very Low	Salamander	Ensatina	<i>Ensatina eschscholtzii</i>	51	51	75	Med	
	Very Low	Salamander	Yellow-blotched Ensatina	<i>Ensatina eschscholtzii croceater</i>	51	51	75	Med	
	Very Low	Salamander	Large-blotched Ensatina	<i>Ensatina eschscholtzii klauberi</i>	51	51	75	Med	<i>E. eschscholtzii croceater</i>
	Very Low	Lizard	Southern Alligator Lizard	<i>Elgaria multicarinata</i>	51	51	106	Low/Med	<i>E. coerulea</i>
	Very Low	Lizard	Panamint Alligator Lizard	<i>Elgaria panamintina</i>	51	51	106	Low/Med	<i>E. coerulea</i>
	Very Low	Frog	Sierra Nevada Yellow-legged Frog	<i>Rana sierrae</i>	51	51	420	Med	
	Very Low	Lizard	Western Fence Lizard	<i>Sceloporus occidentalis</i>	49	49	160	Med	
	Very Low	Salamander	Limestone Salamander	<i>Hydromantes brunus</i>	48	48	80	Low	
	Very Low	Salamander	Mount Lyell Salamander	<i>Hydromantes platycephalus</i>	48	48	80	Low	
	Very Low	Salamander	Clouded Salamander	<i>Aneides ferreus</i>	44	44	39	Med	<i>A. vagrans</i>
	Very Low	Salamander	Arboreal Salamander	<i>Aneides lugubris</i>	44	44	39	Med	<i>A. vagrans</i>
	Very Low	Snake	Giant Gartersnake	<i>Thamnophis gigas</i>	44	44	174	High	
	Very Low	Snake	Sierra Gartersnake	<i>Thamnophis couchii</i>	44	44	115	Low/Med	<i>T. gigas</i> (-34% for size diff)
	Very Low	Lizard	Granite Spiny Lizard	<i>Sceloporus orcutti</i>	43	43	91	Low/Med	
	Very Low	Snake	Western Blind Snake	<i>Rena humilis</i>	42	42	50	Low	
	Very Low	Lizard	Desert Spiny Lizard	<i>Sceloporus magister</i>	41	41	91	Low	
	Very Low	Frog	Oregon Spotted Frog	<i>Rana pretiosa</i> (Possibly extinct in CA)	41	41	100	Low	
	Very Low	Lizard	Common Sagebrush Lizard	<i>Sceloporus graciosus</i>	41	41	41	Med/High	
	Very Low	Snake	Aquatic Gartersnake	<i>Thamnophis atratus</i>	40	40	99	Low/Med	<i>T. gigas</i> (-43% for size diff)
	Very Low	Lizard	Gilbert's Skink	<i>Plestiodon gilberti</i>	39	39	93	Low/Med	<i>P. skiltonianus</i> , <i>P. fasciatus</i> , <i>S. laterale</i>
	Very Low	Lizard	Western Skink	<i>Plestiodon skiltonianus</i>	39	39	93	Low/Med	
	Very Low	Lizard	California Legless Lizard	<i>Anniella pulchra</i>	39	39	15	High	
	Very Low	Turtle	Sonoran Mud Turtle	<i>Kinosternon sonoriense</i>	37	37	60	Med	
	Very Low	Salamander	Black Salamander	<i>Aneides flavipunctatus</i>	35	35	39	Med	<i>A. vagrans</i>
	Very Low	Salamander	Santa Cruz Black Salamander	<i>Aneides flavipunctatus niger</i>	35	35	39	Med	<i>A. vagrans</i>
	Very Low	Lizard	Great Basin Collared Lizard	<i>Crotaphytus bicinctores</i>	35	35	150	Low/Med	<i>C. collaris</i>
	Very Low	Lizard	Baja California Collared Lizard	<i>Crotaphytus vestigium</i>	35	35	150	Low/Med	<i>C. collaris</i>
	Very Low	Lizard	Sandstone Night Lizard	<i>Xantusia gracilis</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Lizard	Granite Night Lizard	<i>Xantusia henshawi</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Lizard	Island Night Lizard	<i>Xantusia riversiana</i>	33	33	14	High	
	Very Low	Lizard	Sierra Night Lizard	<i>Xantusia sierrae</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Lizard	Desert Night Lizard	<i>Xantusia vigilis</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Lizard	Wiggins' Night Lizard	<i>Xantusia wigginsii</i>	33	33	14	Med/High	<i>X. riversiana</i>
	Very Low	Frog	Lowland Leopard Frog	<i>Lithobates yavapaiensis</i> (Possibly extinct in CA)	31	31	100	Low	
	Very Low	Lizard	Long-tailed Brush Lizard	<i>Urosaurus graciosus</i>	27	27	130	Low/Med	<i>S. occidentalis</i> , <i>S. graciosus</i>
	Very Low	Lizard	Baja California Brush Lizard	<i>Urosaurus nigricaudus</i>	27	27	130	Low/Med	<i>S. occidentalis</i> , <i>S. graciosus</i>
	Very Low	Lizard	Ornate Tree Lizard	<i>Urosaurus ornatus</i>	27	27	130	Low/Med	<i>S. occidentalis</i> , <i>S. graciosus</i>
	Very Low	Frog	Foothill Yellow-legged Frog	<i>Rana boylei</i>	26	26	40	Med/High	
	Very Low	Frog	Southern Mountain Yellow-legged Frog	<i>Rana muscosa</i>	26	26	40	Med	<i>R. boylei</i>
	Very Low	Lizard	Mearns' Rock Lizard	<i>Petrosaurus mearnsi</i>	21	21	80	Low/Med	
Very Low	Lizard	Mearns' Rock Lizard	<i>Petrosaurus mearnsi</i>	21	21	80	Low/Med		

over the surface during high flow events. These may be used as road crossings by species traveling along ephemeral stream corridors with or without water flow. Given these potential vulnerabilities, we believe that road impacts to aquatic connectivity of herpetofauna deserve greater consideration.

Across broad taxonomic groups, chelonids (tortoises/turtles) and snakes had the greatest percentages of species at 'high' or 'very high' risk from roads. They are similar in that many move long distances (home

range and/or migratory), tend not to avoid roads (or are attracted to them for thermoregulation), are long lived, and have relatively low fecundity in comparison to other herpetofaunal groups. Because of these traits, chelonids and snakes have been identified elsewhere as being particularly susceptible to negative population effects from roads (Gibbs and Shriver 2002; Andrews et al. 2015b; Jackson et al. 2015).

There are only four species of chelonids in California, (desert tortoise (*Gopherus agassizii*),



Northwestern pond turtle (*Actinemys marmorata*), Southwestern pond turtle (*Actinemys pallida*), and the Sonoran mud turtle (*Kinosternon sonoriense*). There has been a high level of attention to road impacts on the desert tortoise (*Gopherus agassii*) as numerous studies have documented not only high road mortality, but measurable road effect zones, and mostly positive responses to barriers and underpasses (e.g., Boarman and Sasaki 1996, 2006; Peaden et al. 2016; but see Peadon et al. 2017). Although not listed as a primary threat to pond turtle populations in California (Thomson et al. 2016), road mortality is a major concern for western pond turtle populations in Oregon (Rosenberg et al. 2009). Pond turtles travel kilometers within perennial waters and from pool to pool in intermittent aquatic habitats to forage and find mates (Goodman and Stewart 2000). In addition, females nest and lay eggs in terrestrial habitats up to 0.5 km away from water which make roads that parallel aquatic habitat a threat to both females and hatchlings (Reese and Welsh 1997; Rathbun et al. 2002; Pilliod et al. 2013). In fact, road mortality of females has been identified as a cause for male-biased sex ratios in some populations of pond turtles and other freshwater turtle species (Steen et al. 2006; Rosenberg et al. 2009; Reid and Peery 2014). Therefore, this species requires consideration of both aquatic and terrestrial connectivity to satisfy their annual resource requirements. Sonoran mud turtles also travel long distances within intermittent streams and thus may be at risk of roads that transect their aquatic habitat (Hensley et al. 2010).

Larger colubrid snakes (Family Colubridae; many genera) and rattlesnakes (genus *Crotalus*) were ranked among the highest risk from negative road effects. In addition to being attracted to paved road surfaces for thermoregulation, many large snakes have wide home-ranges or may move large distances between winter hibernacula and summer foraging areas. In contrast to smaller species, larger snakes are also less likely to avoid roads (Rosen and Lowe 1994; Andrews and Gibbons 2005; Andrews et al. 2008; Siers et al. 2016). High road mortality (e.g., Klauber 1931; Rosen and Lowe 1994; Jones et al. 2011), reduced abundance near roads (Rudolph et al. 1999; Jones et al. 2011), increased extinction risk (Row et al. 2007), and decreased genetic diversity (Clark et al. 2010; Hermann et al. 2017) have been documented for numerous snake species; as have positive responses to barriers

and underpasses (Dodd et al. 2004; Colley et al. 2017). In our statewide risk analysis, coachwhips (genus *Masticophis/Coluber*) were amongst the highest risk groups at both the population and species-levels. These are particularly wide-ranging and very active foragers in comparison to other snake genera (Stebbins and McGinnis 2012). The coachwhip (*Masticophis flagellum*) was found to be ninefold more likely to be extirpated from habitats that were fragmented by roads and urbanization, contributing to their decline throughout California (Case and Fisher 2001; Mitrovich 2006). Similarly, habitat fragmentation from roads and urbanization were identified as primary threats to the Alameda whipsnake (*Masticophis lateralis euryxanthus* USFWS 2011). Although road use and mortality have been documented for many other terrestrial California snake species on road-riding surveys (e.g., Klauber 1931; Jones et al. 2011; Shilling and Waetjen 2017), there is a paucity of studies examining population-level effects of roads on California snake species. We could find only one such study, where presence of a highway was shown to reduce gene flow in the Western diamond-backed rattlesnake (*Crotalus atrox*) in the Sonoran Desert, AZ (Hermann et al. 2017).

Long foraging movements within aquatic habitats also contributed to the majority of garter snakes (genus: *Thamnophis*) falling within the highest road risk categories. Maintaining aquatic and wetland connectivity is of primary concern for these species. Garter snakes also use terrestrial habitats for overwintering, reproduction, and for moving among wetland or aquatic patches. Some migrate long distances to winter hibernacula, making them also susceptible to roads within adjacent terrestrial habitats (Roe et al. 2006; Jackson et al. 2015). The highly aquatic giant garter snake (*Thamnophis gigas*) had the highest aquatic road risk score. Because it moves only short distances on land (Halstead et al. 2015), mitigation may best focus on functional aquatic passages with lengths of adjacent road barriers based upon their terrestrial movement distances.

Toads were the third highest ranking group with 64% ranked in the highest risk categories. In particular, Bufonid toads (family Bufonidae) may move large distances (> 1 km) in both aquatic and terrestrial habitats to satisfy their annual resource requirements; thus 5 of 7 bufonid species ranked high or very high risk from roads. Consistent with our risk assessment

**Table 10** Aquatic risk ranking and population buffer distances

Risk Level (Aquatic)		Species			Risk Scores (Aquatic)		Movement Distances (Aquatic)		
Species	Population	Group	Common Name	Scientific name	Road Risk: Species- Level	Road Risk: Population- Level	95% Population Movement Distance (m)	Confidence in Distance Estimate	Surrogate Used
Very High	Very High	Snake	Giant Gartersnake	<i>Thamnophis gigas</i>	710	240	1556	Med/High	
	Very High	Turtle	Southern Western Pond Turtle	<i>Actinemys pallida</i>	707	320	3145	High	
	Very High	Snake	San Francisco Gartersnake	<i>Thamnophis sirtalis tetraetenia</i>	663	224	1146	Med	<i>T. sirtalis</i>
	Very High	Snake	California Red-sided Gartersnake	<i>Thamnophis sirtalis infernalis</i>	588	224	1146	Med	<i>T. sirtalis</i>
	Very High	Turtle	Northern Western Pond Turtle	<i>Actinemys marmorata</i>	547	320	3145	High	<i>A. pallida</i>
	Very High	Snake	Two-striped Gartersnake	<i>Thamnophis hammondi</i>	541	224	979	Low	<i>T. gigas</i> (-37% for size diff)
High	Turtle	Sonoran Mud Turtle	<i>Kinosternon sonoriense</i>	399	166	1000	Med		
High	Med	Frog	Oregon Spotted Frog	<i>Rana pretiosa</i> (Possibly extinct in CA)	315	120	1300	Low	
	Very High	Snake	Sierra Gartersnake	<i>Thamnophis couchii</i>	304	192	1021	Low	<i>T. gigas</i> (-34% for size diff)
	Med	Frog	California Red-legged Frog	<i>Rana draytonii</i>	300	120	1864	High	
	Med	Toad	Sonoran Desert Toad	<i>Incilius alvarius</i> (Possibly extinct in CA)	285	120	1400	Low/Med	<i>A. cognatus</i>
	Med	Toad	Yosemite Toad	<i>Anaxyrus canorus</i>	284	96	1152	Med/High	
	Med	Toad	Black Toad	<i>Anaxyrus exsul</i>	284	96	951	Low/Med	<i>A. canorus</i> , <i>A. punctatus</i>
	Very High	Snake	Common Gartersnake	<i>Thamnophis sirtalis</i>	271	224	1146	Med	
	High	Snake	Aquatic Gartersnake	<i>Thamnophis atratus</i>	266	168	889	Low	<i>T. gigas</i> (-43% for size diff)
	Med	Toad	Arroyo Toad	<i>Anaxyrus californicus</i>	248	96	1000	Med/High	
	High	Snake	Northwestern Gartersnake	<i>Thamnophis ordinoides</i>	245	168	775	Low	<i>T. gigas</i> (-50% for size diff)
	Very High	Snake	Western Terrestrial Gartersnake	<i>Thamnophis elegans</i>	240	192	931	Low	<i>T. gigas</i> (-40% for size diff)
Medium	Med	Frog	Northern Red-legged Frog	<i>Rana aurora</i>	230	120	1864	Med	<i>R. draytonii</i>
	High	Snake	Checkered Gartersnake	<i>Thamnophis marcianus</i>	210	144	835	Low	<i>T. gigas</i> (-46% for size diff)
	Med	Frog	Foothill Yellow-legged Frog	<i>Rana boylei</i>	199	90	2420	Med/High	
	Med	Toad	Great Plains Toad	<i>Anaxyrus cognatus</i>	175	120	1400	Med/High	
	Med	Toad	Woodhouse's Toad	<i>Anaxyrus woodhousii</i>	175	120	1400	Low/Med	<i>A. cognatus</i>
	Med	Toad	Western Toad	<i>Anaxyrus boreas</i>	130	120	1274	Low/Med	
	Med	Salamander	Red-bellied Newt	<i>Taricha rivularis</i>	72	72	600	High	
	Med	Salamander	California Newt	<i>Taricha torosa</i>	72	72	600	Med/High	<i>T. rivularis</i>
	Med	Salamander	Sierra Newt	<i>Taricha sierrae</i>	72	72	600	Med	<i>T. rivularis</i>
	Med	Salamander	Rough-skinned Newt	<i>Taricha granulosa</i>	72	72	600	Med	<i>T. rivularis</i>
	Med	Salamander	California Giant Salamander	<i>Dicamptodon ensatus</i>	72	72	600	Low	Educated guess
	Med	Frog	Cascades Frog	<i>Rana cascadae</i>	72	72	759	High	
	Med	Toad	Red-spotted Toad	<i>Anaxyrus punctatus</i>	72	72	750	Med	
Low	Low	Frog	Lowland Leopard Frog	<i>Lithobates yavapaiensis</i> (Possibly extinct in CA)	54	54	900	Low	
	Low	Frog	Southern Mountain Yellow-legged Frog	<i>Rana muscosa</i>	54	54	665	Med	
Very Low	Very Low	Salamander	Coastal Giant Salamander	<i>Dicamptodon tenebrosus</i>	48	48	600	Low	Educated guess
	Very Low	Frog	Pacific Treefrog	<i>Pseudacris regilla</i>	36	36	400	Low	Educated guess
	Very Low	Frog	Sierra Nevada Yellow-legged Frog	<i>Rana sierrae</i>	36	36	525	Med/High	
	Very Low	Frog	Coastal Tailed Frog	<i>Ascaphus truei</i>	30	30	266	Med/High	
	Very Low	Frog	California Treefrog	<i>Pseudacris cadaverina</i>	26	26	200	Low/Med	
Very Low	Salamander	Southern Torrent Salamander	<i>Rhyacotriton variegatus</i>	5	5	50	Low/Med	<i>R. cascadae</i>	

results, there is evidence that bufonid toads are particularly susceptible to negative impacts from roads elsewhere (Trenham et al. 2003; Orłowski 2007; Eigenbrod et al. 2008).

Roads and traffic have been associated with reduced abundance and species richness of frog populations (e.g., Fahrig et al. 1995; Houlahan and Findlay 2003). However, approximately half of California species are small, primarily aquatic, highly

fecund, with relatively limited movements and thus ranked low for road impacts. Four of 11 species ranked within the highest risk groupings; California red-legged frog (*Rana draytonii*), Oregon spotted frog (*R. pretiosa*), Northern red-legged frog (*R. aurora*), and Cascades frog (*R. cascadae*). The Oregon spotted frog (*R. pretiosa*) is known to move large distances within aquatic habitats (Bourque 2008; USFWS 2009). Construction of a highway that bisected the



Yellowstone population of Oregon spotted frogs was one important factor that reduced the population dramatically in the 1950s (see discussion in Watson et al. 2003). Although portions of the populations show high site fidelity, California red-legged frog and Northern red-legged frog migrants can move large distances (> 1 km) across both aquatic and terrestrial habitats (Bulger et al. 2003; Fellers and Kleeman 2007; Hayes et al. 2007). Road mortality or habitat fragmentation from roads and urbanization were listed as primary threats to these species elsewhere (USFWS 2002; COSEWIC 2015).

Lizards had relatively low percentages of species in the high risk groupings. Many lizard species are small, non-migratory, territorial, have small home ranges and are thus at low risk of negative road effects. Similar to snakes, lizards can also be attracted to road surfaces for thermoregulation. A few wide ranging species scored in the highest risk categories including the Gila monster (*Heloderma suspectum*), leopard lizards (genus *Gambelia*) and two horned lizard species (genus *Phrynosoma*). The Gila monster has been negatively associated with urbanization, where larger home ranges and greater movement rates result in higher mortality for males (Kwiatkowski et al. 2008). Sensitive to habitat fragmentation, the blunt-nosed leopard lizard (*Gambelia sila*) was found to be largely absent from habitat patches less than 250 ha (Bailey and Germano 2015). Flat-tailed horned lizards (*Phrynosoma mcallii*) are also susceptible to habitat fragmentation with very large home ranges for their size, particularly in wet years (Young and Young 2000). In fact, road mortality is a well-known threat for this species (see review by CDFW 2016b). Horned lizards are also particularly vulnerable to being killed on roads due to their tendency to flatten and remain motionless while being approached (Young and Young 2000).

Salamanders also had relatively low percentages of species in the high risk grouping. Over 75% (35/46) of the California salamanders are lungless salamanders (Plethodontidae) and Torrent salamanders (Rhyacotritonidae). These species are mostly small, sedentary, non-migratory, closed habitat specialists with limited movement distances and these traits have resulted in a high level of speciation. This is exemplified by there being at least 20 species of slender salamanders (genus *Batrachoseps*) in California alone (Martinez-Solano et al. 2007; Vences and Wake 2007). However, within the salamander group, newts and several other

migratory salamander species were ranked within the highest risk categories from negative road effects. There is substantial evidence that habitat fragmentation and mortality due to roads negatively affect many of these species. For instance, newts regularly migrate long distances over land from and to breeding ponds, and to terrestrial foraging habitats (> 2 km; Trenham 1998). Large numbers are found dead on roads during dispersal periods and newt species are often the first to disappear in fragmented landscapes (Gibbs 1998; Trenham 1998, Shields pers. comm.). Similarly, road mortality and habitat fragmentation are primary threats to the California tiger salamander and other Ambystomid salamanders because terrestrial habitat is used for interpond migration and overwintering (Semlitsch 1998; Trenham et al. 2001; Bolster 2010).

Because this assessment covers a wide array of species and habitats, the risk to particular species populations must be re-assessed on a local level. This includes consideration of the locations, types, and densities of roads in relation to population and species ranges along with goals for functional, meta-population, and genetic connectivity (e.g., Marsh and Jaeger 2015). Due to very low road densities in their limited ranges, some species and populations may be at lower risk. For instance the Gila monster, Oregon spotted frog, Sonoran mud turtle, Sonoran desert toad (*Incilius alvarius*) and Yosemite toad (*Anaxyrus canorus*) scored high due to life history and space-use characteristics, however their limited ranges are largely in protected or low road density areas in the state. Thus roads may not be a significant threat to these species in California. In contrast, high road densities may increase the risk for species within coastal regions such as remaining populations of Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*), Alameda striped racer (*Masticophis lateralis euryxanthus*), and San Francisco garter snake (*Thamnophis sirtalis tetrataenia*). However, most species consist of numerous populations with a myriad of differing road-related threat levels. Although detailed species ranges and occupancy within ranges are well known for some species with very limited ranges, for most species range-wide surveys have not been conducted. Therefore, only general range boundaries are available that encompass large portions of the state and availability of species distribution models of habitat suitability and occupancy within their ranges is rare. This lack of detailed spatial information on species distribution

further limits the potential to incorporate road locations, types, and densities in a state and species-wide assessment.

We also note that relative risk to negative road impacts is provided for both populations and species. Risk was elevated for species with small and isolated ranges and that are facing a myriad of other threats. Because of this, a few common widespread species scored high at the population-level but not at the species-level. This included gopher snakes (*Pituophis catenifer*) and western toads (*Anaxyrus boreas*) where road mortality has been identified as a threat to the persistence of local populations (e.g., COSEWIC 2012; Jochimsen et al. 2014).

To potentially aid in local assessments, we have provided distance estimates or “buffer zones” that contain estimates for 95% of population-level movements for all species (e.g., Semlitsch and Bodie 2003). We provide all references evaluated for distance estimates in Appendix 2. Meta-population movements can be very important to the stability of pond-breeding amphibians (e.g., Semlitsch 2008; Jackson et al. 2015) and are included in many of the buffer zone calculations. However, we note that buffer zones may not include meta-population-level movements if the rate of these dispersal movements was less than 5% in the studies we used for our analyses.

This should be considered an initial assessment of susceptibility to negative road impacts in a hierarchical framework (e.g., see Level 2; Hobday et al. 2011). Therefore, as previously stated it will be important to re-assess the risk of specific populations to roads within their habitat and to evaluate and compare alternatives at the local scale (e.g., Suter 2016). This may include more detailed information on specific road attributes (e.g., density, type, location), as well as species behavior (Jaeger et al. 2005; Rouse et al. 2011; Rytwinski and Fahrig 2013; Jacobson et al. 2016). Age structured and spatially explicit population viability models are valuable tools to predict long-term population responses to roads and to compare outcomes of multiple mitigation scenarios (e.g., Gibbs and Shriver 2005; Borda-de-Água et al. 2014; Polak et al. 2014; Crawford 2015). Need and placement of mitigation structures can be guided by local population or meta-population dynamics, landscape attributes, movement routes, and road mortality hot spots (e.g., Bissonette and Adair 2008; Langen et al. 2009, 2015b; D’Amico et al. 2016; Loraamm and Downs 2016).

The quantity and quality of life history information, particularly movement data, are highly variable among species (see confidence levels; Tables 9 and 10). Therefore it is important to re-assess risk as new information becomes available. Finally, this is a structured assessment of comparative risk across a range of target species; therefore specific values for high risk have not been established. The ranking or assessment methodology should be adaptive and updated with advancements of road ecology science (e.g., Linkov et al. 2006).

## Conclusion

Although roads are a significant cause of mortality and habitat fragmentation for many wildlife populations, road-related risk rankings have been based largely on expert opinion due to a scarcity of literature on road effects for most species. Therefore, we developed an objective and scientifically-based comparative risk approach to assess the potential threat from negative road impacts using species life history and movement data. After applying it to over 160 herpetofaunal species (and subspecies) in the state of California, the results are consistent with road ecology literature in identifying known high risk species, and call attention to some species not previously identified. Overall, we found that snakes and chelonids had the largest proportion of species at high risk for negative road impacts due to longer movement distances (home range and/or migratory), lack of road avoidance, and relatively low fecundity in comparison to other herpetofaunal groups. Results also indicated that consideration of aquatic connectivity appears to be under-represented for semi-aquatic herpetofauna that use both terrestrial and stream, riverine, or wetland habitats.

In addition to informing transportation planning and mitigation considerations for California herpetofauna, we believe this approach may be useful for comparing the risk of road-related fragmentation and mortality for species elsewhere and for other taxonomic groups. The results can help to inform multi-criteria threat assessments for special status species or those in consideration for listing. Finally, this serves to highlight species that may deserve further study and consideration for aquatic and terrestrial road mitigation to reduce mortality and to maintain population-level connectivity.

This risk assessment approach compares the susceptibility of species to negative road impacts. Commonly, there are numerous populations within a species range that occupy areas with greatly differing road pressures. Therefore, the actual risk to specific species populations will depend upon local road densities, road-types, traffic, and road locations in relation to species habitat and movement corridors.

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# Chapter 3. Spatial Mapping - California Essential Habitat Connectivity Lands, Highways, and High-Risk Species

Authors: Elise Watson and Cheryl Brehme, U.S. Geological Survey

## Introduction

The California Department of Transportation (Caltrans) and California Department of Fish and Wildlife (CDFW) commissioned the California Essential Habitat Connectivity (CEHC) Project because a functional network of connected wildlands is essential to the continued support of California's diverse natural communities in the face of human development and climate change. This report is also intended to make transportation and land-use planning more efficient and less costly, while helping reduce dangerous wildlife-vehicle collisions (Spencer et al. 2010).

The statewide essential connectivity network consists of 850 relatively intact and well conserved Natural Landscape Blocks (ranging from 2,000 to about 3.7 million acres each) with over 1,000 potential connections among them. The 192 Essential Connectivity Areas represent principle connections between the Natural Landscape Blocks within which land conservation and management actions should be prioritized to maintain and enhance ecological connectivity (Spencer et al. 2010).

CEHC maps and spatial layers depict large, relatively natural habitat blocks that support native biodiversity and areas considered essential for regional large-scale connectivity. To better represent natural areas not included in the large-scale CEHC map but large enough to support sensitive amphibian and reptile populations in California, we also incorporated smaller natural areas between 25 to 2000 acres (10 to 809 ha) that were included in the CEHC map database for regional and local scale analyses. We then combined these into a spatial geodatabase to crosswalk the CEHC Map, State Highways, and the California amphibian and reptile road risk assessment (Brehme et al. 2018).

The spatial geodatabase includes:

1. CEHC natural habitat blocks greater than 10 ha (25 ac).
2. Range maps of high and very-high risk amphibian and reptile species.
3. California highway segments that intersect the ranges of high and very high-risk amphibian and reptile species.
4. California highway segments that intersect the ranges of high and very high-risk amphibian and reptile species and CEHC lands.
5. Postmile markers of all California highway segments that intersect the ranges of high and very high-risk amphibian and reptile species and CEHC lands.
6. The total number of high and very-high risk species ranges that intersect the highway segments and CEHC lands.

This geodatabase was designed to be a useful planning tool for Caltrans to quickly identify road segments that may warrant planning for increased connectivity of high-risk amphibian and reptile species.

## Methods

The GIS analyses were conducted using ArcGIS 10.5.1 software. Species range and highway layers were obtained from Caltrans and CDFW.

### Species Range Layers

Species ranges were obtained from the ARSSC\_DFG\_HerpRoadRiskRanges shapefile provided by Dr. Amber Wright (University of Hawaii), co-author of the California amphibian and reptile species of special concern (Thomson et al. 2016), and the California Wildlife Habitat Relationships (CWHR) GIS database (downloaded from the CDFW, <https://wildlife.ca.gov/Conservation/Planning/Data-and-Tools> on June 16, 2016). Updated range layers for 4 species were provided by email from CDFW in April 2020. All species range layers were merged into a single feature class, ARSSC\_DFG\_CWHR\_SppRoadRiskRanges (CWHR). Table 1 lists the species that were included and the source of the GIS layers.

Table 1. List of High and Very-High Risk Species and GIS Source.

Scientific Name	Common Name	Cons. Status <sup>a</sup>	Species Group	GIS Source
<i>Actinemys marmorata</i>	Northern Western Pond Turtle	ARSSC 3	Turtle	ARSSC (2016)
<i>Actinemys pallida</i>	Southern Western Pond Turtle	ARSSC 1	Turtle	CWHR (2020)
<i>Ambystoma californiense</i> <sup>1</sup>	California Tiger Salamander	THR <sup>F,S</sup> , END <sup>F</sup>	Salamander	ARSSC (2016)
<i>Ambystoma macrodactylum croceum</i>	Santa Cruz Long-toed Salamander	END <sup>F,S</sup>	Salamander	ARSSC (2016)
<i>Ambystoma macrodactylum sigillatum</i>	Southern Long-toed Salamander	ARSSC 2	Salamander	CWHR (2020)
<i>Anaxyrus californicus</i>	Arroyo Toad	END <sup>F</sup> , ARSSC 1	Toad	ARSSC (2016)
<i>Anaxyrus canorus</i>	Yosemite Toad	THR <sup>F</sup> , ARSSC 1	Toad	ARSSC (2016)
<i>Anaxyrus cognatus</i>	Great Plains Toad		Toad	ARSSC (2016)
<i>Anaxyrus exsul</i>	Black Toad	THR <sup>S</sup>	Toad	ARSSC (2016)
<i>Anaxyrus woodhousii</i>	Woodhouse's Toad		Toad	CWHR (2016)
<i>Arizona elegans occidentalis</i>	California Glossy Snake	ARSSC 1	Snake-Terrestrial	ARSSC (2016)
<i>Aspidoscelis tigris stejnegeri</i> <sup>2</sup>	San Diegan Tiger Whiptail	ARSSC 2	Lizard	CWHR (2016)
<i>Coleonyx switaki</i>	Switak's Banded Gecko	THR <sup>S</sup>	Lizard	CWHR (2016)
<i>Coluber constrictor</i>	North American racer		Snake-Terrestrial	ARSSC (2016)
<i>Crotalus atrox</i>	Western Diamond-backed Rattlesnake		Snake-Terrestrial	ARSSC (2016)
<i>Crotalus cerastes</i>	Sidewinder		Snake-Terrestrial	CWHR (2016)
<i>Crotalus mitchellii</i>	Speckled Rattlesnake		Snake-Terrestrial	ARSSC (2016)
<i>Crotalus oreganus</i>	Western Rattlesnake		Snake-Terrestrial	ARSSC (2016)
<i>Crotalus ruber</i>	Red Diamond Rattlesnake	ARSSC 3	Snake-Terrestrial	ARSSC (2016)
<i>Crotalus scutulatus</i>	Mojave Rattlesnake		Snake-Terrestrial	CWHR (2016)
<i>Crotalus stephensi</i>	Panamint Rattlesnake		Snake-Terrestrial	ARSSC (2016)
<i>Diadophis punctatus regalis</i>	Regal ring-necked Snake	ARSSC 2	Snake-Terrestrial	ARSSC (2016)
<i>Dicamptodon ensatus</i>	California Giant Salamander	ARSSC 3	Salamander	ARSSC (2016)
<i>Gambelia copeii</i>	Cope's Leopard Lizard	ARSSC	Lizard	ARSSC (2016)
<i>Gambelia sila</i>	Blunt-nosed Leopard Lizard	END <sup>F</sup>	Lizard	ARSSC (2016)
<i>Gambelia wislizenii</i>	Long-nosed Leopard Lizard		Lizard	CWHR (2016)
<i>Gopherus agassizii</i>	Mohave Desert tortoise	THR <sup>F,S</sup>	Tortoise	ARSSC (2016)

Scientific Name	Common Name	Cons. Status <sup>a</sup>	Species Group	GIS Source
<i>Heloderma suspectum cinctum</i>	Banded Gila Monster	ARSSC	Lizard	ARSSC (2016)
<i>Hypsiglena chlorophaea</i>	Desert Nightsnake		Snake-Terrestrial	CWHR (2016)
<i>Hypsiglena ochrorhyncha</i>	Nightsnake		Snake-Terrestrial	ARSSC (2016)
<i>Incilius alvarius</i>	Sonoran Desert Toad	ARSSC 1	Toad	ARSSC (2016)
<i>Kinosternon sonoriense</i> <sup>3</sup>	Sonora Mud turtle	ARSSC 1	Turtle	ARSSC (2016)
<i>Phyllorhynchus decurtatus</i>	Spotted Leaf-nosed Snake	ARSSC 2	Snake-Terrestrial	CWHR (2016)
<i>Masticophis flagellum</i>	Coachwhip		Snake-Terrestrial	ARSSC (2016)
<i>Masticophis flagellum ruddocki</i>	San Joaquin Coachwhip	ARSSC 2	Snake-Terrestrial	ARSSC (2016)
<i>Masticophis fuliginosus</i>	Baja California Coachwhip	ARSSC 3	Snake-Terrestrial	ARSSC (2016)
<i>Masticophis lateralis</i>	Striped Racer		Snake-Terrestrial	ARSSC (2016)
<i>Masticophis lateralis euryxanthus</i>	Alameda Striped Racer	THR <sup>F,S</sup>	Snake-Terrestrial	CWHR (2020)
<i>Masticophis taeniatus</i>	Striped Whipsnake		Snake-Terrestrial	ARSSC (2016)
<i>Phrynosoma mcallii</i>	Flat-tailed Horned Lizard	THR <sup>F</sup> , ARSSC 2	Lizard	ARSSC (2016)
<i>Phrynosoma platyrhinos</i>	Desert Horned Lizard		Lizard	ARSSC (2016)
<i>Rana aurora</i>	Northern Red-legged Frog	ARSSC 2	Frog	ARSSC (2016)
<i>Rana cascadae</i>	Cascades Frog	ARSSC 2	Frog	CWHR (2016)
<i>Rana draytonii</i>	California Red-legged Frog	THR <sup>F</sup> , ARSSC 1	Frog	ARSSC (2016)
<i>Rana pretiosa</i>	Oregon Spotted Frog	THR <sup>F</sup> , ARSSC 1	Frog	ARSSC (2016)
<i>Salvadora hexalepis</i>	Western Patch-nosed Snake		Snake-Terrestrial	ARSSC (2016)
<i>Salvadora hexalepis virgulata</i>	Coast Patch-nosed Snake	ARSSC 2	Snake-Terrestrial	ARSSC (2016)
<i>Sonora occipitalis</i>	Western Shovel-nosed Snake		Snake-Terrestrial	CWHR (2016)
<i>Sonora semiannulata</i>	Western Groundsnake		Snake-Terrestrial	CWHR (2016)
<i>Spea hammondi</i>	Western Spadefoot	ARSSC 1	Toad	ARSSC (2016)
<i>Taricha granulosa</i>	Rough-skinned Newt		Salamander	ARSSC (2016)
<i>Taricha rivularis</i>	Red-bellied Newt	ARSSC 2	Salamander	ARSSC (2016)
<i>Taricha sierrae</i>	Sierra Newt		Salamander	ARSSC (2016)
<i>Taricha torosa</i>	Coast Range Newt	ARSSC 2	Salamander	ARSSC (2016)
<i>Thamnophis atratus</i>	Aquatic Gartersnake		Snake-Aquatic	ARSSC (2016)
<i>Thamnophis couchii</i>	Sierra Gartersnake		Snake-Aquatic	ARSSC (2016)
<i>Thamnophis elegans</i>	Terrestrial Gartersnake		Snake-Aquatic	ARSSC (2016)
<i>Thamnophis gigas</i>	Giant Gartersnake	THR <sup>F,S</sup>	Snake-Aquatic	ARSSC (2016)
<i>Thamnophis hammondi</i>	Two-striped Gartersnake	ARSSC 2	Snake-Aquatic	ARSSC (2016)
<i>Thamnophis ordinoides</i>	Northwestern Gartersnake		Snake-Aquatic	ARSSC (2016)
<i>Thamnophis sirtalis infernalis</i> <sup>4</sup>	California Red-sided Gartersnake	ARSSC 1	Snake-Aquatic	ARSSC (2016)
<i>Thamnophis sirtalis tetrataenia</i>	San Francisco Gartersnake	END <sup>F,S</sup>	Snake-Aquatic	CWHR (2020)
<i>Trimorphodon lambda</i>	Sonoran Lyresnake		Snake-Terrestrial	ARSSC (2016)
<i>Trimorphodon lyrophanes</i>	California Lyresnake		Snake-Terrestrial	ARSSC (2016)

<sup>a</sup>Conservation Status: THR=Threatened, END= Endangered, Superscripts F and S are used to delineate State and Federal listing status, ARSSC= State Species of Special Concern with Priority Ranking 1-3.

<sup>1</sup>California tiger salamander Sonoma and Santa Barbara distinct population segments are federally endangered while central DPS is federally threatened.

<sup>2</sup>Species range layer for subspecies was not available so the species range for *Aspidoscelis tigris* was used.

<sup>3</sup>Species range does not contain any State highways

<sup>4</sup>Species range layer for subspecies was not available so the species range for *Thamnophis sirtalis* spp., and the South Coast Gartersnake, were used.

## Connectivity Areas Layers

Essential Connectivity Areas (ECA), Natural Landscape Blocks (NLB), and Natural Areas\_small (NA; Natural areas smaller than 2,000 acres that otherwise meet NLB criteria) from the Essential Connectivity Map geodatabase were provided by CDFW. The ECA and NLB were

merged together with NA areas 10 hectares or greater. The resulting layer was then dissolved into a single polygon feature class with a buffer of 100 meters added to it. This connected many of the smaller polygons. This final layer was used to identify CEHC connectivity areas that overlapped with the target species ranges.

### *Roads Layers*

Road features were obtained from the Caltrans 2012 State Highway Network (SHN) geodatabase provided by Caltrans. The roads layer was clipped to the merged Essential Habitat Connectivity layer (Merged NLB\_ECA\_NA areas) to create a layer of highway segments that occur in essential habitat connectivity areas. This layer was then clipped to select target species ranges (Table 1). The resulting SHN\_Lines\_SpeciesRanges feature class represents potential highway segments of concern where species ranges at high risk of negative road impacts intersect with both California highways and California Essential Habitat Connectivity lands. Potential highway segments of concern maps for high risk species with conservation status (threatened, endangered, and species of special concern) are presented in Figures 1–35. Potential highway segments of concern maps for high risk species with no conservation status are not presented in this report. Some species range maps are based on greater knowledge and survey efforts than others. Also, most species are patchily distributed across their known ranges. In this feature class, highway segments of concern are based upon the intersection of broad species range maps, CEHC lands, and State highways. Thus, the segments of concern likely over-represent locations of many species in relation to highways. This feature class is meant to represent potential presence of high risk herpetofauna species. Local knowledge or surveys may be needed to verify their presence or absence adjacent to specific highway segments.

Using the SHN\_Lines\_SpeciesRanges feature class, start and end point vertices were generated for each road segment of concern for each species (PostMileMarkers\_SpeciesRanges). The nearest postmile marker along the same route was identified using the Near Analysis. Postmile marker features were identified using a State Highway Postmile shapefile obtained from Caltrans (shn204v3\_TenthPM.shp). The distance from the road start/end point to the postmile the Odometer (distance in miles from start of highway to postmile), post mile marker interval, and route identifier of the marker were included in the feature class.

### *Species Density Layers*

A hexagonal grid with an area of 15 km<sup>2</sup> per grid was generated for the entire state of California using the Generate Tessellation tool. This grid was then intersected with the species range layer (ARSSC\_DFG\_CWHR\_SppRoadRiskRanges). The Summary Statistics tool was used to calculate the number of unique species whose ranges fell within each grid cell as well as number of species per group (frogs, toads, lizards, salamanders, terrestrial and aquatic snakes, turtles, and tortoise). This species density grid was intersected with the SHN lines feature class to create a species density overlay of the road network. These features overall and by group are included in a final map package provided to Caltrans. Densities of all high and very-high risk species across the state and associated highway segments are presented in Figures 36 and 37.

## Results: Maps High and Very-High Risk Species

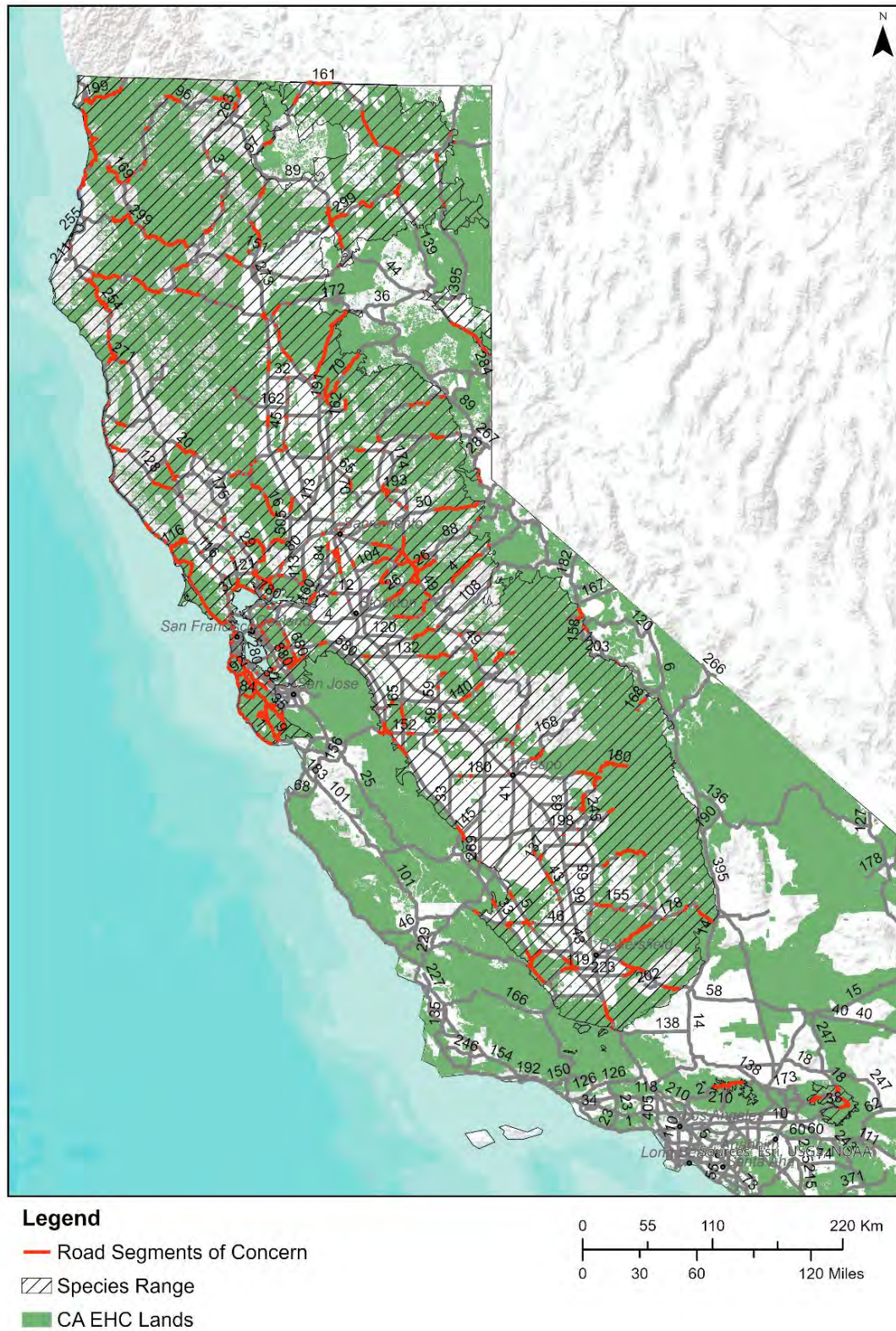


Figure 1. Highway Segments of Concern: Northern Western Pond Turtle (*Actinemys marmorata*)





Figure 2. Highway Segments of Concern: Southern Western Pond Turtle (*Actinemys pallida*)



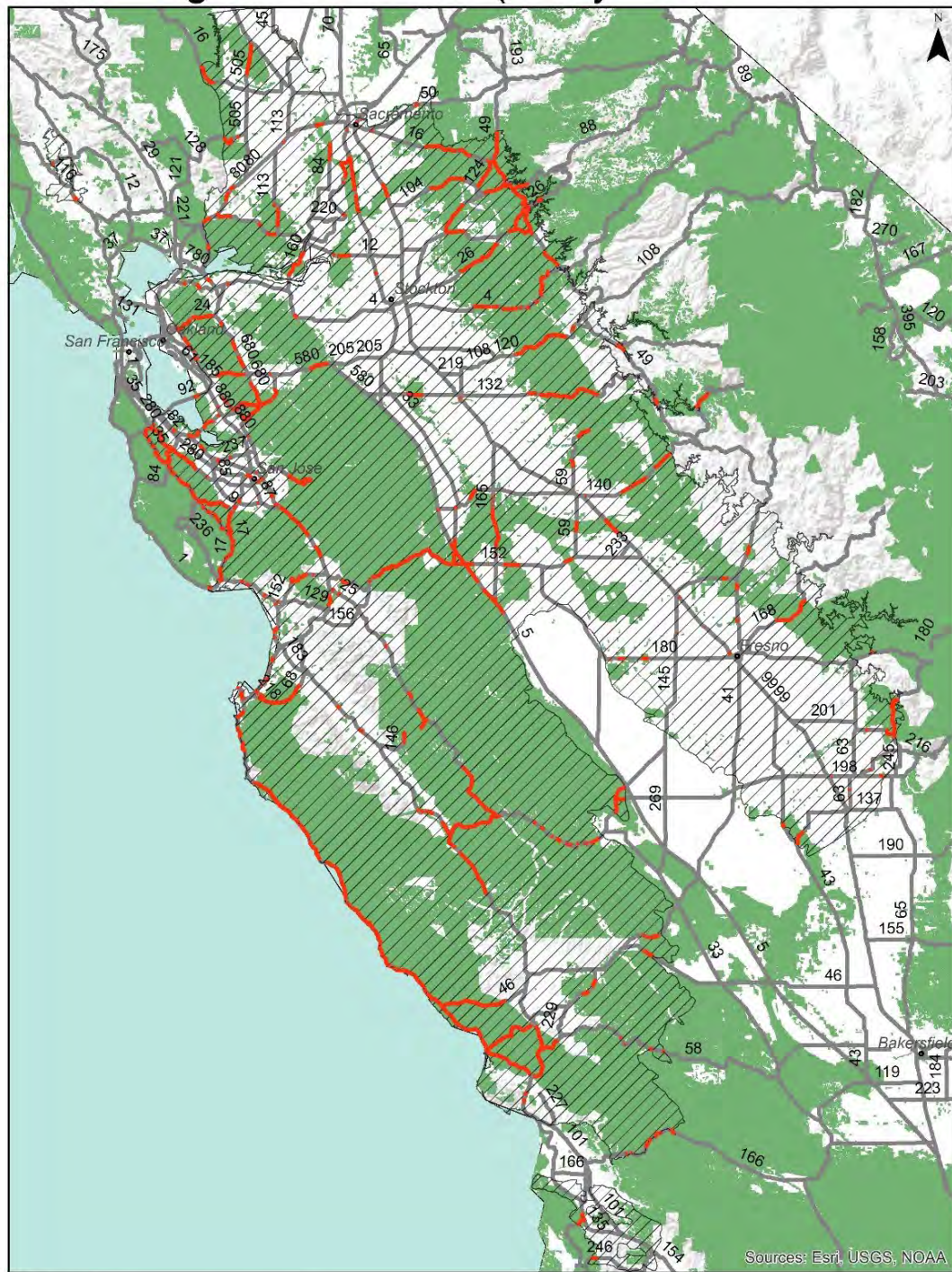


Figure 3. Highway Segments of Concern: California Tiger Salamander (*Ambystoma californiense*)



Figure 4. Highway Segments of Concern: Santa Cruz Long-toed Salamander (*Ambystoma macrodactylum croceum*)



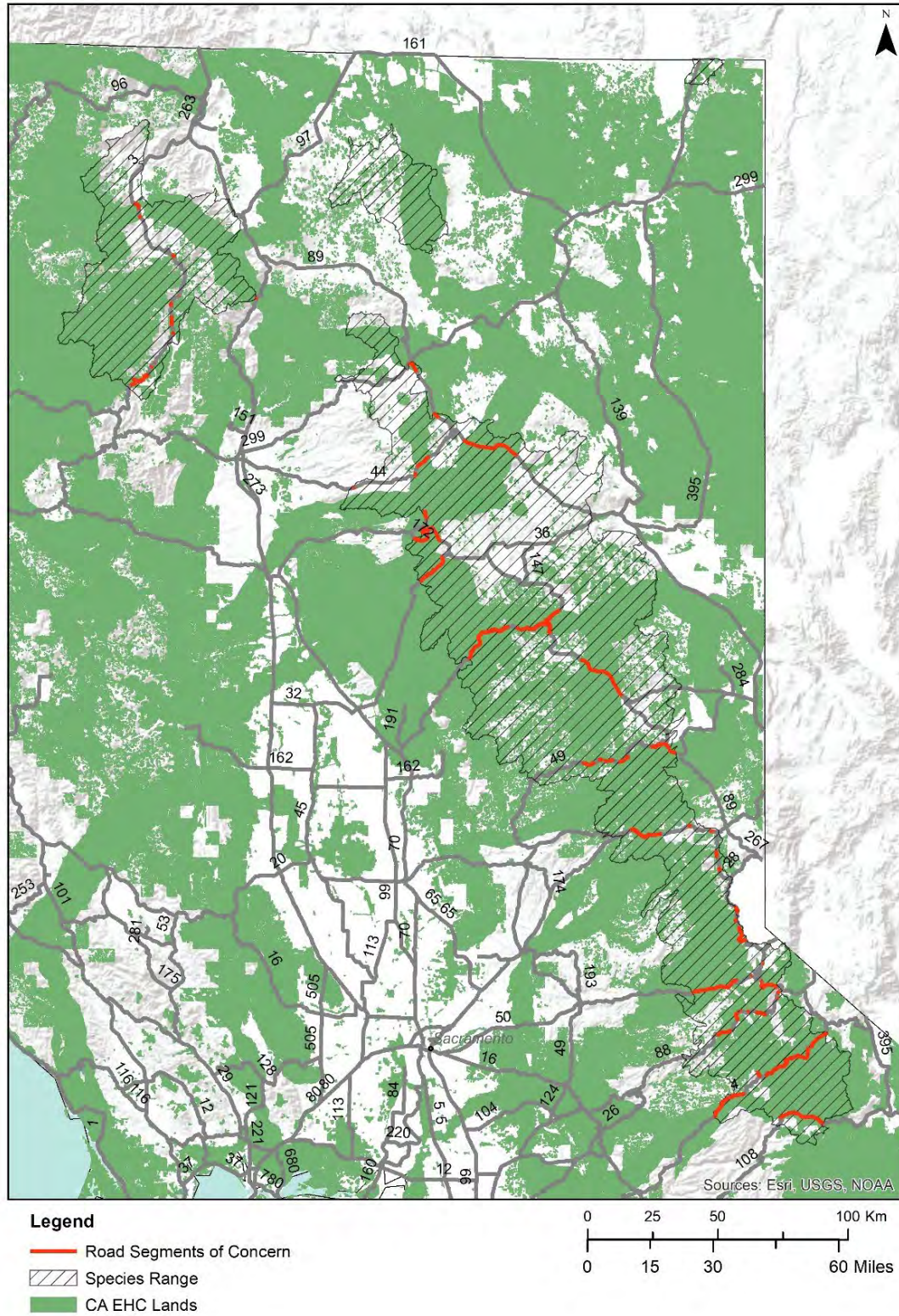


Figure 5. Highway Segments of Concern: Southern Long-toed Salamander (*Ambystoma macrodactylum sigillatum*)



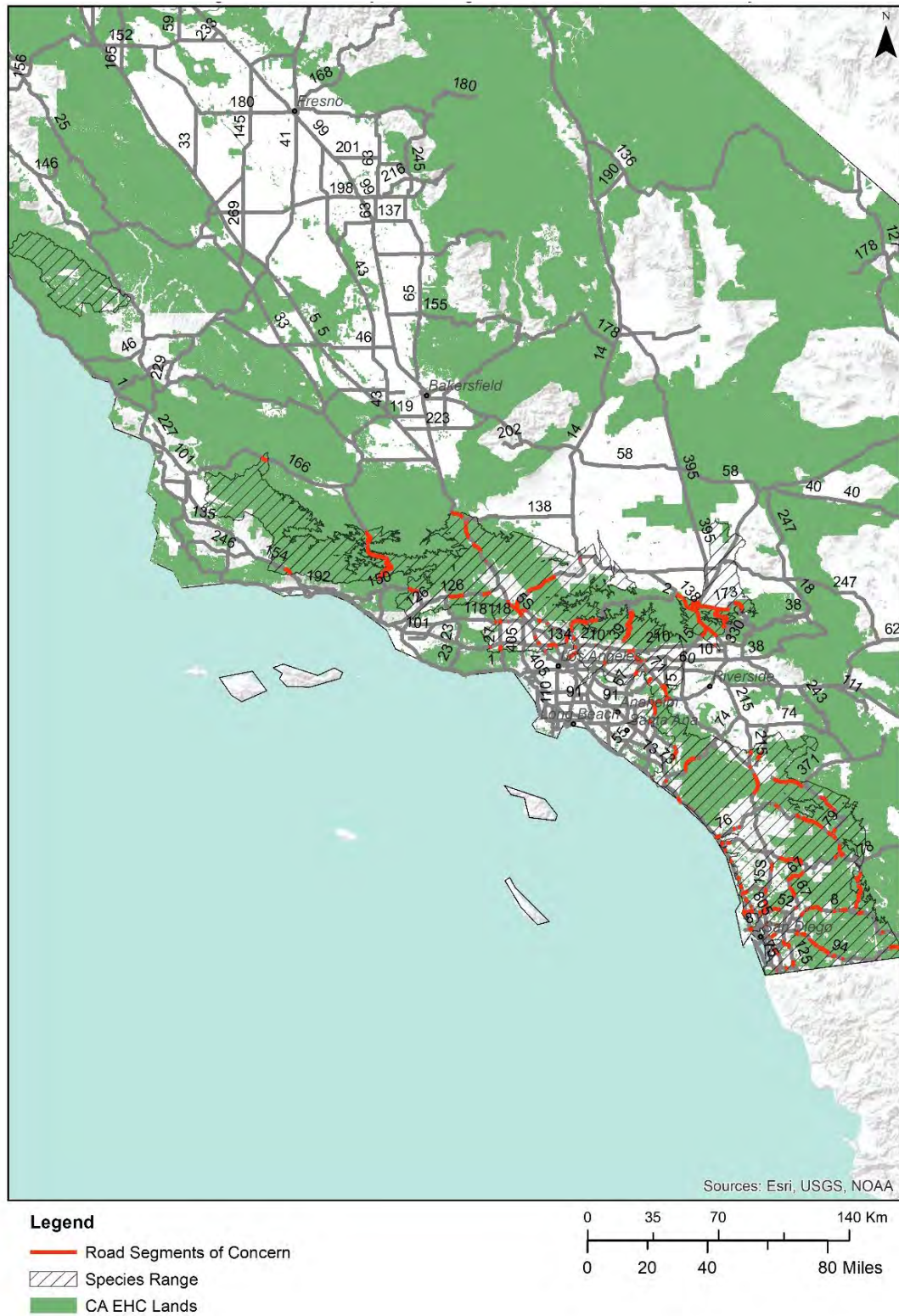


Figure 6. Highway Segments of Concern: Arroyo Toad (*Anaxyrus californicus*)



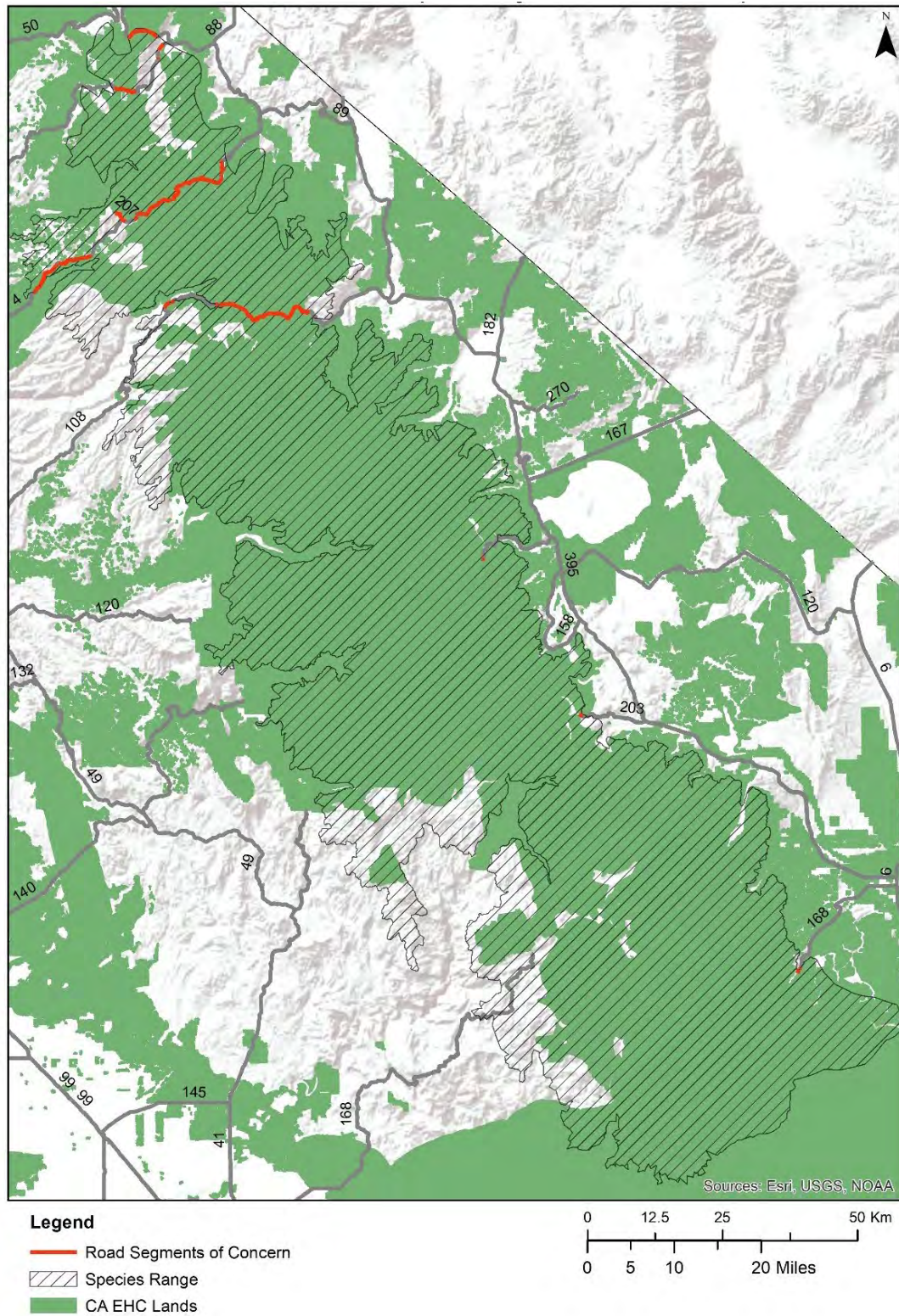


Figure 7. Highway Segments of Concern: Yosemite Toad (*Anaxyrus canorus*)





Figure 8. Highway Segments of Concern: Black Toad (*Anaxyrus exsul*)



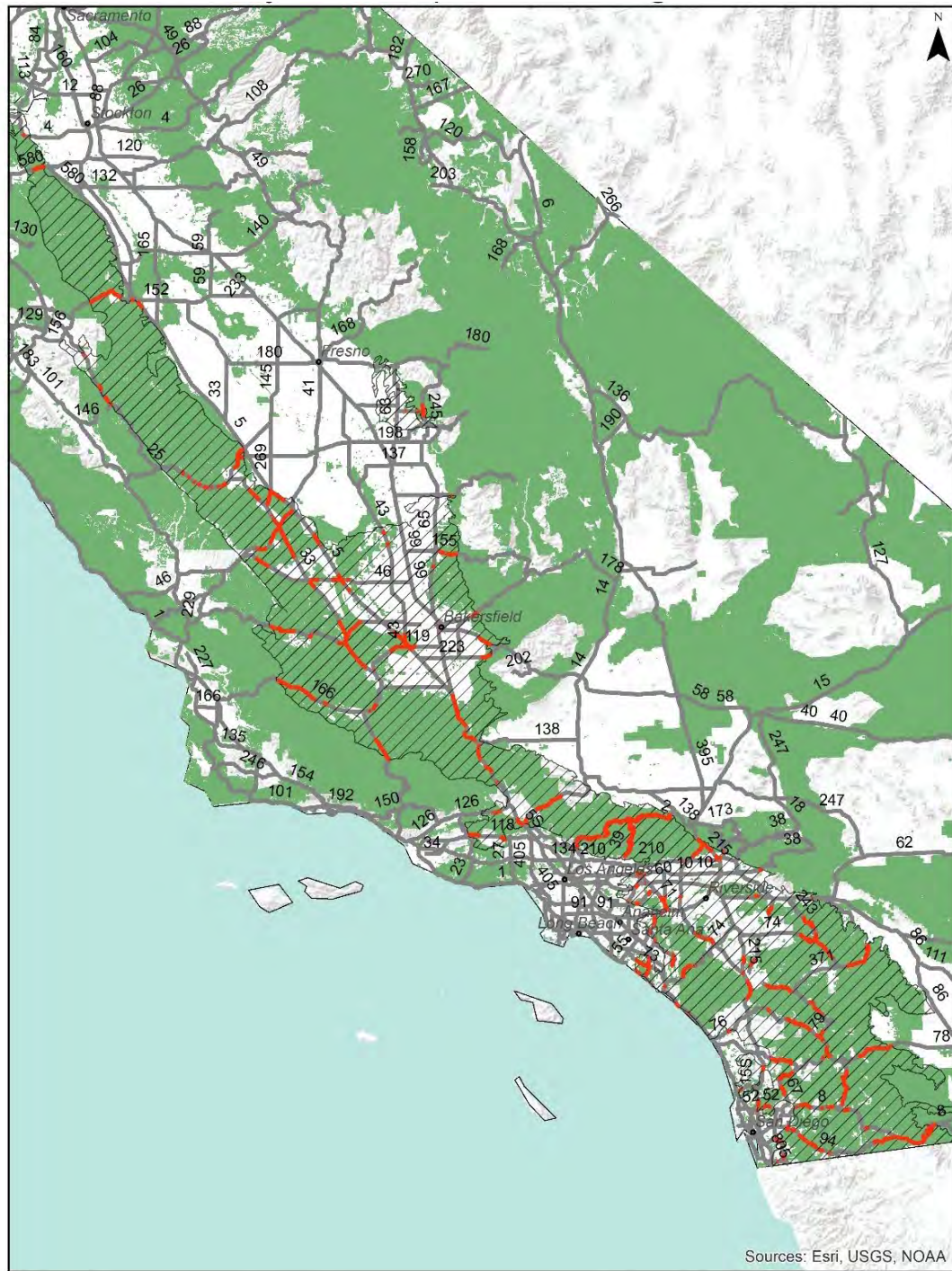
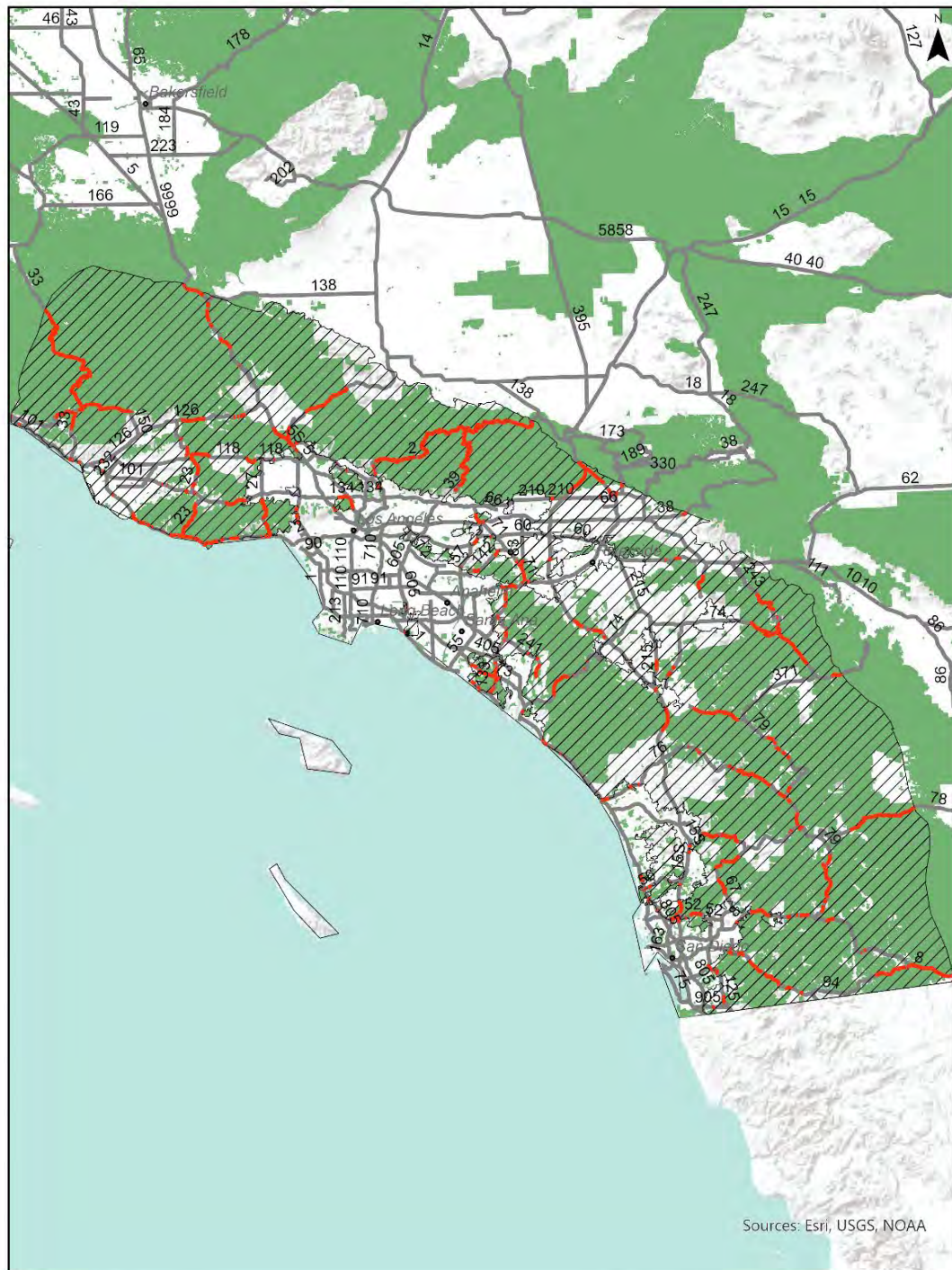


Figure 9. Highway Segments of Concern: California Glossy Snake (*Arizona elegans occidentalis*)



**Legend**

- Road Segments of Concern
- / / Species Range
- CA EHC Lands

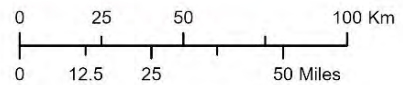


Figure 10. Highway Segments of Concern: San Diegan Tiger Whiptail (*Aspidoscelis tigris stejnegeri*)



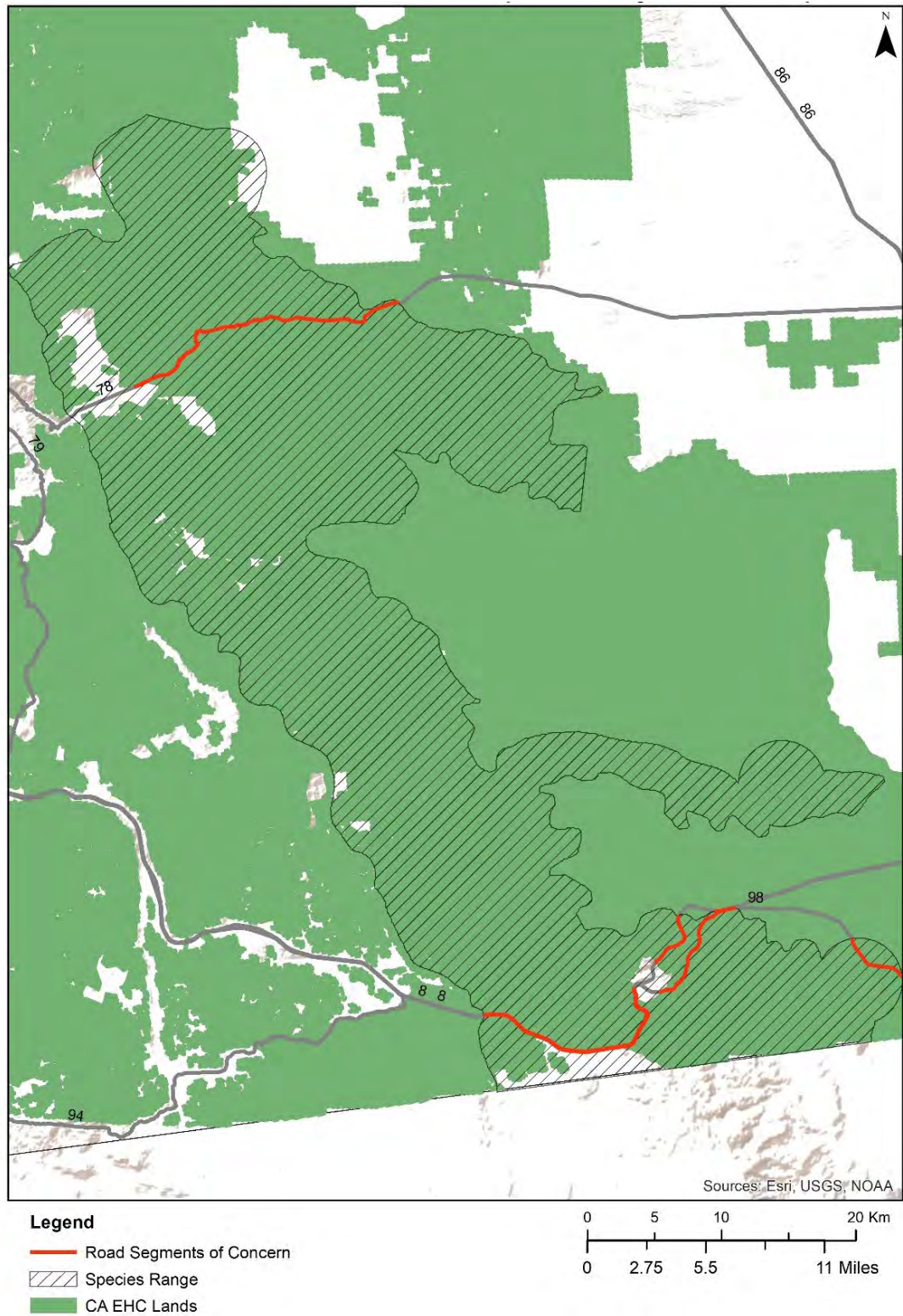


Figure 11. Highway Segments of Concern: Switak's Banded Gecko (*Coleonyx switaki*)

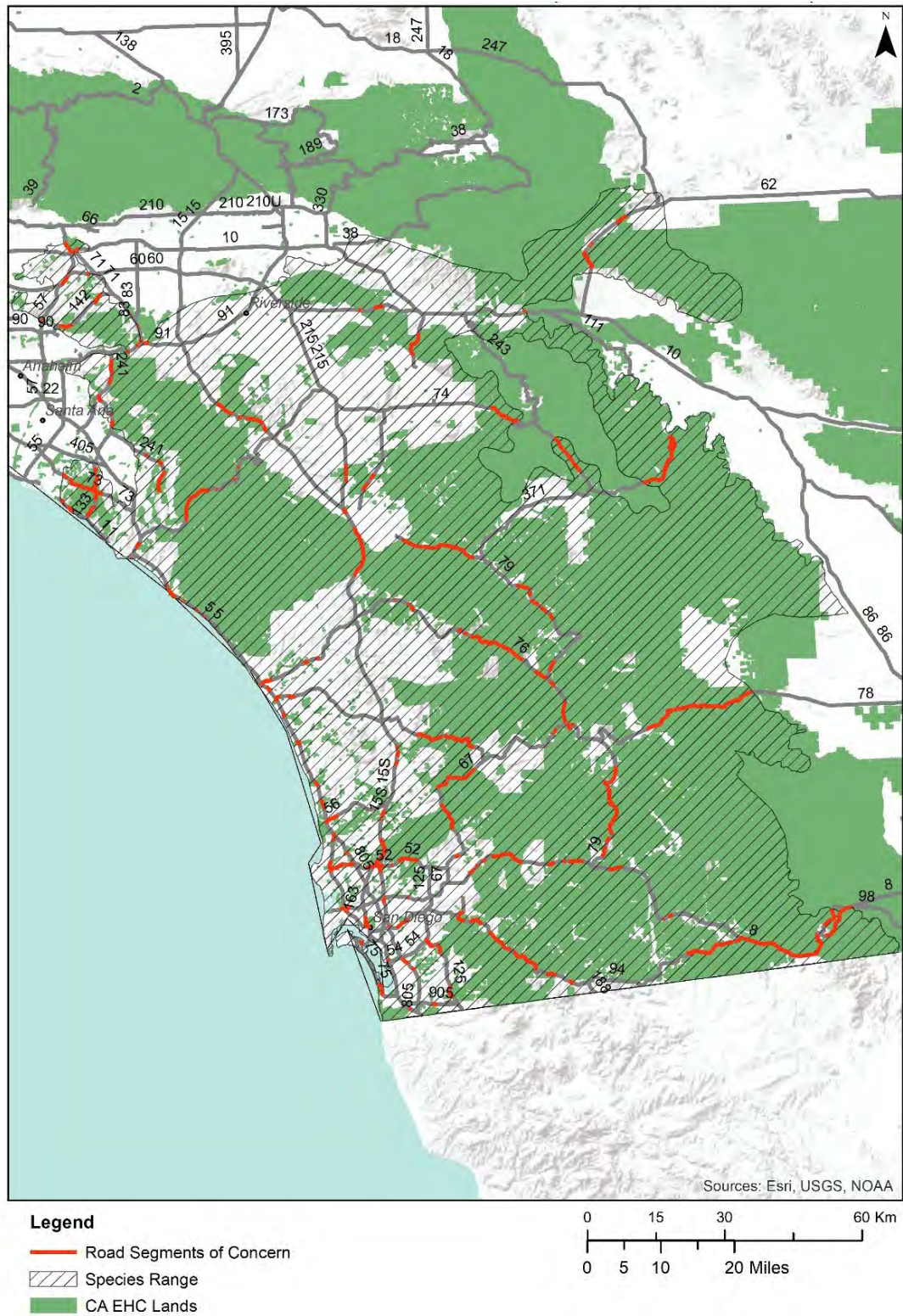
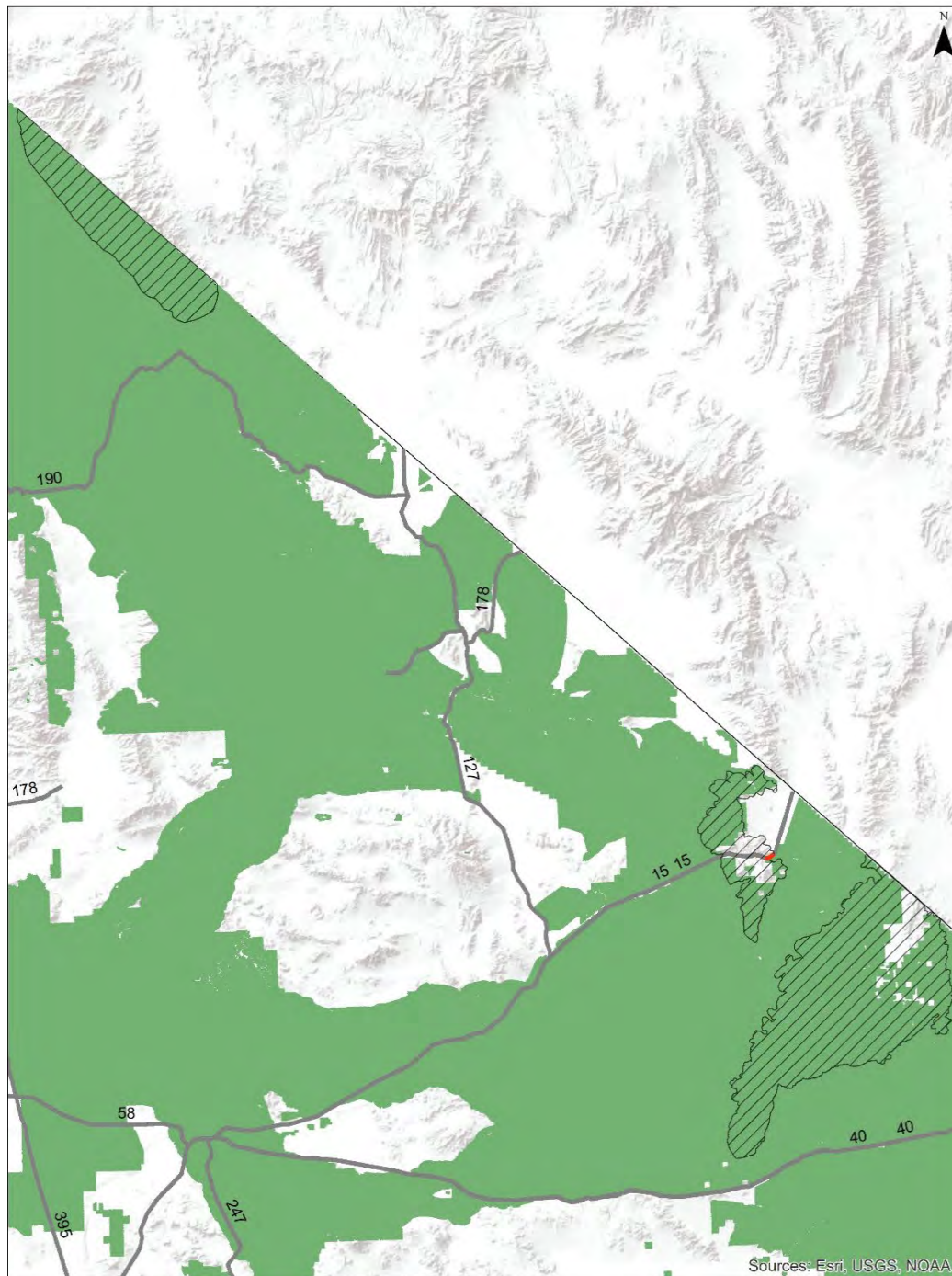


Figure 12. Highway Segments of Concern: Red Diamond Rattlesnake (*Crotalus ruber*)





**Legend**

- Road Segments of Concern
- Species Range
- CA EHC Lands

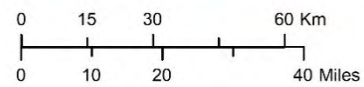


Figure 13. Highway Segments of Concern: Regal Ring-necked Snake (*Diadophis punctatus regalis*)

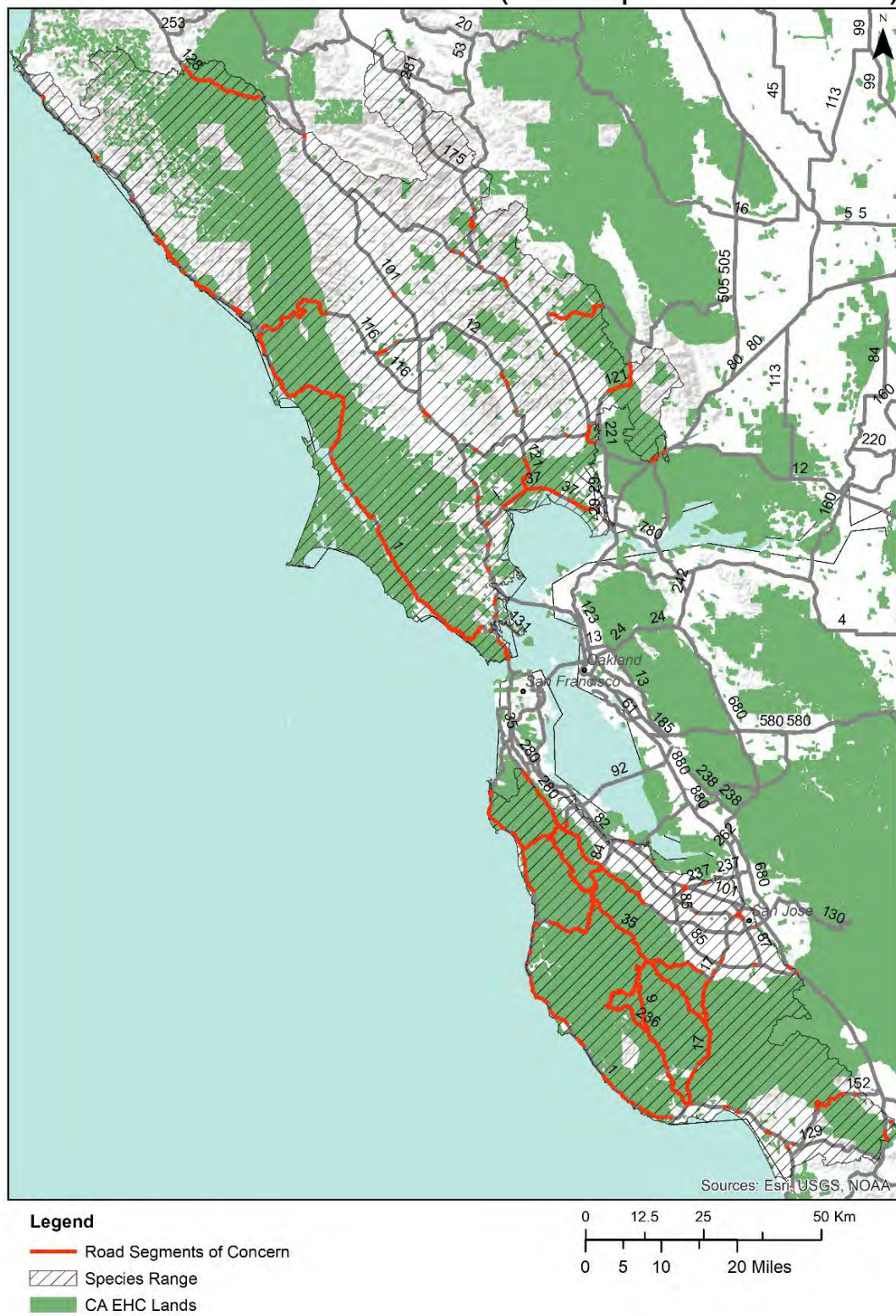


Figure 14. Highway Segments of Concern: California Giant Salamander (*Dicamptodon ensatus*)





- Legend**
- Road Segments of Concern
  - Species Range
  - CA EHC Lands

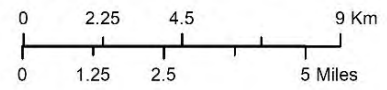


Figure 15. Highway Segments of Concern: Cope's Leopard Lizard (*Gambelia copeii*)





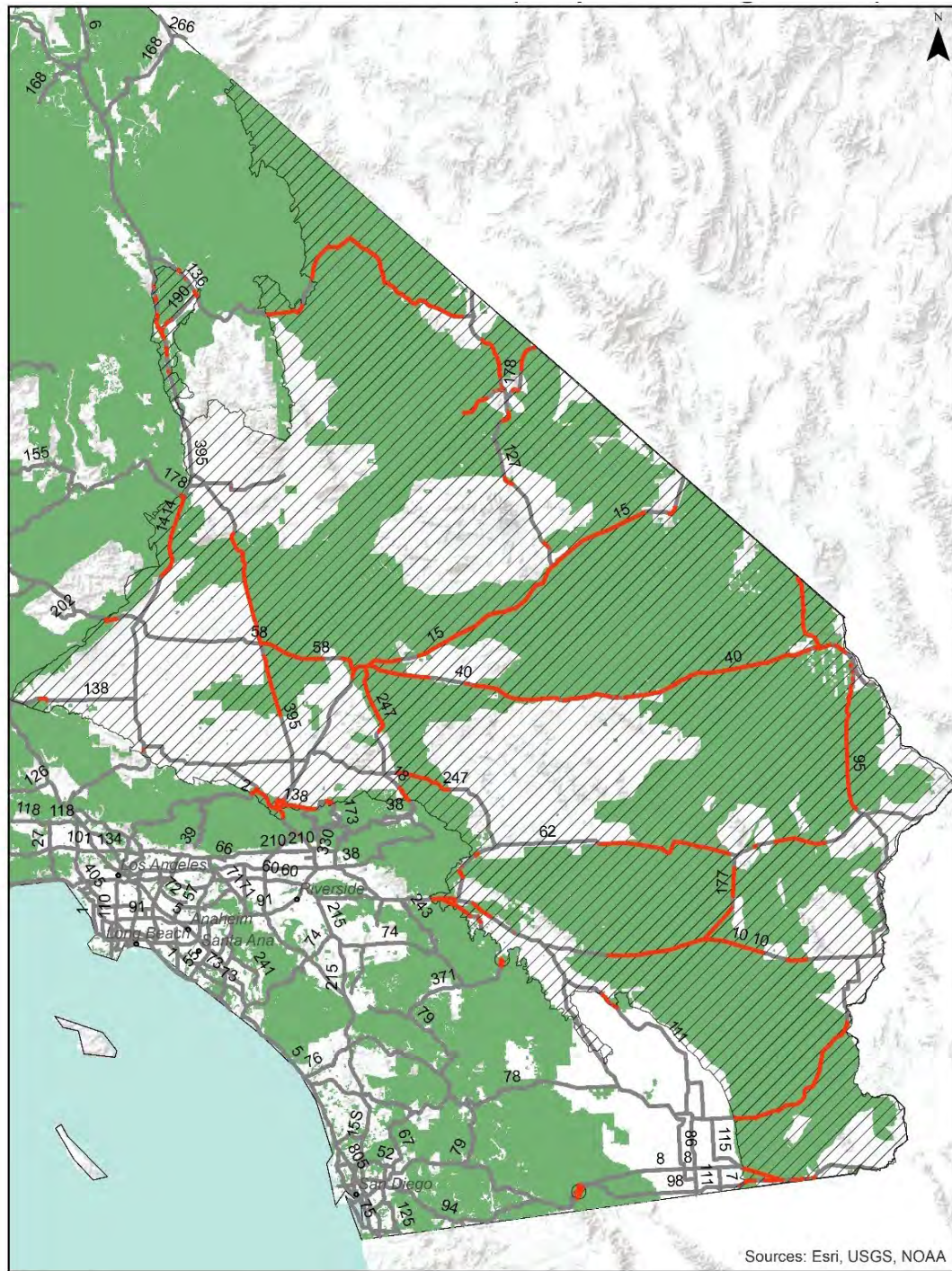


Figure 17. Highway Segments of Concern: Mohave Desert Tortoise (*Gopherus agassizii*)

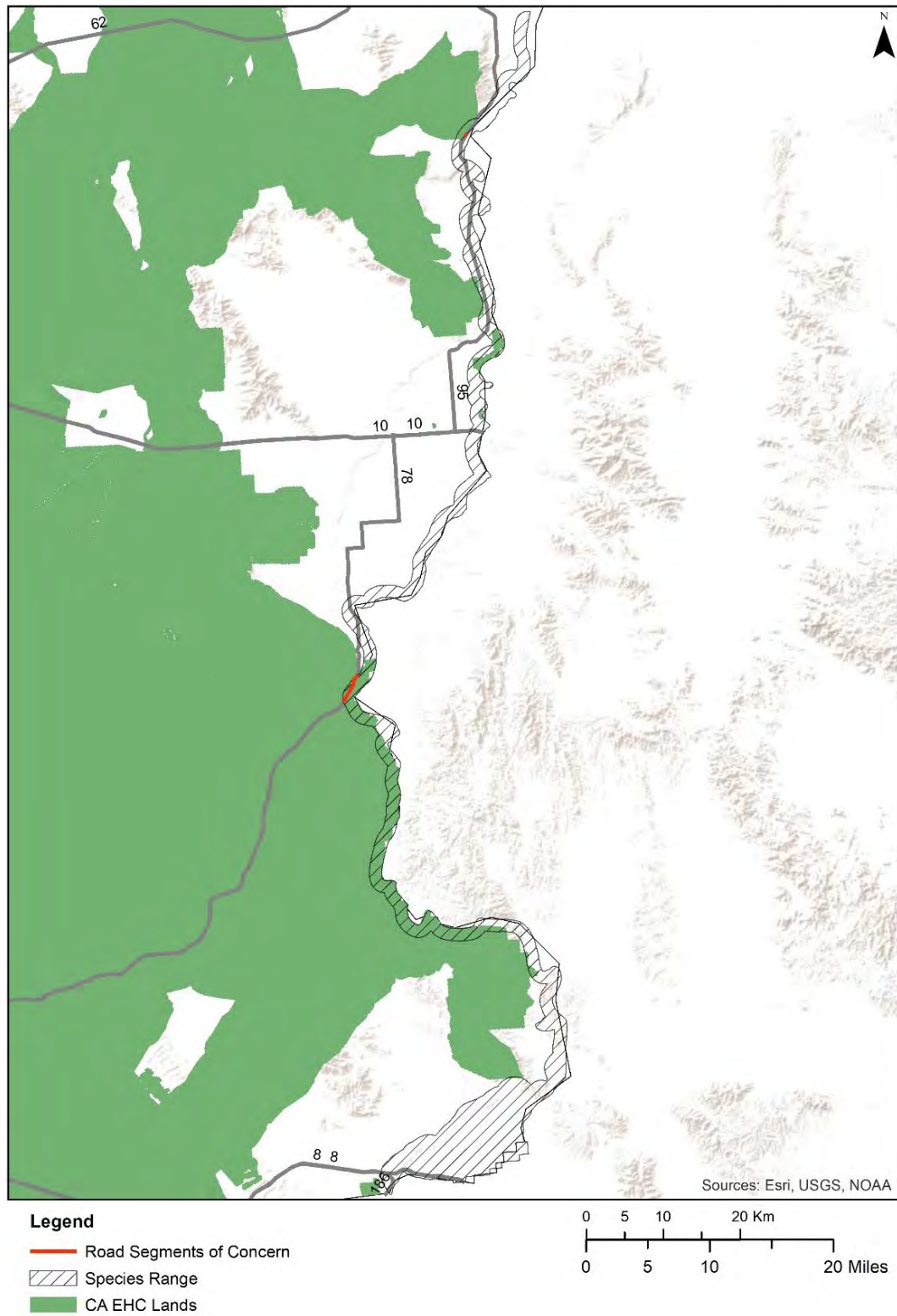


Figure 18. Highway Segments of Concern: Sonoran Desert Toad (*Incilius alvarius*)  
 Note: Possibly extinct in CA.





Figure 19. Highway Segments of Concern: Sonoran Mud Turtle (*Kinosternon sonoriense*)

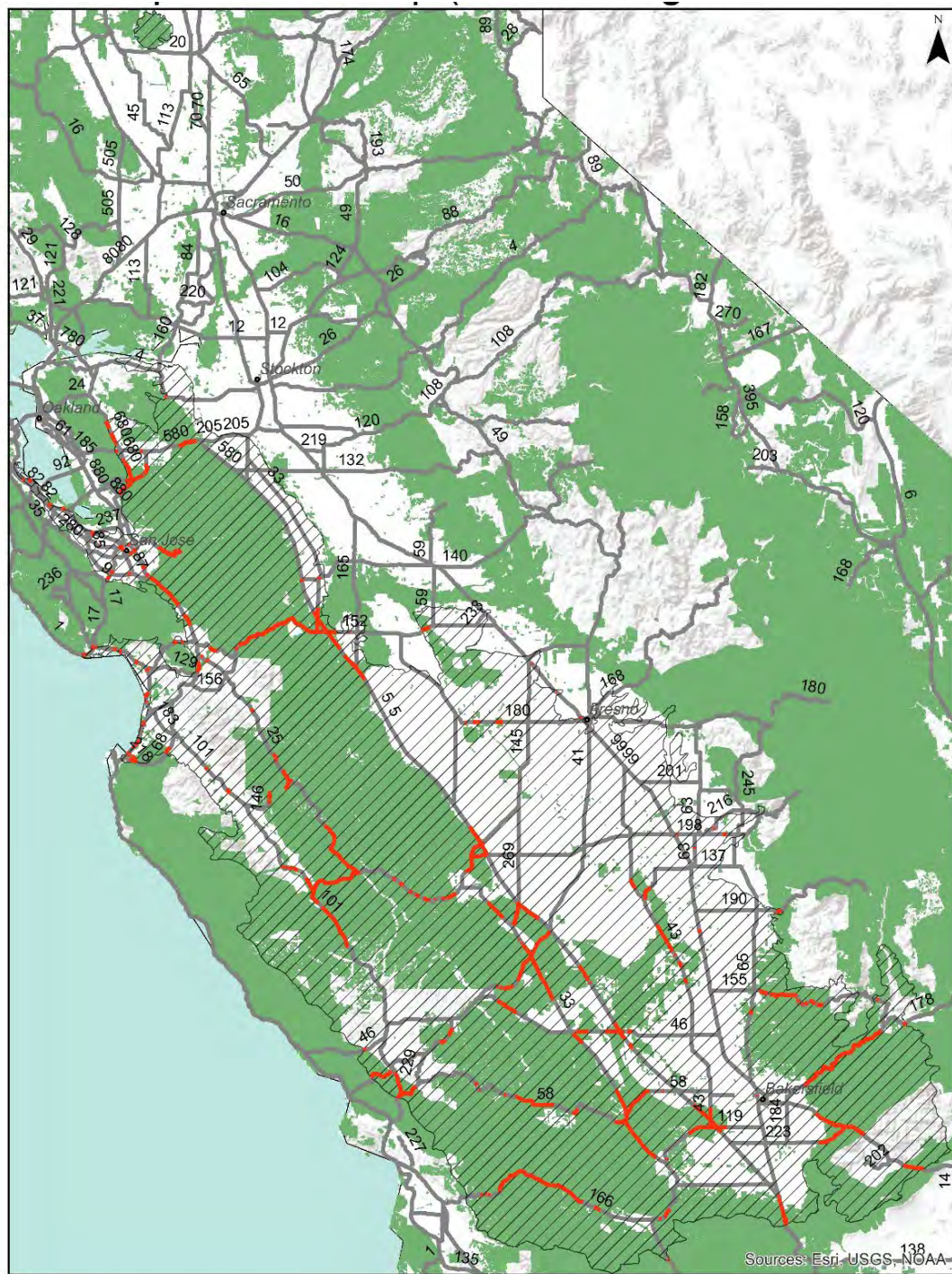


Figure 20. Highway Segments of Concern: San Joaquin Coachwhip (*Masticophis flagellum ruddocki*)





Figure 21. Highway Segments of Concern: Baja California Coachwhip (*Masticophis fuliginosus*)





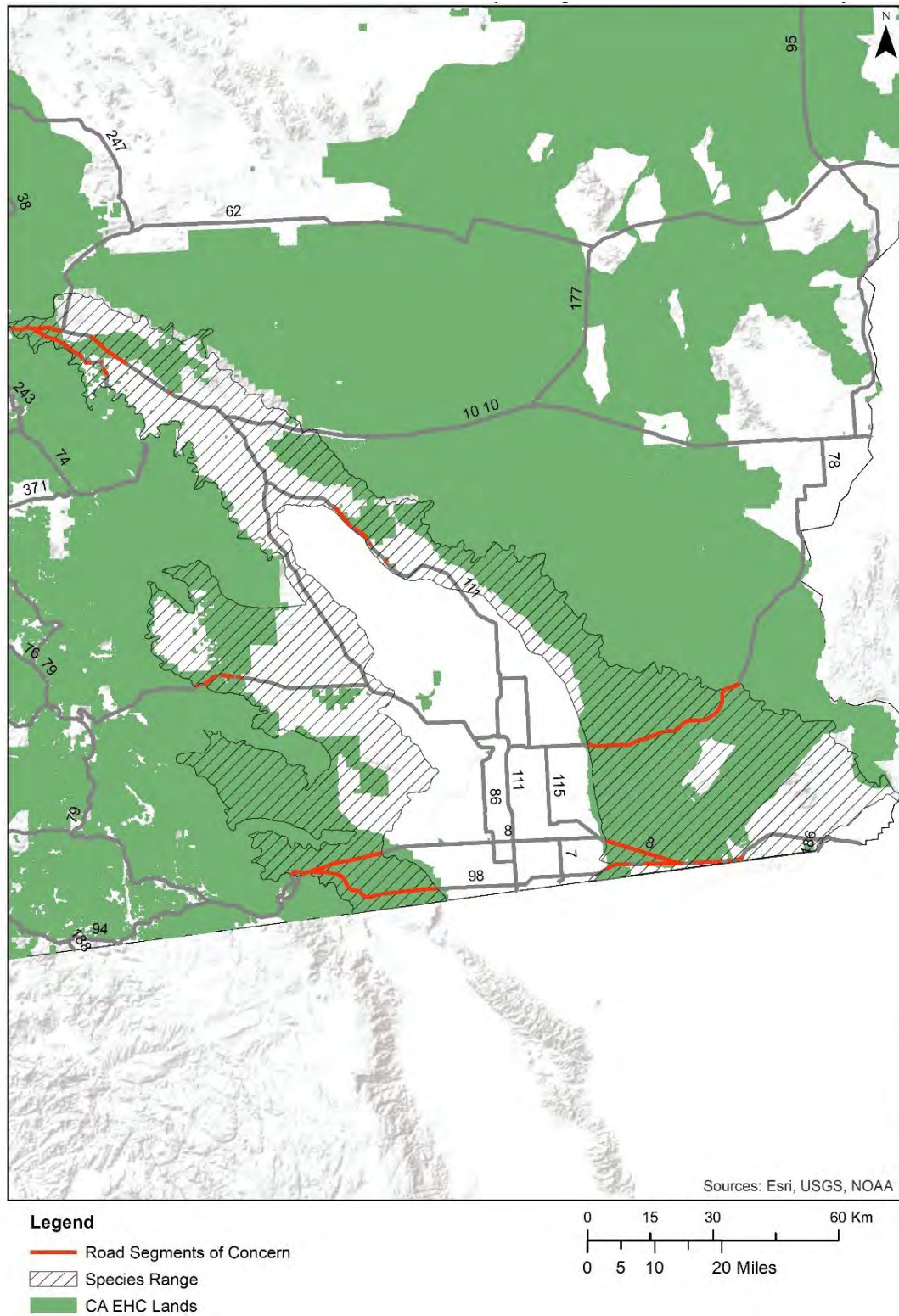


Figure 23. Highway Segments of Concern: Flat-tail Horned Lizard (*Phrynosoma mcallii*)

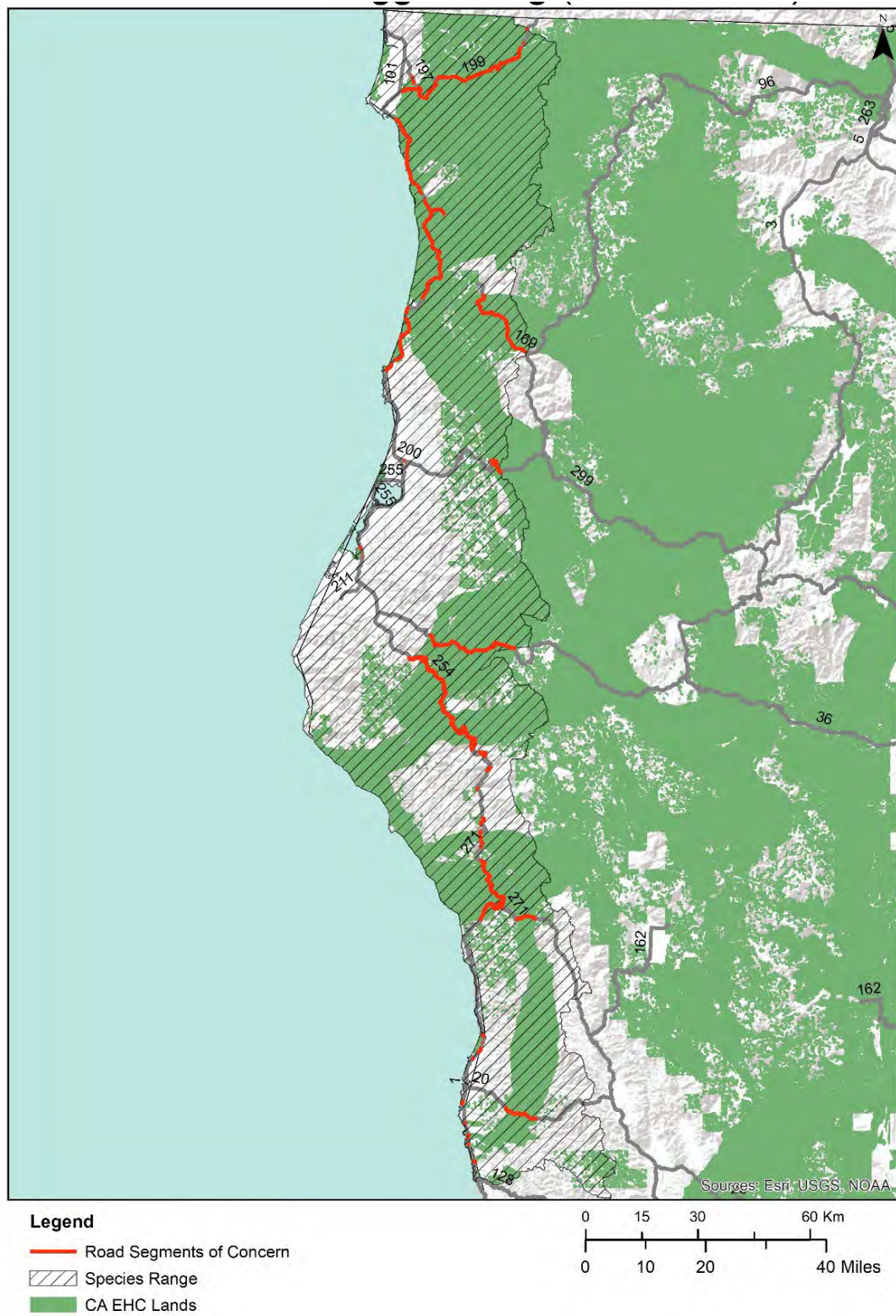


Figure 24. Highway Segments of Concern: Northern Red-legged Frog (*Rana aurora*)



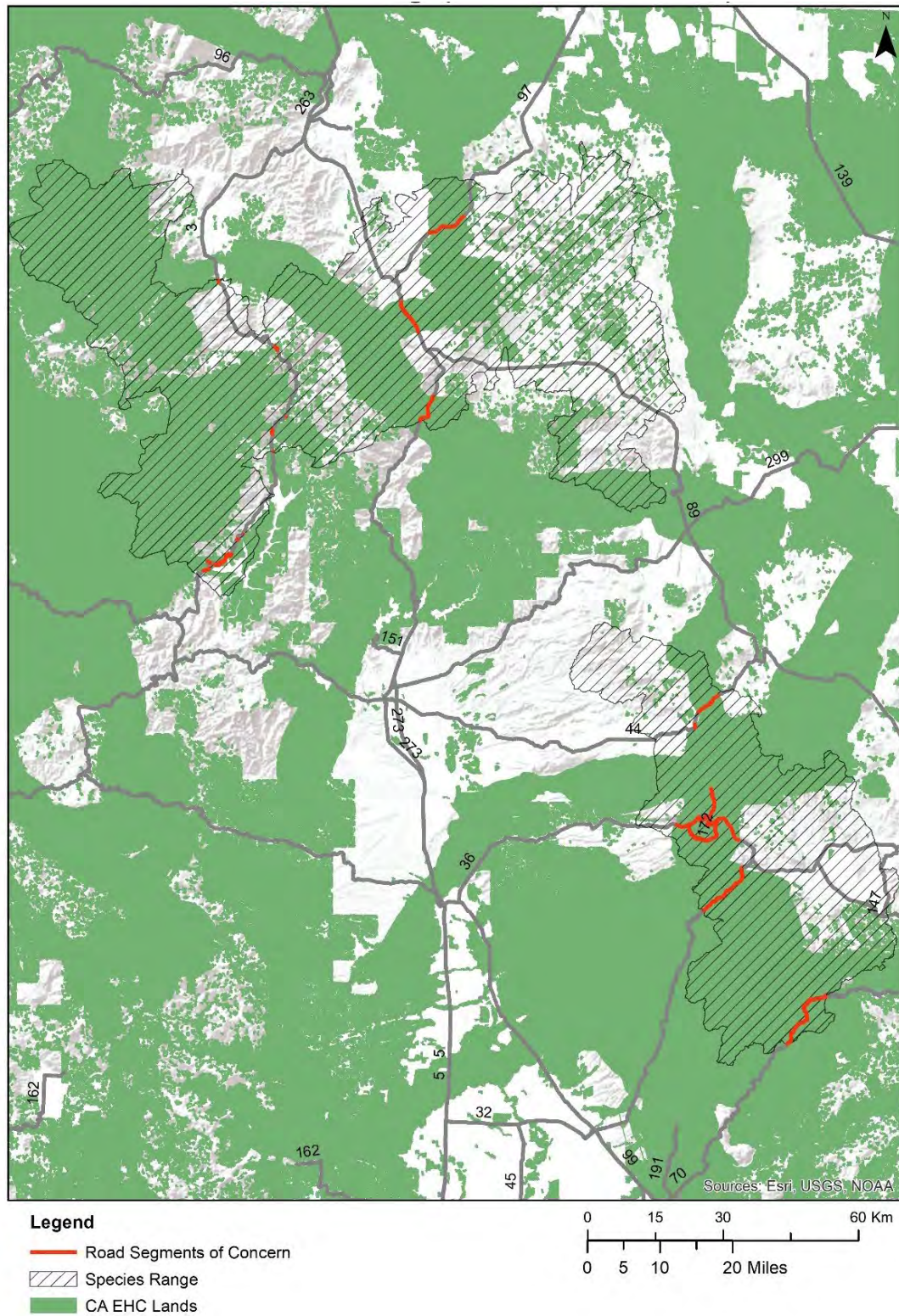


Figure 25. Highway Segments of Concern: Cascades Frog (*Rana cascadae*)





Figure 26. Highway Segments of Concern: California Red-legged Frog (*Rana draytonii*)



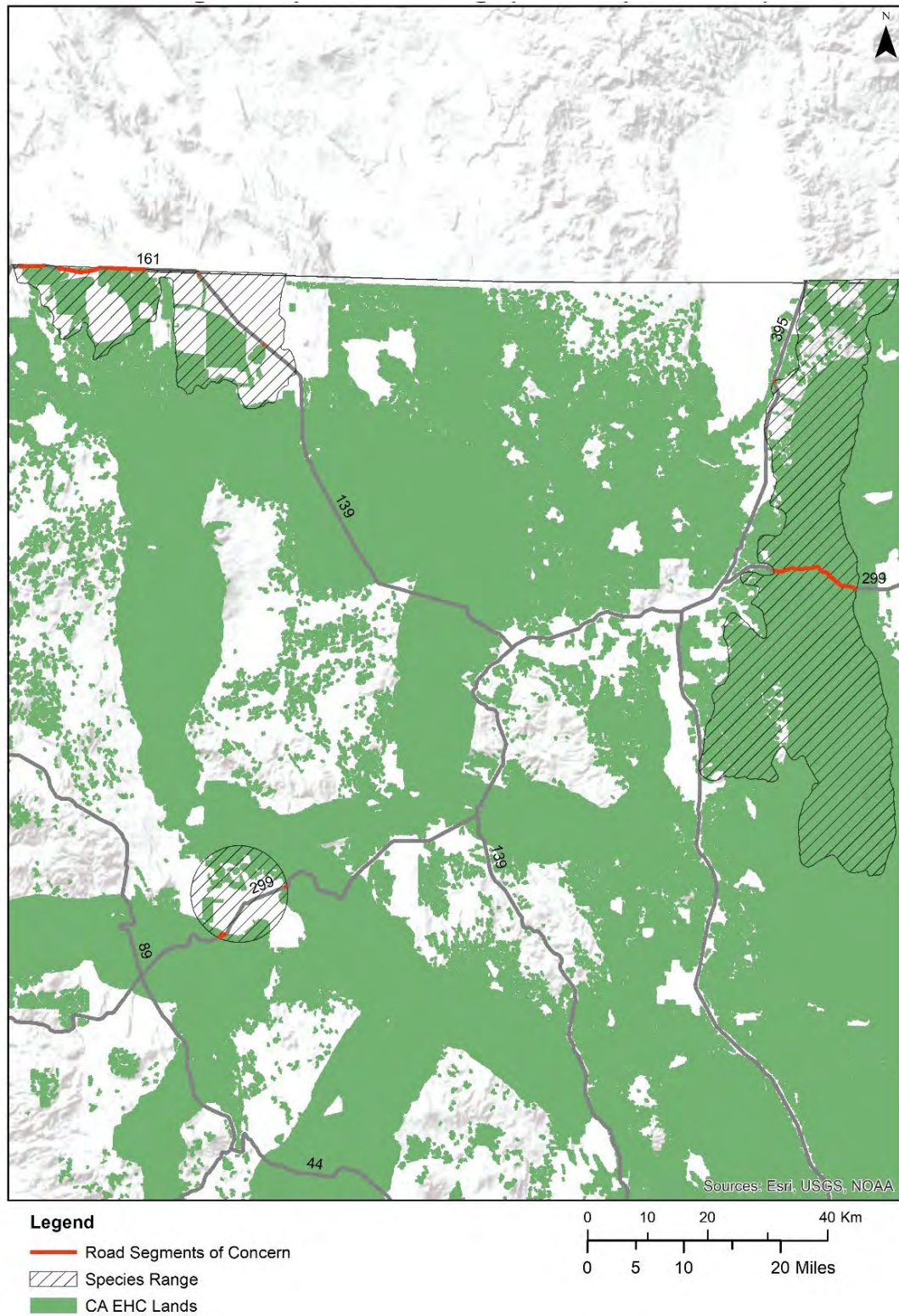


Figure 27. Highway Segments of Concern: Oregon Spotted Frog (*Rana pretiosa*)  
 Note: Possibly extinct in CA.

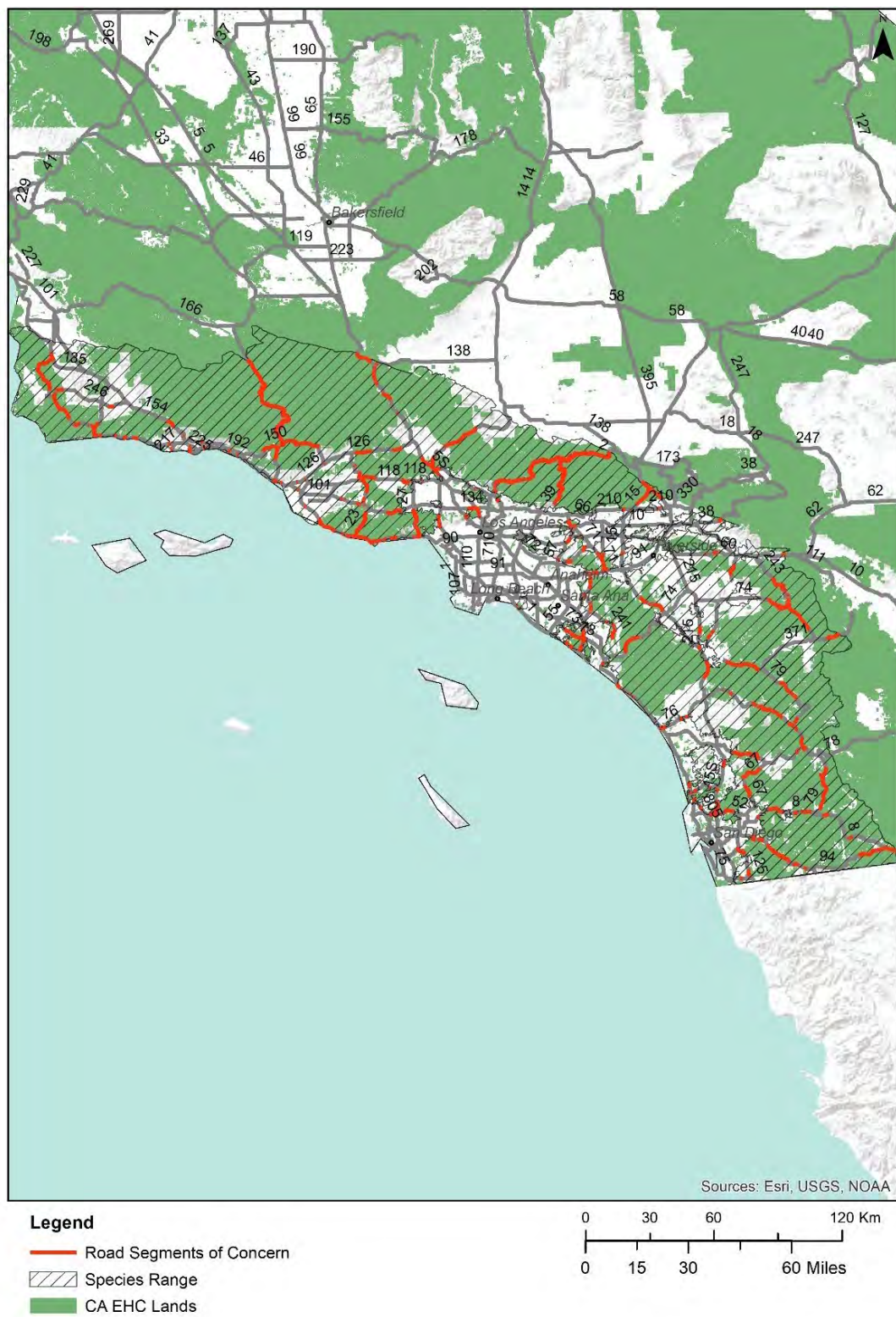


Figure 28. Highway Segments of Concern: Coast Patch-nosed Snake (*Salvadora hexalepis virgulata*)





Figure 29. Highway Segments of Concern: Western Spadefoot (*Spea hammondi*)



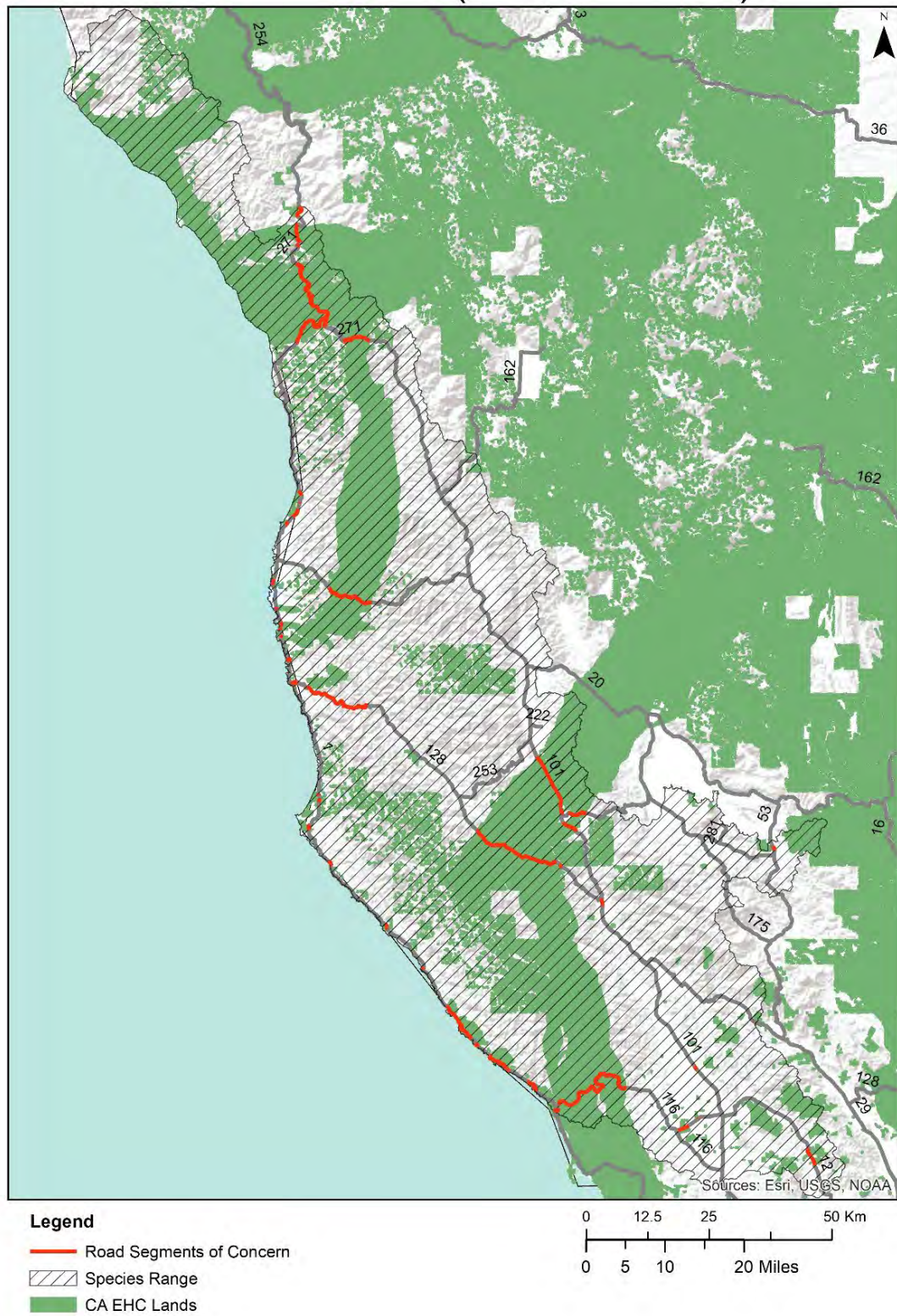


Figure 30. Highway Segments of Concern: Red-bellied Newt (*Taricha rivularis*)



**Legend**

- Road Segments of Concern
- Species Range
- CA EHC Lands

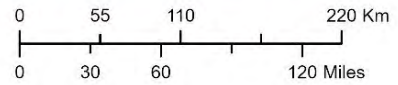


Figure 31. Highway Segments of Concern: Coast Range Newt (*Taricha torosa*)



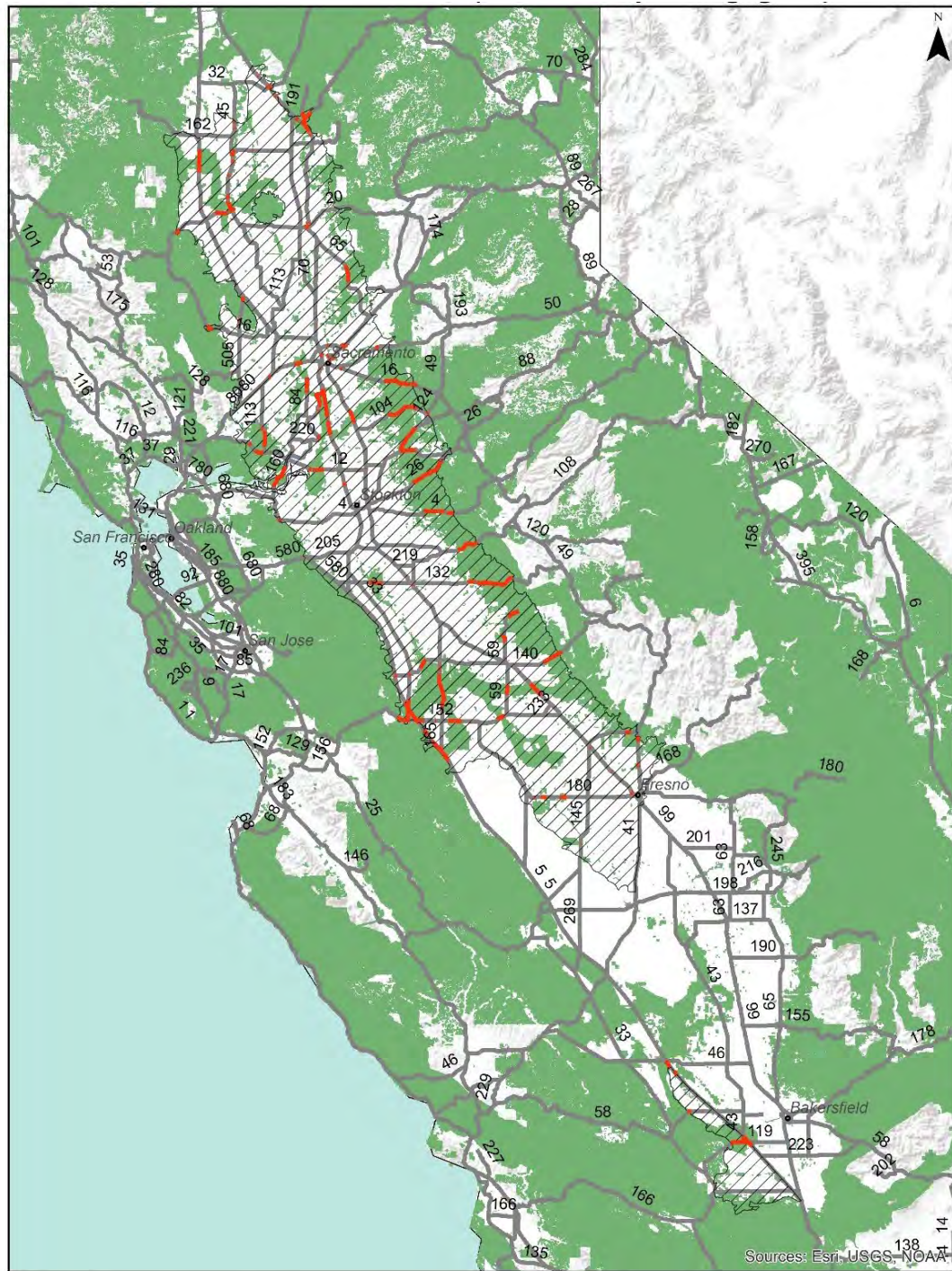


Figure 32. Highway Segments of Concern: Giant Gartersnake (*Thamnophis gigas*)



- Legend**
- Road Segments of Concern
  - / / / / Species Range
  - CA EHC Lands

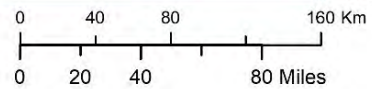


Figure 33. Highway Segments of Concern: Two-striped Gartersnake (*Thamnophis hammondi*)





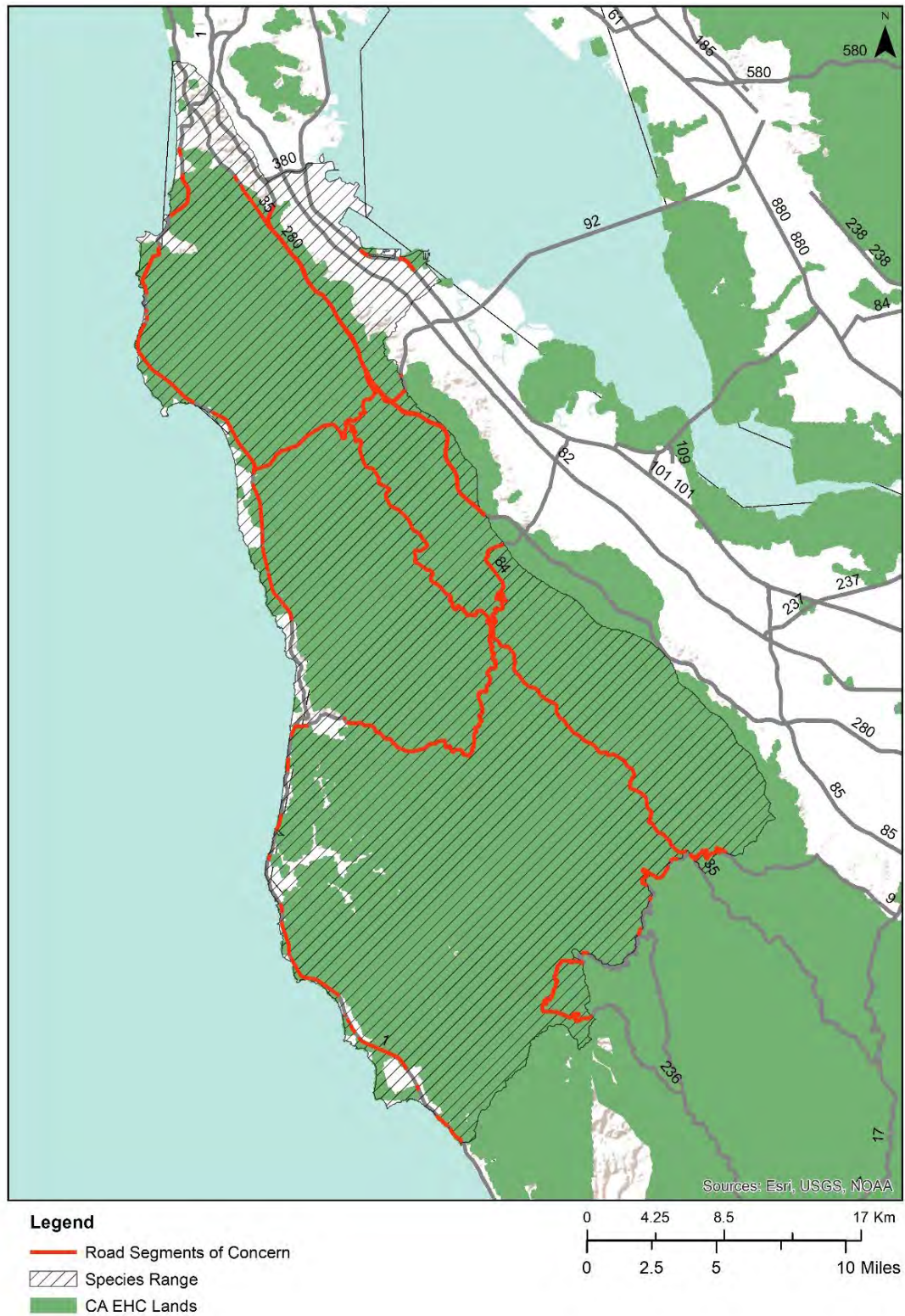


Figure 35. Highway Segments of Concern: San Francisco Gartersnake (*Thamnophis sirtalis tetrataenia*)



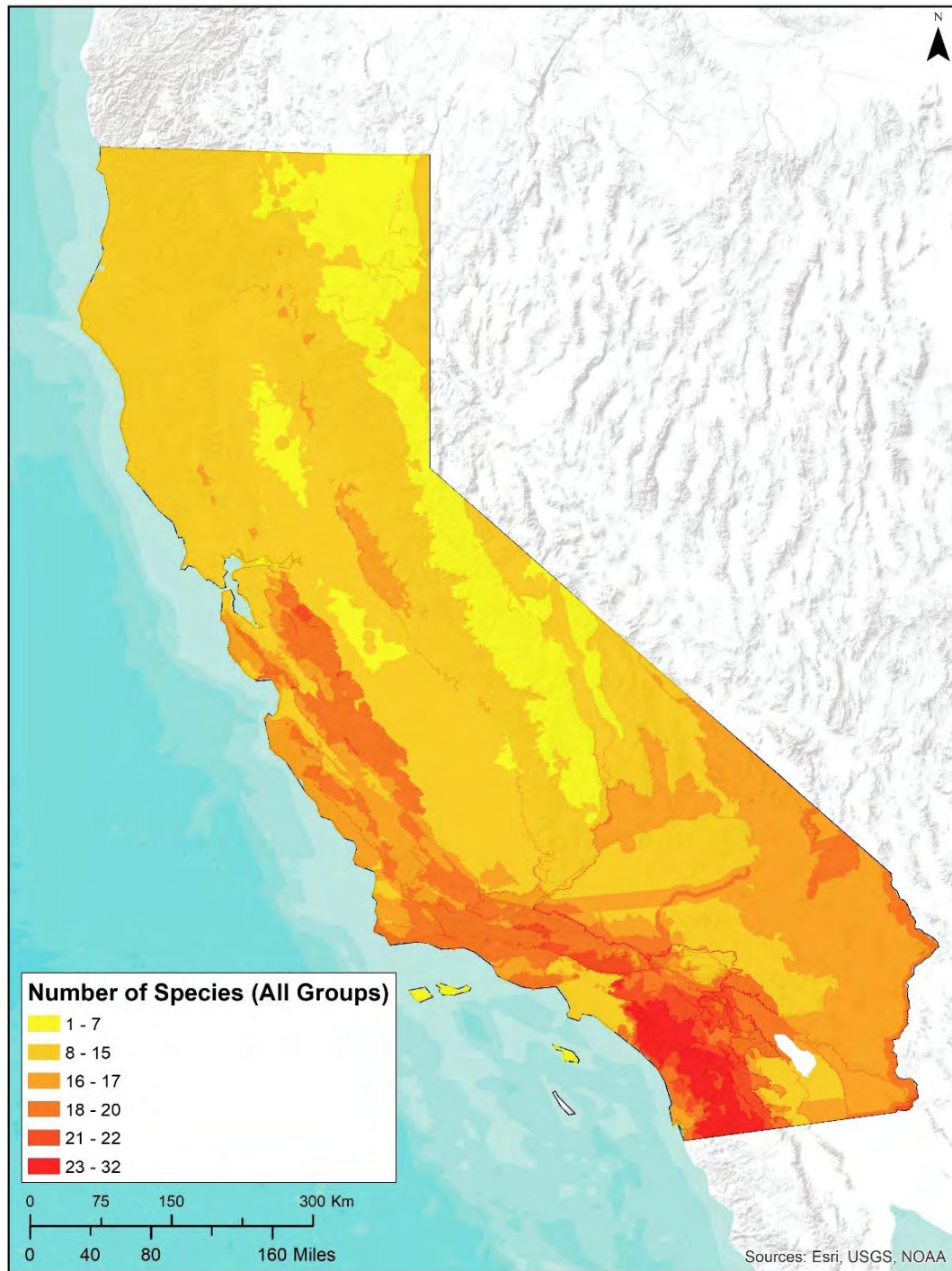


Figure 36. Range Density of Reptiles and Amphibians at High and Very-high Risk of Negative Road Impacts.



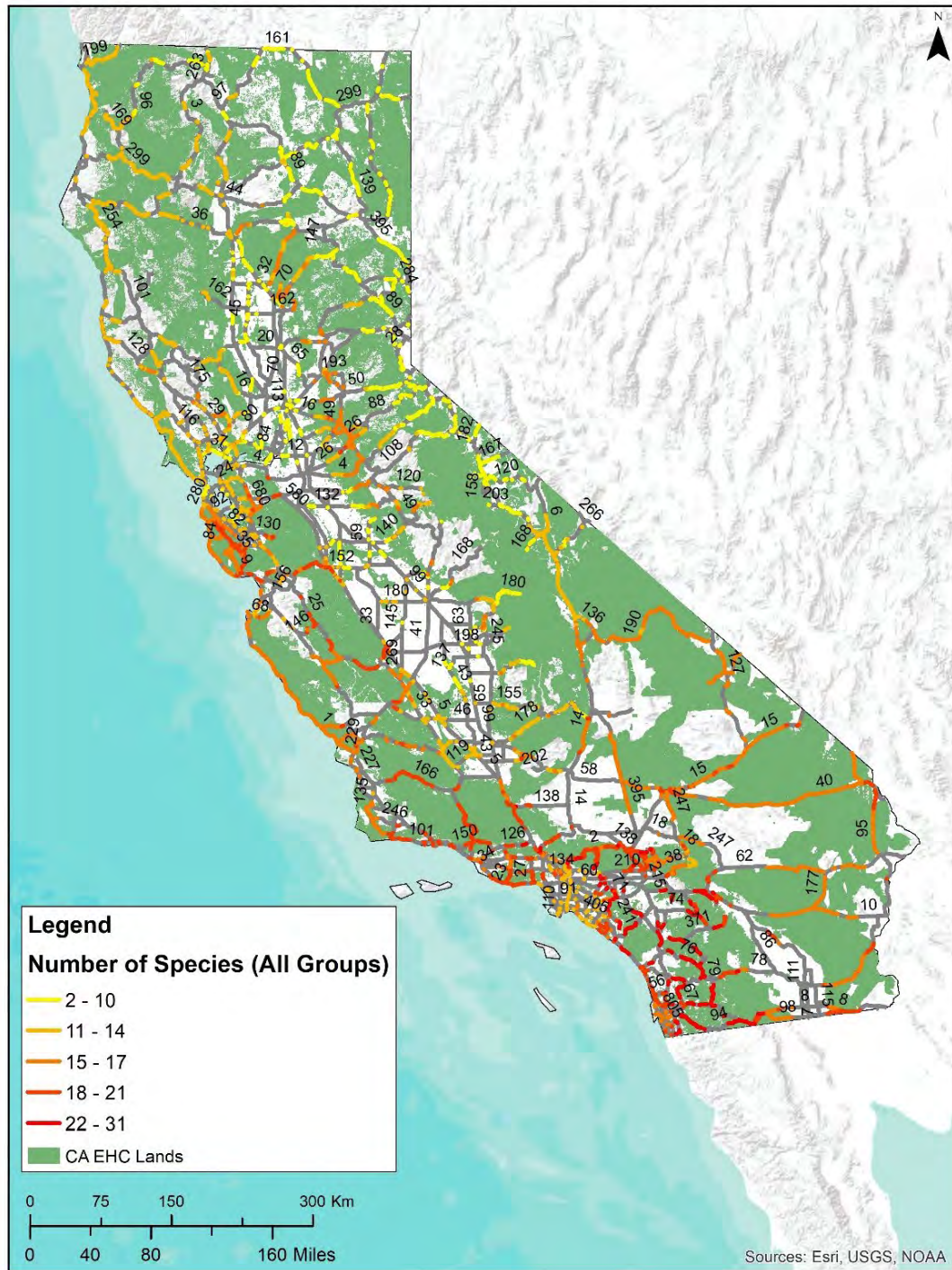


Figure 36. Range Density of Reptiles and Amphibians at High and Very-high Risk of Negative Road Impacts in Relation to California Highways

## References

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# Chapter 4. Movement of California Tiger Salamanders Along Barrier Fencing and Underpasses in Stanford, CA

Authors: Cheryl Brehme<sup>1</sup>, Jeff Tracey<sup>1</sup>, Brittany Ewing<sup>1</sup>, Michael Hobbs<sup>2</sup>, Tritia Matsuda<sup>1</sup>, Alan Launer<sup>3</sup>, Esther Adelsheim<sup>3</sup>, Robert Fisher<sup>1</sup>

<sup>1</sup>USGS Western Ecological Research Center, <sup>2</sup>Hobbs Ecology, <sup>3</sup>Stanford University

## Introduction

Many migratory amphibians make annual population level migrations among breeding wetlands and over-wintering and/or summer foraging upland terrestrial habitats. This requires high levels of connectivity among these habitats (Semlitch 2008, Hamer and McDonnell 2008, Hamer et al. 2015). Because roads often intersect these migratory pathways, all California migratory salamanders, toads and some frogs ranked in the highest risk categories for potential negative road effects, as analyzed by Brehme et al. (2018).

There is substantial evidence that habitat fragmentation and mortality due to roads negatively affect many of these amphibians. For instance, newts regularly migrate long distances over land between breeding ponds and terrestrial foraging habitats (2 km; Trenham 1998). Large numbers are found dead on roads during dispersal periods and newt species are often the first to disappear in fragmented landscapes (Gibbs 1998, Trenham 1998, Shields pers. comm.). Similarly, road mortality and habitat fragmentation are primary threats to the California tiger salamander and other Ambystomid salamanders because terrestrial habitat is used for interpond migration and overwintering (Semlitsch 1998, Trenham et al. 2001, Bolster 2010). There is also evidence that migrating bufonid toads are particularly susceptible to negative impacts from roads (Trenham et al. 2003, Orłowski 2007, Eigenbrod et al. 2008).

To reduce the negative impacts from road mortality on these vulnerable populations, it has been standard practice to build safe crossings in the form of small passages (e.g. culverts, tunnels, etc.) connected by barrier fencing as mitigation. There are a wide variety of small passages and barrier materials that have been constructed with varying degrees of success, although post mitigation monitoring is relatively rare (see review by Langton and Clevenger 2017). The permeability of tunnel systems to amphibian movement may be influenced by openness ratio ( $(\text{height} \times \text{width}) / \text{length}$ ), moisture and temperature conditions within the passage, noise and vibrations, and the correct placement of passages in the landscape (Jochimsen et al. 2004, Hamer et al. 2015, Langton and Clevenger 2017, Helldin and Petrovan 2019).

However, in addition to crossing success within the passage(s), the permeability of crossing systems to amphibian population movements is also dependent upon the proportion of migrating animals that even reach the passage opening. There is evidence that road mitigation systems with inadequate underpass spacing may filter movements of pond breeding amphibians (e.g. Langton 1989, Allaback and Laabs 2002, Pagnucco et al. 2012, Ottburg and van der Grift 2017, Matos et al. 2019). Individuals from a population of the common toad, *Bufo bufo*, in the Netherlands turned around or “gave-up” after an average of 50 m if they did not reach an underpass (Ottburg and van

der Grift 2017). The authors considered this the main factor causing a steep population decline in the five years after the tunnel and barrier system was installed. The extent of this potential problem with other mitigation systems and species is largely unknown.

Currently, little science is available in California to inform decisions about the number of crossings and spacing between crossings. Therefore, we studied whether this “giving up” behavior is exhibited in pond breeding amphibians in California, and if so, at what distances different migratory species (and age classes of species) give-up when moving along barrier fencing? This information could inform best management practices for underpass spacing for these species.

There is also some evidence that animals may spend more time trying to climb or interact with transparent fencing compared to solid fencing (Ruby et al. 1994, Milburn-Rodriguez et al. 2016). Therefore, we were interested in whether fencing opacity affects the probability or speed at which CTS and other amphibians find wildlife crossings. Finally, we were also interested in whether ‘turnarounds’ at fence ends may be effective in altering the trajectory of CTS movement.

We studied a population of California tiger salamanders (CTS: *Ambystoma californiense*) in Stanford, CA to investigate these kinds of behaviors. In this location, a busy two-lane paved road (Juniper Serra Blvd: ave. 17,300 vehicles per day; (City of Menlo Park 2017)) transects upland habitat and Lagunita Lake, a historic CTS breeding site. Large rates of CTS road mortality spurred the construction of a three-tunnel system (5 m apart) in 2003 with approximately 5–10 m of barrier fencing on each side. For our study, we expanded the footprint of existing barrier fencing 150 m in each direction using solid fencing in one direction semi-transparent mesh fencing on the other side.

We addressed the following questions in this study:

1. What is the probability a salamander will reach an underpass based upon the distance from the underpass an animal first encounters the barrier wall?
2. How quickly do CTS travel along the barrier wall toward the underpass?
3. How does the opacity of fencing effect the questions above?
  - a. Solid barrier (high-density polyethylene (HDPE-2); Animex®)
  - b. Semi-transparent barrier (water- permeable rigid polymer matrix; ERTEC® E-Fence, referred to hereon as “mesh”)
4. Are fence end ‘turnarounds’ effective in redirecting the trajectory of CTS movement?
5. Once CTS reach the tunnels, what is the permeability of the road crossing tunnel system to CTS passage?

## Methods

### Field Study

We studied the movement of CTS adjacent to three existing underpasses along Junipero Serra Blvd. in Stanford, CA (Stanford University) in the winter breeding seasons of 2017/18 and 2018/19. The road bisects a historic CTS breeding pond (Lake Lagunita) and upland CTS habitat (Figure 1).



Figure 1. Map of Barrier and Tunnel Study System at Stanford University Between Upland and Breeding Habitat for CTS.

A total of 300 m of barrier fencing was installed along the south side of Junipero Serra Blvd. (150 m in each direction); the new fencing was connected to 5 m of existing barrier fencing adjacent to three salamander tunnels (ACO Wildlife®). The tunnels, installed in 2003, are 14 m in length and spaced 5 m apart. One portion of the fencing installed was semi-transparent mesh (ERTEC® rigid polymer matrix) and the other portion was solid (Animex® high-density polyethylene (HDPE-2)). To minimize potential for vandalism, the fencing was placed within existing security fencing present on site. Jump-outs (ERTEC® cones and high berms) were installed a minimum of every 25 m along the fence to provide CTS and other small vertebrates a way to get back into the habitat if they ended up on the roadside of the barrier fencing. At outer fence ends, turnarounds were installed to redirect animals away from the road and back toward the upland habitat in a U-shaped fashion. The turnarounds were approximately 2 m long and 1 m in width. Fencing was installed with the bottom buried in the ground according to manufacturers' guidelines.



HALT<sup>®</sup> camera systems (Hobbs and Brehme 2017) were placed every 25 m along the new fence lines from 0 to 125 m from the existing tunnel system (Figure 2). Each 0 m camera was approximately 5–8 m from the closest tunnel opening where our newly installed fencing intersected with the existing barrier fencing.

At fence end turnarounds, HALT camera systems were placed above the fence end at the turn-around to record video of animals' movement trajectory after coming out of the turn-around. Due to evidence of CTS turning around but not being recorded on video, in 2019, we narrowed the terminal end of the turnaround from 1 m to approximately 0.35 m from the main fence creating a tear drop shape. This allowed us to install the HALT trigger at the turnaround opening so that we could record animals entering and exiting the turnaround. In 2019, we also placed these camera systems within each tunnel opening and exit to record tunnel permeability. Cameras were set whenever rain was predicted and checked on a weekly basis during the winter adult migration season from the uplands toward the pond (Nov.–Feb.). Each time we set and checked the cameras, we took a photo of a battery powered atomic clock in order to calibrate exact minutes and seconds upon processing. All work was performed under Stanford University Habitat Conservation Plan (Federal incidental take permit # TE182827-0) and California State Consistency Determination (2080-2016-001-03)

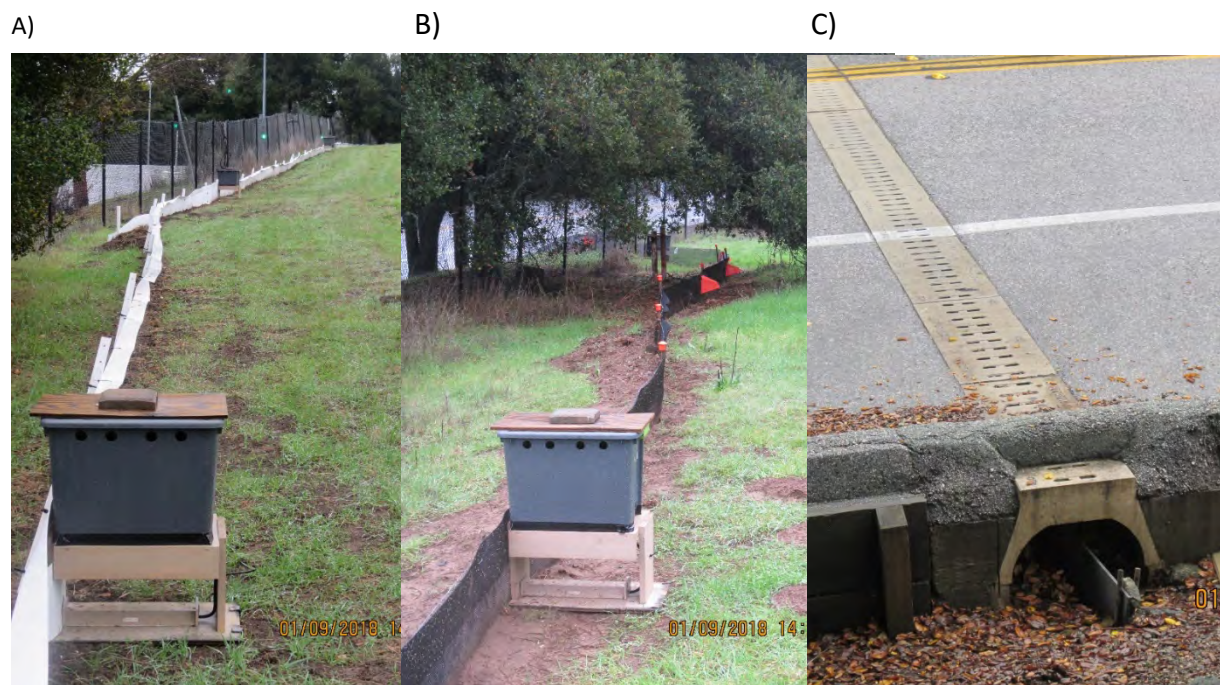


Figure 2. Solid (A) and Mesh (B) Fence Lines with Cameras Within Wood Structures and Plastic Bins Facing Down Toward HALT Triggers. Fencing Leads to a Series of 3 Tunnels Under the Roadway (C).

## Analysis

Photos of all CTS were analyzed using pattern recognition software to identify individuals by their unique spot patterns (I<sup>3</sup>S Spot; Van Tienhoven et al. 2007; Figure 3). Camera location, time, and direction of movement were recorded for each individual. Snout to vent length was measured with Program ImageJ (Rasband 1997–2018) using the 1 cm grids from the HALT trigger for calibration.

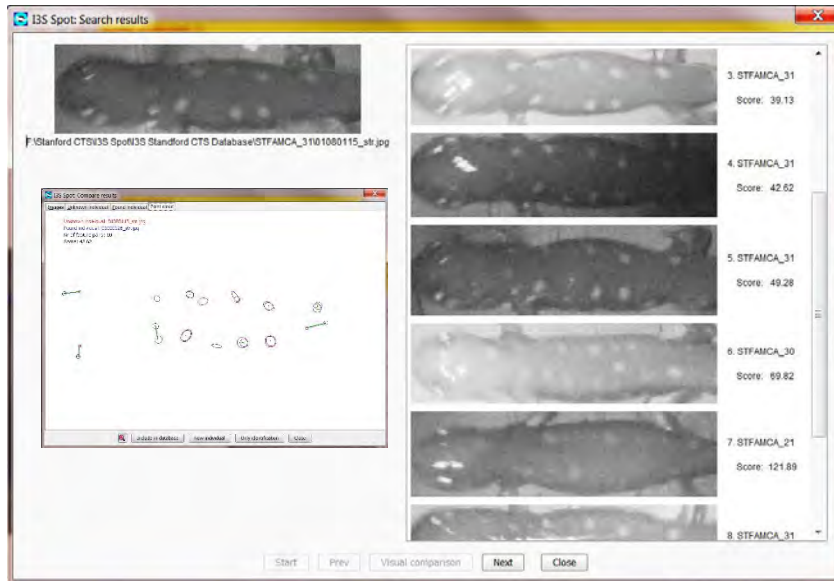


Figure 3. Example of CTS Identified to Individual Using I<sup>3</sup>S Software to Distinguish Spot Patterns (top 3 on right are same individual)

For individual CTS, we then calculated movement distances along the fence lines, numbers of turn arounds, speed, and “success” at reaching 0 m cameras next to underpass system. Because cameras were placed 25 m apart, our margin of error for estimating fence movement distance ranged between 0 and 25 m. For instance, if an animal was only detected at a single camera between 25 m and 125m, then our average estimated distance was 25 m (12.5 m before reaching the camera and 12.5 m after exiting the camera). Similarly, if an individual was detected at multiple consecutive cameras moving in the same direction, our margin of error was typically 25 m. In the instances where individuals were detected at consecutive cameras, we also calculated the movement speed between segments. If such an individual then turned around and was re-detected at a camera while moving in the other direction, we were able to estimate the distance travelled along the fence before turning around by multiplying the time between detections by its average speed. Because of this, if individuals travelled back and forth several times, we were able to more accurately estimate the total distance of fence line traversed (fence movement distance). If an individual reached the 0 m camera (where the experimental fence lines attached to the short length of existing fence), this was considered a “success” at reaching the passage system with no added error for distance moved afterward.

We used Markov Chain Monte Carlo (MCMC) implemented in the R programming language and the runjags package (Denwood 2016) to interface with JAGS (Just Another Gibbs Sampler) to sample values of all unknown parameters from the joint posterior distribution. In each case, four chains were sampled to perform standard diagnostics for convergence. In all cases, non-informative prior distributions were used for all parameters.

### Logistic Regression for Success in Reaching Underpass Opening

We modeled the probability of success of CTS in reaching the 0 m camera near the crossing opening. For this, we used a Bayesian approach to logistic regression modeling (Congdon 2006; Figure 4). The response was a Bernoulli random variable, where 0 indicates failure and 1 indicates success in being detected by the camera at the opening of the crossing (ReachedTunnel). The probability of success for the Bernoulli distribution is a logistic (i.e.  $p = \exp(y)/(1 + \exp(y))$ ) function of the linear component of the model that consists of four predictors (FenceType, InitLoc, InitAway, InitLocAway) and five parameters that include an intercept and a regression coefficient corresponding to each of the predictors. FenceType is a binary variable where 0 indicates a mesh fence and 1 indicates a solid fence. InitLoc is the position along the fence where the animal was first detected in meters from the crossing opening (with error described in the previous paragraph), InitAway is a binary variable where 0 indicates that the animal was initially moving toward the crossing and 1 indicates it was initially moving away from the crossing, and InitLocAway is an interaction (product of) InitLoc and InitAway. All predictors were standardized (the mean subtracted from each value and then divided by the standard deviation) prior to modeling. The priors for the parameters were non-informative normal distributions with mean 0 and 0.001 precision (i.e. a variance of 1000). The parameters were sampled from their posterior distributions using MCMC (as described above) and described by mean, median, and quantiles of their marginal distributions. This allowed us to assess the effect of each predictor on the probability of success.

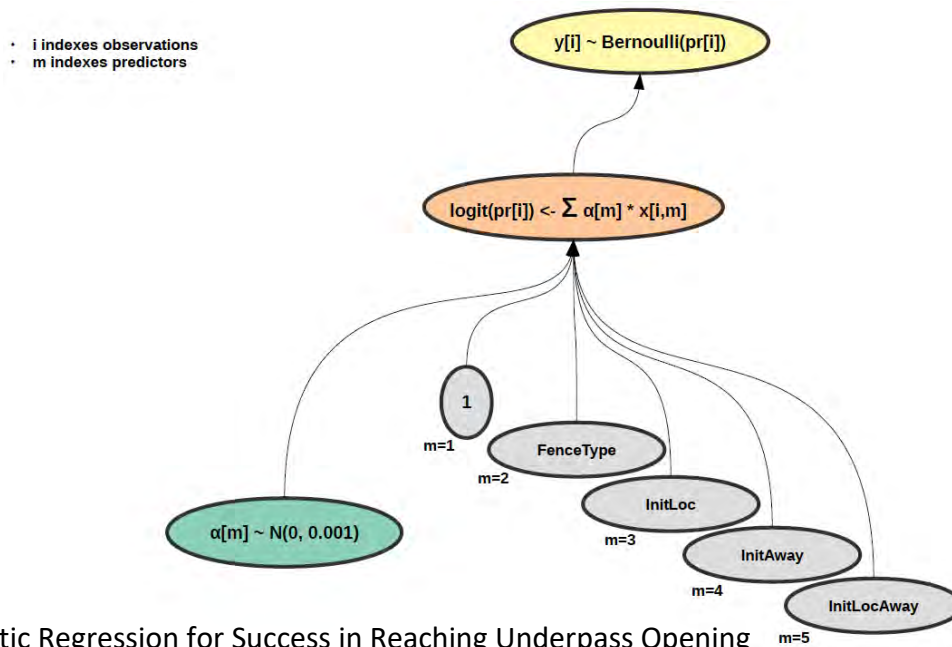


Figure 4. Logistic Regression for Success in Reaching Underpass Opening

### Gamma Regression for Distance Moved Along Fence

We also modeled the distance that CTS moved along the fence. We used a Bayesian approach to regression modeling of the probability of successfully reaching the underpass opening (Figure 5). The response was assumed to be a gamma distributed random variable, which is a continuous positive variable representing the distance the animal moved along the fence as described. The gamma distribution has a shape parameter, which we assumed to be independent of any predictors, and a rate parameter that we model as an exponential (i.e.  $\text{rate} = \exp(y)$ ) function of the linear component of the model that consists of four predictors FenceType, InitLoc, InitAway, ReachedTunnel, and six parameters that include an intercept and a regression coefficient corresponding to each of the predictors. All predictors, except for ReachedTunnel, were standardized prior to modeling. The prior for the shape parameter was a non-informative exponential distribution with a rate of 0.00001. The priors for the regression parameters for the rate were normal distributions with mean 0 and 0.001 precision (i.e. a variance of 1000). The parameters were sampled from their posterior distributions using MCMC (as described above) and described by mean, median, and quantiles of their marginal distributions. This allowed us to assess the effect of each predictor on the distance moved along the fence.

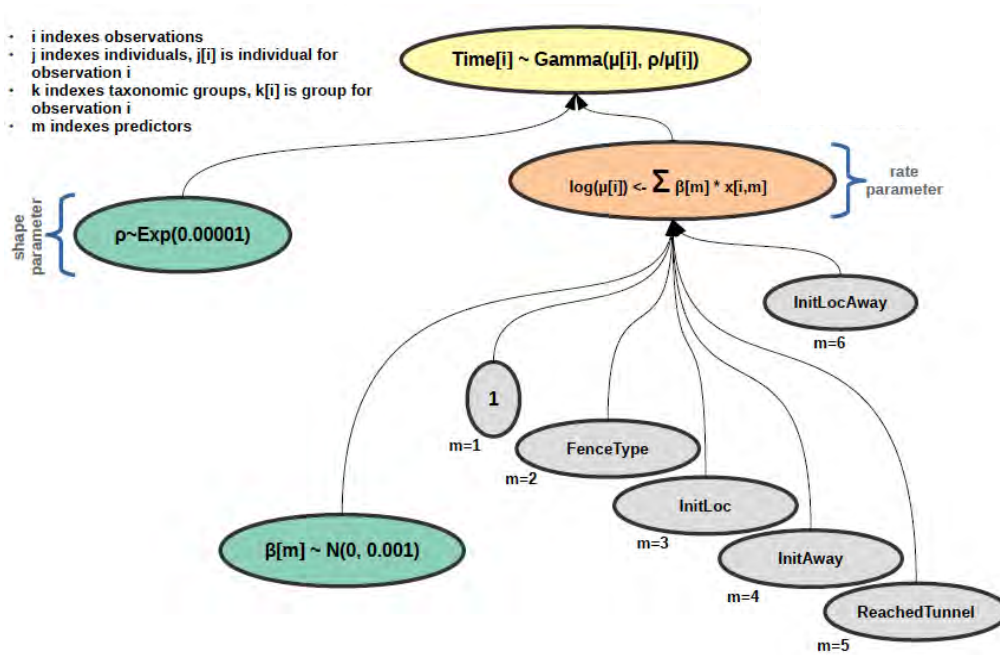


Figure 5. Gamma Regression for Distance Moved Along Fence

Tunnel System Permeability was calculated as the number of complete passes (individual detected at entrance and exit) divided by number of attempts. Other data, such as speed and turnaround rates, were also calculated.



## Results

We documented 41 adult CTS over 4 nights in 2018 and 50 adults over 18 nights in 2019 moving along the fence-line. We did not compare individuals between years, and therefore, considered individual movements from 2018 and 2019 as independent in the analysis. Total precipitation during the winter months from November to March was 3.7 in. and 27.0 in. for 2018 and 2019, respectively (World Weather Online; Palo Alto). The average winter rainfall is 13 in. (Western Regional Climate Center Stn 046646-4). The Stanford University Conservation Program observed no recruitment in 2018 but confirmed high recruitment of CTS in 2019 (A. Launer and E. Adelsheim, pers. comm.).

Of the 91 CTS movements, 37 were along the solid fence line and 54 were along the mesh fence line. Fifty-six percent of CTS moved an estimated 25 m or less. Mean fence movement distances averaged approximately 40 m and did not differ by fence type. However, CTS movement speed was 43% slower and CTS changed direction an average of three times more frequently along the mesh fence than the solid fence (Table 1, Figure 6). Upon reaching the fence, 64% of CTS initially turned and moved in the direction of the passage system while 36% initially moved away from the passages. Two out of the three CTS that reached the fence ends 150 m from the passage system turned around and were subsequently documented on another camera 25-125 m away continuing to move back along the fence line.

Table 1. CTS Movement Metrics by Fence Type

Fence Type	Sample Size	Fence Distance (m)		Movement Speed (m/min)*		Direction Changes (turnarounds/25m)	
		Mean	90% CI	Mean	90% CI	Mean	90% CI
Solid	37 (14*)	41.8	32.0- 47.8	2.1	1.7-2.5	0.13	0.04- 0.23
Mesh	54 (26*)	39.3	34.5- 42.2	1.2	1.0-1.4	0.41	0.15- 0.67

\*individuals that passed more than one camera where movement speed was calculated

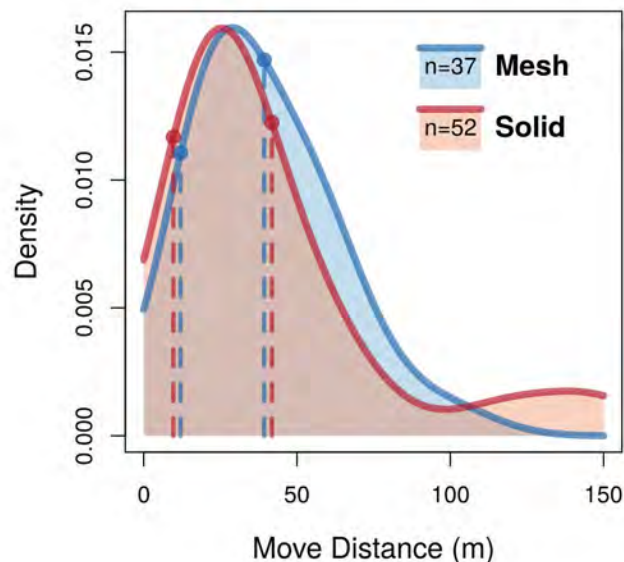


Figure 6. Distributions of Movement Distances by Fence Type. Lines Represent the Mean and Lower 90% Confidence Level Based on Cumulative Density of Observed Data.



The linear regression modeling indicates CTS moved longer distances if they encountered the fence farther away from the tunnel system. However, this was only if their initial direction choice was toward the tunnel system (Figure 7). There was no difference in predicted move distances for those CTS that encountered the fence and initially turned in the “wrong” direction

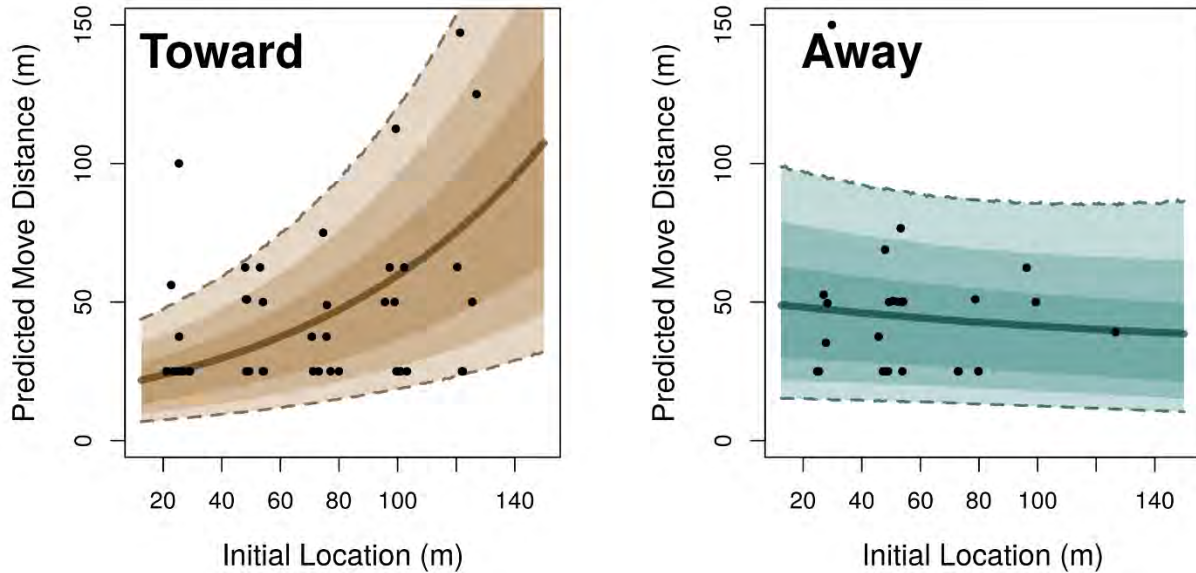


Figure 7. Movement Distance by Initial Location and Direction of Travel (Toward or Away from Underpass) with 90% Confidence Intervals.

The probability that CTS reached the tunnel system (0 m camera) decreased rapidly with increasing distance from the tunnels and was also highly dependent upon their initial direction choice. The average predicted probability of an individual reaching the tunnel system if the CTS encountered the fence at a distance of 25 m and was moving toward the tunnels was 0.48. This was reduced to only 0.15 if the CTS was initially moving away from the tunnels. Model estimated probabilities of success were lower along the mesh fencing than solid fencing, but fence type was not a significant predictor of success at reaching the underpass system (Table 2, Figure 8).

Table 2. Predicted Probabilities of Reaching Underpass by Initial Location and Direction of Travel (Toward or Away from Underpass)

	Solid Fencing				Mesh Fencing			
	TOWARD Underpass		AWAY from Underpass		TOWARD Underpass		AWAY from Underpass	
Initial Distance	Probability of Success	90% CI	Probability of Success	90% CI	Probability of Success	90% CI	Probability of Success	90% CI
12.5	.76	.57- .91	.35	.11- .64	.60	.37- .81	.20	.05- .42
25	.59	.38- .79	.21	.04- .46	.40	.21- .61	.11	.02- .24
50	.24	.08- .44	.07	.00- .25	.13	.04- .26	.03	.00- .10
75	.07	.01- .19	.03	.00- .15	.03	.00- .09	.01	.00- .06
100	.02	.00- .07	.02	.00- .10	.01	.00- .03	.01	.00- .04
125	.01	.00- .03	.01	.00- .06	.00	.00- .01	.00	.00- .02

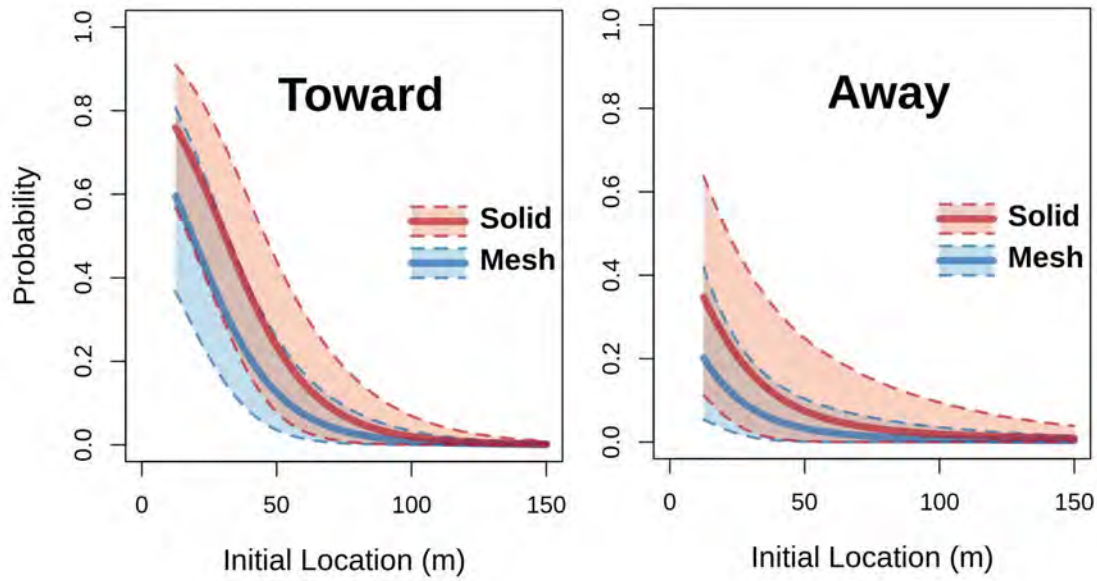


Figure 8. Probability of Reaching Underpass by Initial Location and Direction of Travel (Toward or Away from Underpass) with 90% Confidence Intervals.

Based upon timing, speed, and diagonal views of CTS entering and exiting the tunnels, we estimate that 5 to 11 out of the 51 CTS we documented traveling along the upland fence lines passed through the tunnel system from upland habitat toward the lake and 11 to 16 CTS entered the tunnels in the 20 m wide passage system without ever interacting with the fence. Once CTS entered a tunnel, there was a very high probability of them making it to the other side (0.89). Speed of passage through the tunnels was consistent with the speed at which CTS moved along the solid fencing (Table 3).

Table 3. Underpass System Permeability Metrics (2019)

No. CTS entered	No. CTS turned around	No. CTS successful passage	Tunnel System Permeability	Average Individual Passage Time (min:sec)		Average Passage speed (m/min)	
				Mean	90% CI	Mean	90% CI
41 <sup>a</sup>	4	33 <sup>b</sup>	0.89	6:33 <sup>c</sup>	4:48- 8:18 <sup>c</sup>	2.1 <sup>c</sup>	1.5- 2.8 <sup>c</sup>

<sup>a</sup> 4 CTS unknown if complete passage due to camera battery failure

<sup>b</sup> 22 CTS passed from upland to lake, 10 CTS passed from lake to upland, 1 CTS passed 3x from lake to upland to lake to upland

<sup>c</sup> a single passage time of 11 hours 18 min was excluded. Only CTS individual that spent day in passage.

## Discussion

Our results showed that a relatively small proportion of the CTS that were documented migrating from upland habitat reached the passage system leading to breeding habitat at Lagunita Lake. CTS moved an average distance of 40 m along barrier fencing before “giving up” and their probability of making it to the passage system decreased rapidly with increasing distance from the tunnels.

The average distance moved by an individual CTS was 40 m. Approximately half of the individuals moved longer distances and half moved shorter distances before “giving up.” This did not mean that all individuals moved along the barrier fencing in one direction and then either made it to the tunnel or gave up. Many individuals moved back and forth along the fencing and the 40 m represents the average span of total fence distance moved. Although this was an average, we estimated a fence span distance of less than 12.5 m would encompass 90% of population movements from the movement density distribution. Because our cameras were set 25 m apart, we were unable to estimate the specific distance with high confidence. Our logistic model predicted that 66% of individuals encountering the fence at the median distance of 12.5 m would successfully reach the tunnel system if headed toward the passage. For suggesting minimum distances between passages across a migratory pathway, we assume that either direction a CTS turns, it will encounter a passage. Therefore, these results suggest that underpasses spaced less than 12.5 m from one another along CTS migratory pathways could provide a high level of connectivity to the population. Future studies with cameras placed closer together will allow for more precise estimates for targeted levels of permeability.

In addition to distance moved, the direction the salamanders turned when reaching the barrier fencing was a large factor in whether they reached the passage system. CTS that reached the barrier fencing and then travelled in the wrong direction (away from the passages) were significantly less likely to reach the crossing than CTS that made the correct initial direction choice. In fact, CTS that made the correct initial direction choice were also more likely to travel longer distances to reach the passages.

Other studies have estimated average movement distances of migrating long-toed salamanders along fencing to be 27 m or less (Allaback and Laabs 2003, Pagnucco et al. 2012). These results are consistent with our findings and it would be expected that CTS move farther based upon their larger body size and longer migration distances. It is possible that not all CTS were making migratory movements during our study, as they may have been foraging. However, in that case we would expect to document the same individuals on multiple dates along the fence line which was rare in our study (2 out of 91 individuals). This was the first study to passively monitor individual movements of amphibians along fencelines and tunnels using new active trigger camera traps (HALT; Hobbs and Brehme 2017).

Previous studies have employed capture-recapture by hand and with pitfall traps to actively track individuals (Allaback and Laabs 2003, Pagnucco et al. 2012, Ottburg and van der Ree 2019, Matos et al. 2019). These active methods can potentially alter animal behavior, direction, speed, movement distances and require subsampling over the active period of the target species. Matos

(2019) successfully used hand capture-recapture and fluorescent dye to track short distance foraging movements of newts (<26 m), however this method is not effective for monitoring movements over longer distances or time periods (e.g. Eggert 2002, Brehme et al. 2013). The use of these cameras coupled with individual identification by spot patterns allowed us to passively monitor species movements across the entire season along the fencing and underpasses unaffected by human presence. By calibrating cameras to atomic clocks, we were able to monitor not only distance but the precise speed of all individuals that passed by more than one camera.

It is also relevant to note that the barrier fencing was placed along a slightly curved road that created an approximate 10 to 20 degree angle leading to the passages and was perpendicular to the assumed main migratory path. Caltrans best management practices and others recommend installing barrier fencing at an angle into the habitat (“V” shaped toward the tunnel) in order to better lead migrating amphibians toward the tunnels (Federal Ministry of Transport 2000, Iuell et al. 2003, Schmidt and Zumbach 2008, Clevenger and Huijser 2011, Gunson et al. 2016, Langton and Clevenger 2020). There have not been any published studies we are aware of that directly compare the success of these configurations. However, the use of more directional fencing at a greater angle is expected reduce the proportion of individuals moving in the wrong direction away from the passage entrance. This configuration would also be expected increase movement distances along fencing because it is closer to the trajectory of the migrating amphibians. For these reasons, it is estimated that distances between passages can be farther apart with more directional fencing than with perpendicular fencing to accomplish the same level of permeability (e.g. Langton and Clevenger 2020). However, these “V” shaped configurations typically require planning of multiple passages that are spaced apart across an entire migratory pathway. In this case, there is a single crossing structure of 3 passages and placing fencing at greater angles would have excluded a substantial amount of upland CTS habitat.

If fencing must be set parallel to the roadway along an easement, it is possible that small turnarounds placed at frequent intervals along the fencing would be effective in turning individuals moving away from the tunnels in the right direction closer to the tunnel system (rather than only at fence ends). Turnarounds were shown to be effective for two out of three individuals that reached the fence ends in our study and have been shown to be effective at changing the initial trajectory of movement for lizards, snakes and toads in San Diego (Chapter 7). Future studies on the effects of multiple turnarounds are planned for this and other study sites.

The transparency of fencing (mesh vs. solid) did not significantly affect the movement distances or probability of CTS making it to the underpass system. However, the speed and time of travel were significant by fence type. CTS moving along solid fencing moved at almost twice the average speed and were 3 times less likely to turn around and repeatedly move back and forth. This indicates that CTS moving along fencing that they can see through results in them expending a higher amount of energy to make it to the crossing. We and others have shown in other studies (Ruby et al. 1994, Milburn-Rodríguez et al. 2016, Chapter 6) that animals interact with transparent fencing with behaviors such as poking, attempting to climb, and moving back and forth. Higher energy and time expenditures of these behaviors may have negative impacts on breeding success (Carr 2011, Navas et al. 2016). However, mesh fencing has benefits in ease of installation,

increased permeability to wind and water, and reduced temperature and wind differentials from the surrounding environment (Boyle et al. 2019, Langton and Clevenger 2020). In concurrent studies on lizards, snakes and toads (Chapter 6), we have found that addition of a visual barrier along the bottom edge of the fence is effective in both reducing these fence interaction behaviors and increasing the speed of movement to that comparable to a full solid barrier. The potential use of visual barriers should allow flexibility in choosing fence materials for amphibian crossing systems. We intend to test this as part of a Before-After Control-Impact study at the Stanford CTS site.

Therefore, the likelihood by distance that animals reach a passage can inform the planning and spacing of crossing systems for migratory amphibians and other migratory species. Without considering this, it is possible that barrier effects of the mitigation could be worse to survivorship and connectivity than the original road mortality problem (Jaeger and Fahrig 2004, Ottburg and van der Grift 2017). This applies when high connectivity is important for the persistence of the population, such as with migratory amphibian species that must make population level movements between upland and breeding habitats (Semlitsch 2008, Hamer and McDonnell 2008, Hamer et al. 2015).

Finally, CTS that did reach the opening of the underpass system at Stanford University had a very high probability (89%) of making a complete crossing to the other side. The tunnels in our study were specially built for amphibians in that they are made of inert materials and incorporate a grid ceiling to allow natural light, moisture and rainfall to permeate the length of the passage. These have been shown to be highly permeable to amphibian movement in other locations, particularly throughout Europe (see review by Langton and Clevenger 2017). Maintenance of barrier fencing and tunnel systems is important for long term success. This includes regular inspection and repair of fencing, maintenance of vegetation by the fencing to prevent climbing, and clearing of excess debris from the tunnels (e.g. Schmidt and Zumbach 2008, van der Ree et al. 2015, Langton and Clevenger 2020).

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# Chapter 5. Movement of Yosemite Toads Along Barrier Fencing and a Novel Elevated Road Segment in Sierra National Forest, CA

Authors: Cheryl Brehme<sup>1</sup>, Stephanie Barnes<sup>2</sup>, Jeff Tracey, Brittany Ewing<sup>1</sup>, Cassie Vaughan<sup>2</sup>, Robert Fisher<sup>1</sup>

<sup>1</sup>USGS Western Ecological Research Center, <sup>2</sup>U.S. Forest Service, High Sierra Ranger District

## Introduction

Amphibians have been identified as being particularly susceptible to the negative effects of roads within their habitat (e.g. Forman et al. 2003, Rytwinski and Fahrig 2012, Andrews et al. 2015a, 2015b). Many are slow moving, do not avoid roads, and are simply too small for drivers to avoid. During rains many amphibians make long linear terrestrial movements regardless of the presence of intersecting roadways (Glista et al. 2008). In particular, pond breeding amphibians use both aquatic and terrestrial habitat for breeding, development, foraging, and overwintering, and therefore, require connectivity within and between aquatic and terrestrial habitats to support basic life history requirements. Increased mortality of amphibian populations from vehicles using roads that intersect breeding and upland habitat, if significant, can result in reduced population sizes and increased probability of extirpation (e.g. Hamer et al. 2008, Semlitsch 2008, Brehme et al. 2018, Ottburg and van der Grift 2019).

Bufonid toads can move large distances (>1 km) in both aquatic and terrestrial habitats to satisfy their annual resource requirements, and there is evidence that bufonid toads are particularly susceptible to negative impacts from roads (Trenham et al. 2003, Orłowski 2007, Eigenbrod et al. 2008). Endangered and threatened species are considered at risk of extirpation, often due to multiple stressors, and are thus thought to be less likely to be resilient to additional road impacts. Because of these attributes, the Yosemite toad ranked in the highest risk category for susceptibility to negative road impacts in a recent road risk assessment of 166 species of reptiles and amphibians in California (Brehme et al. 2018).

The Yosemite toad is a relatively long-lived toad (12–15 years) that inhabits high elevation, open, montane meadows, willow thickets, and adjoining forests in the Sierra Nevada, California. This species breeds in shallow edges of snowmelt pools and ponds or along edges of lakes and slow-moving streams. Some breeding sites dry up before larvae metamorphose. Females may breed every other year or once every three years. Although still distributed over most of its original range with many populations actively breeding and recruiting (Shaffer et al. 2000), the species has declined or disappeared from more than 50% of the sites from which it has been recorded (Jennings and Hayes 1994, Drost and Fellers 1996, USFWS 2014). Hypotheses for declines include habitat loss and degradation, disease (chytridiomycosis), airborne contaminants, livestock grazing, drought, fish predation, raven predation, road mortality and vehicle vibration effects (e.g. Hammerson et al. 2004, Davidson and Fellers 2005, USFWS 2014).

In 2017, the U.S. Forest Service, Sierra National Forest reported 126 Yosemite toads that had been run over and killed by vehicles on Forest Service roads. Of these, 92 subadults were

found on the 9S09 road between June 24 and October 24. The Forest Service and U.S. Fish and Wildlife Service are particularly concerned about the potential for increased Yosemite toad road mortality due to increased vehicular traffic projected for these roads in the future.

### *Elevated Road Segment*

A common road mitigation strategy for amphibians is to install small passages under the roadway in combination with attached barriers or fencing (1 to 2 feet or more high). The barriers are used to prevent animals from going out onto the roadway and to funnel them toward the passage(s). However, there is evidence that inadequate underpass spacing between uplands and breeding ponds may result in population declines in pond breeding amphibians (Ottburg and van der Grift 2019).

The life history of the Yosemite toad presented a unique challenge to this common mitigation strategy. Yosemite toad adults move from upland habitats to wetlands to breed during early snow melt in the spring, and then migrate back into the upland habitats shortly after breeding. Therefore, a passage-barrier system would likely only be effective for reducing road mortality during post breeding toad migrations to uplands after most of the snow has melted or during the summer migrations (including juveniles). Secondly, Yosemite toads have been shown to travel in straight line trajectories over wide areas, resulting in long lengths of roadways where they are susceptible to road mortality without any clearly defined “hot spots”.

Finally, the road is on a flat landscape, with an upland slope on one side and downward slope on the other. Burrowing passage(s) under the road would require a significant amount of grading and re-contouring on the upland slope side to make passage entrances accessible.

To meet these challenges, in June of 2018, we designed and installed a new road crossing structure in a high road mortality section of 9S09 (Figure 1). The crossing structure is an elevated roadway segment placed on top of the existing road surface and composed of hardwood laminated billet road mats that are designed for use by heavy equipment at construction sites (Emtek®). The road mats are approximately 6 in. thick and were installed on top of 8-in. high support bars installed on and perpendicular to the road, allowing for passage of small animals. They were built to meet codes and specifications for U.S. Forest Service, County, and City roads.





Diagram: Side view depiction of elevated road segment (rectangle with vertical lines) with barrier fencing (lines) and openings for toad passage underneath (solid rectangles); not to scale.



Figure 1. Diagram and Photos of Elevated Road Segment.

This proposed study is part of a larger USGS research program in collaboration with the Western Transportation Institute (WTI; Montana State University) for the California Department of Transportation (Caltrans). The larger study provides research to inform best management practices for barrier and crossing systems for sensitive amphibians and reptiles in California.

#### *Movement along Barrier Fencing*

The common toad, *Bufo bufo*, in the Netherlands turned around after an average of 50 m if they did not reach an underpass (Ottburg and van der Grift 2019). As with the California tiger salamander (Chapter 4), the distance Yosemite toads may travel along a barrier fence to find a passable crossing is unknown. Therefore, a study was warranted to determine toad movement distances along barriers to inform proper passage spacing for the Yosemite toad. There is also evidence that animals may spend more time trying to climb or get through opaque fencing

compared to solid fencing (Milburn-Rodríguez et al. 2016). Therefore, we were also interested in whether fencing opacity affects the probability or speed at which the toads and other amphibians find wildlife crossings.

The results of this study will help to gauge effectiveness of this new road crossing structure, identify underpass spacing needs, evaluate barrier materials, and assess the effectiveness of fence end turnarounds for pond breeding amphibians.

Research questions:

- 1) What is the probability a Yosemite toad will reach an underpass based upon the distance from the underpass an animal first encounters the barrier wall?
- 2) How quickly do toads travel along the barrier wall toward the crossing structure?
- 3) How does the opacity of fencing effect the questions above?
  - a. Solid barrier (high-density polyethylene (HDPE-2); Animex®)
  - b. Semi-transparent barrier (water- permeable rigid polymer matrix; ERTEC® E-Fence, referred to hereon as “mesh”)
- 5) Is the elevated roadway segment effective in reducing road mortality while maintaining connectivity between breeding wetlands and uplands for the Yosemite toad?

Study Location:

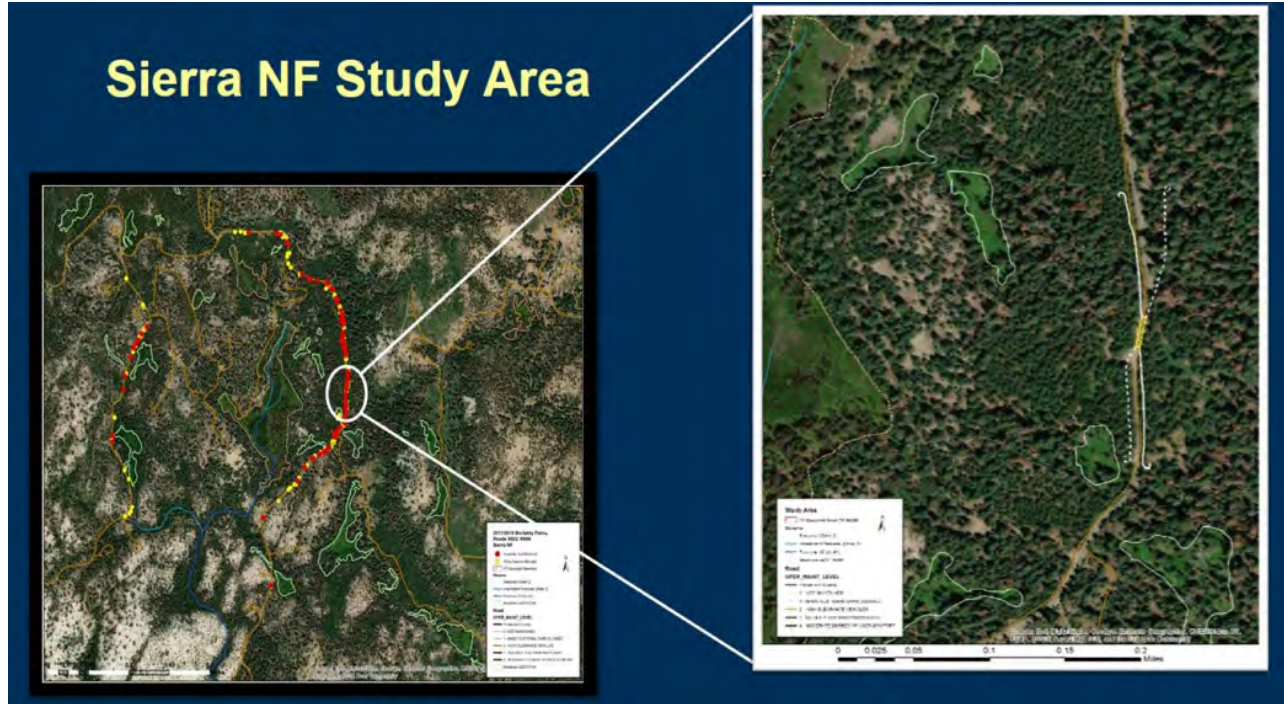
U.S. Forest Service Road 9S09 in Sierra National Forest, CA between Yosemite toad breeding and upland habitat.

## **Methods**

### *Field Study*

We studied the movement of Yosemite toads adjacent to and under the ERS structure along 9S09 in Sierra National Forest, CA in the breeding seasons of 2018 and 2019. The road bisects a Yosemite toad breeding meadow and upland habitat (Figure 2).

B)



B)

Figure 2. Maps of A) Yosemite Toad Road Mortality and B) Location of Barrier and Elevated Road Crossing in Sierra National Forest Between Upland and Breeding Habitat.

A total of approximately 480 m of barrier fencing was installed along the east and west sides of 9S09 (~120 m in each direction) connected to the ERS crossing. One portion of the fencing installed was semi-transparent (ERTEC® rigid polymer matrix E-Fence™) and the other portion was solid (Animex® high-density polyethylene (HDPE-2)). Jump-outs (ERTEC® cones and high berms) were installed a minimum of every 10 m along the fence to provide toads and other small vertebrates a way to get back into the habitat if they ended up on the road side of the barrier fencing. At outer fence ends, turnarounds were installed to redirect animals away from the road and back toward the upland habitat in a U-shaped fashion. The turnarounds were approximately 2 m long and 1 m in width. Fencing was installed with the bottom buried in the ground according to manufacturers' guidelines.

HALT® camera systems (Hobbs and Brehme 2017) were placed against the fencing every 20 m along the new fence lines from 0 to 100 m from the ERS (Figures 3 and 4). Each 0 m camera was approximately 8 m from the closest ERS opening to allow them to be shielded from the view of forest visitors. Cameras were set up on the wetland side as soon as possible after the road opened (spring) and were checked weekly to collect data on toads during their upland migration.



Figure 3. Schematic of Elevated Road Segment, Mesh Fencing (Dotted Lines), Solid Fencing (Lines), HALT Cameras (Circles), and Time Lapse Cameras (Black Circles); Not to Scale.

At fence end turnarounds, HALT camera systems were placed above the end terminal to record video of animals' movement trajectory after reaching the fence-ends (2018). Due to evidence of CTS turning around but not being recorded on video, in 2019, we narrowed the end of the turnaround so that the edge of the "U" was 0.4 m from the beginning of the turnaround creating a tear drop shape. This allowed us to install the trigger at the turnaround opening so that we could record animals entering and exiting the turnaround.

The extreme width of the ERS underpass made it impossible to sample completely; therefore, we had to subsample underpass activity in both space and time. For this, we placed HALT camera systems under both ERS intersections with the fence line on the west side to record tunnel entrances. We then set eight Reconyx cameras set to a time lapse of every 5 minutes on the upland side under the ERS to gather more data on animal movements.

All cameras were set as soon as the snow melted and road opened, and then checked on a weekly basis during the late spring and summer (May–Oct. 2018 and July–Oct 2019). Each time we set and checked the cameras, we took a photo of a battery powered atomic clock in order to calibrate exact minutes and seconds upon processing.

Road mortality surveys were conducted along 9S09 by the U.S. Forest Service.





Figure 4. Solid (A) and Mesh (B) Fence Lines. Along the Fences are Jump Outs and Cameras within Plastic Bins Facing Down Toward HALT Triggers.

### Analysis

#### *Movement along fence line*

Photos of all Yosemite Toads were analyzed using pattern recognition software to identify individuals by their unique spot patterns (I<sup>3</sup>S Spot; Van Tienhoven et al. 2007; Figure 5). Camera location, time, and direction of movement were recorded for each individual. Snout to vent length was measured with Program ImageJ (Rasband 1997-2018) using the 1 cm grids from the HALT trigger for calibration.

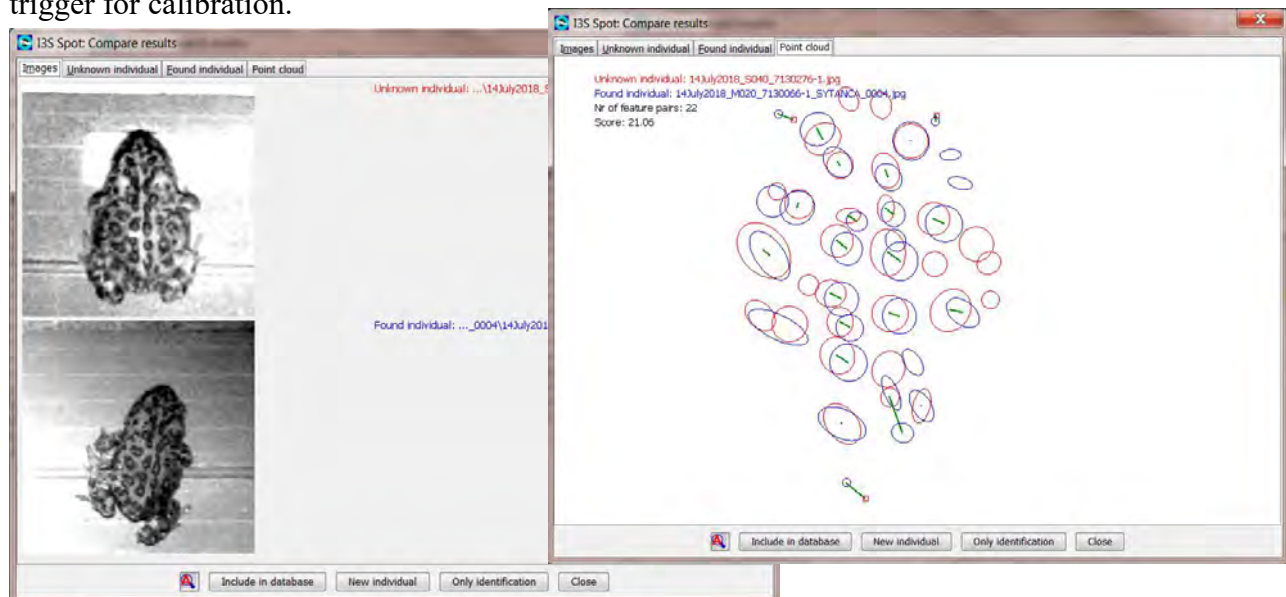


Figure 5. Example of Yosemite Toad Identified to Individual Using i3s Software to Distinguish Spot Patterns.



For individual Yosemite Toads, we then calculated movement distances along the fence lines, numbers of turn arounds, speed, and “success” at reaching 0 m cameras next to underpass system. Because cameras were placed 20 m apart, our margin of error for estimating fence movement distance ranged between 0 and 20 m. For instance, if an animal was only detected at a single camera, then our average estimated distance was 20 m (10 m before reaching the camera and 10 m after exiting the camera). Similarly, if an individual was detected at multiple consecutive cameras moving in the same direction, our margin of error was typically 20 m. In the instances where individuals were detected at consecutive cameras, we also calculated the movement speed between segments. If such an individual then turned around and was re-detected at a camera while moving in the other direction, we estimated the distance travelled along the fence before turning around by multiplying the time between detections by its average speed. Because of this, if individuals travelled back and forth several times, we were able to more accurately estimate the total distance of fence line traversed (fence movement distance). If an individual reached the 0 m camera (where the experimental fence lines attached to the short length of existing fence), this was considered a “success” at reaching the passage system with no added error for distance moved afterward.

For models of movement along fence line, we used Markov Chain Monte Carlo (MCMC) implemented in the R programming language and the runjags package to interface with JAGS (Just Another Gibbs Sampler) to sample values of all unknown parameters from the joint posterior distribution. In each case, four chains were sampled to perform standard diagnostics for convergence. In all cases, non-informative prior distributions were used for all parameters.

#### *Logistic Regression for Success in Reaching Underpass Opening*

We modeled the probability of success of Yosemite toads in reaching the 0 m camera near the crossing opening. For this, we used a Bayesian approach to logistic regression modeling (Figure 6). The response was a Bernoulli random variable, where 0 indicates failure and 1 indicates success in being detected by the camera at the opening of the crossing (ReachedTunnel). The probability of success for the Bernoulli distribution is a logistic (i.e.  $p = \exp(y)/(1 + \exp(y))$ ) function of the linear component of the model that consists of four predictors (FenceType, InitLoc, InitAway, InitLocAway) and five parameters that include an intercept and a regression coefficient corresponding to each of the predictors. FenceType is a binary variable where 0 indicates a mesh fence and 1 indicates a solid fence. InitLoc is the position along the fence where the animal was first detected in meters from the crossing opening (with error described in the previous paragraph), InitAway is a binary variable where 0 indicates that the animal was initially moving toward the crossing and 1 indicates it was initially moving away from the crossing, and InitLocAway is an interaction (product of) InitLoc and InitAway. All predictors were standardized (the mean subtracted from each value and then divided by the standard deviation) prior to modeling. The priors for the parameters were non-informative normal distributions with mean 0 and 0.001 precision (i.e. a variance of 1000). The parameters were sampled from their posterior distributions using MCMC (as described above) and described by mean, median, and quantiles of their marginal distributions. This allowed us to assess the effect of each predictor on the probability of success.

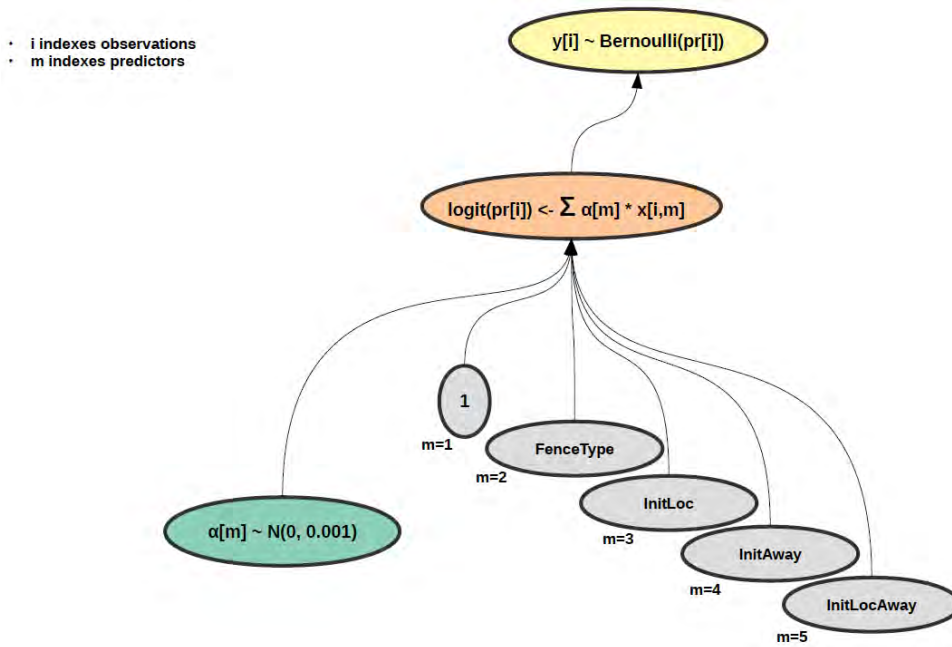


Figure 6. Logistic Regression for Success in Reaching Underpass Opening

*Gamma Regression for Distance Moved Along Fence*

We also modeled the distance that Yosemite toads moved along the fence. We used a Bayesian approach to regression modeling of the probability of successfully reaching the underpass opening (Figure 7). The response was assumed to be a gamma distributed random variable, which is a continuous positive variable representing the distance the animal moved along the fence as described. The gamma distribution has a shape parameter, which we assumed to be independent of any predictors, and a rate parameter that we model as an exponential (i.e.  $\text{rate} = \exp(y)$ ) function of the linear component of the model that consists of four predictors FenceType, InitLoc, InitAway, ReachedTunnel, InitLocAway and six parameters that include an intercept and a regression coefficient corresponding to each of the predictors. All predictors, except for ReachedTunnel, were standardized prior to modeling. The prior for the shape parameter was a non-informative exponential distribution with a rate of 0.00001. The priors for the regression parameters for the rate were normal distributions with mean 0 and 0.001 precision (i.e. a variance of 1000). The parameters were sampled from their posterior distributions using MCMC (as described above) and described by mean, median, and quantiles of their marginal distributions. This allowed us to assess the effect of each predictor on the distance moved along the fence.

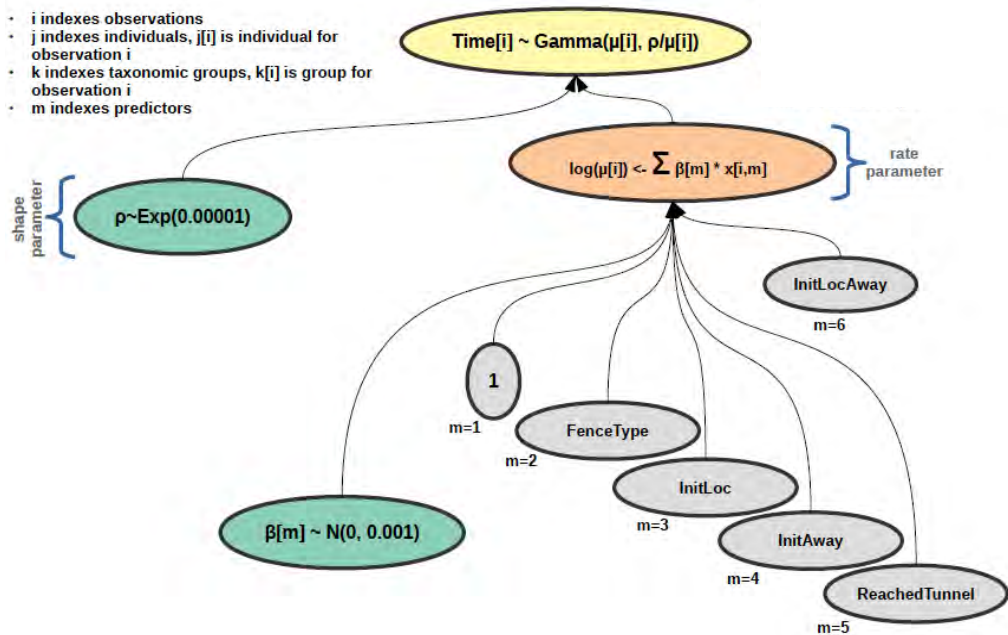


Figure 7. Gamma Regression for Distance Moved Along Fence

*Elevated Road Segment Crossing*

Because the ERS crossing system is so wide (>100 ft), it was not possible to monitor the entire underpass. Therefore, we subsampled by placing two HALT cameras along the fence lines underneath the ERS (wetland side) and eight Reconyx time lapse cameras underneath middle portions of the ERS on the upland side (Figure 1: not to scale). All active trigger camera images were considered a single species event if within one minute of each other. Because of the large number of time lapse images generated, they were only scanned for the presence of Yosemite toads during time periods they were detected with the HALT cameras along the fence lines.

To assess ERS crossing permeability, we analyzed the number of individual Yosemite toads monitored along the fence that reached the passage. For all species, we also compared the relative number of species detections immediately outside the ERS (red circles; 0 m cameras) vs. under the ERS on each side (yellow circles; Figure 8).



Red circles: HALT cameras immediately outside of ERS system  
 Yellow circles: HALT cameras underneath ERS adjacent to the fence line  
 Black open circles: Time lapse cameras placed underneath the ERS on the upland (terrestrial) side facing toward the wetland habitat side. Note: length of ERS not to scale and numbers of time lapse cameras greater than depicted (8).

Figure 8. Schematic of General Locations of Cameras Used to Monitor ERS Permeability (Red and Yellow Circles).

## Results

Due to road closures during winter and spring months, we began monitoring upland toad movements immediately after snow melt and during the summer months when toads are typically active and moving during rainfall events. Total summer precipitation in nearby Huntington Lake during the monitoring periods was 1.12 in. for 2018 (June-Oct) and 0.59 in. for 2019 (July- Oct) after the snow melt (Huntington Lake Historical Weather; worldweatheronline). Both summer seasons were approximately 3.0 in. below average rainfall during these periods (Western Regional Climate Center 044176-5). Breeding and recruitment were documented by USFS in 2019; however, we likely missed most of the upland dispersal at the site due to the extended period of snowpack through June and lack of access to the site during this time.

### Fence Movement

We documented a total of 37 individually identified Yosemite toads in 2018 (24 over 12 nights) and 2019 (13 over 6 nights) moving along the fence-line. Five or fewer individuals (5 photos) were not included in the initial analysis due to low confidence in these identifications. Of the 37 individuals in the analysis, 19 were subadults (<44 mm snout-to-vent length (SVL)) and 18 were adults (>44 mm SVL). Among fence types, eight subadults and 13 adults were recorded along the mesh and 11 subadults and five adults were recorded along the solid. We considered individual movements from 2018 to 2019 as independent in the analysis.

Because our sample size was low, confidence intervals are extremely wide for most parameters. We present averages and confidence intervals of fence distance, movement speed, and direction changes (i.e. back and forth movements) among fence types and age classes in Table 1.

Fence movement distances averaged approximately 52 m (Table 1, Figure 9) and did not significantly differ by fence type or age class, although mean distance moved was farther along the solid (63 m) than mesh (43 m) fencing. With these preliminary data, there were no significant differences in the response variables by fence type. Yosemite toads moved an average of 1 m/min and changed directions an average of 0.5 times per 20 m (i.e. per camera location). Adults were 71% faster than subadults and changed directions 75% more often, although not significantly.

Seven out of 10 Yosemite toads changed course at a turnaround back toward the fence line or out into habitat, and of these, four toads were subsequently documented on other cameras 40-80 m away continuing to move back along the fence line.

Table 1. Yosemite Toad Movement Metrics by Fence Type and Age Class

		Sample Size	Fence Distance Moved (m)		Movement Speed (m/s)*		Direction Changes per 20m	
			Mean	90% CI	Mean	90% CI	Mean	90% CI
By Fence Type	Solid	16 (13*)	63.3	10- 109	1.0	0.7- 1.3	0.6	0.3- 0.9
	Mesh	21 (9*)	43.2	10- 105	0.9	0.6- 1.2	0.5	0.2- 0.8
By Age Class	Subadult	19 (13*)	48.9	38.3- 59.6	0.7	0.6- 0.9	0.4	0.2- 0.6
	Adult	18 (9*)	43.1	30.0- 56.3	1.2	1.0- 1.5	0.7	0.4- 1.0
<b>All Toads</b>		<b>37</b>	<b>52.3</b>	<b>10- 110</b>	<b>1.0</b>	<b>0.6- 1.3</b>	<b>0.5</b>	<b>0.3- 0.7</b>

\*Individuals that passed more than one camera where movement speed was calculated

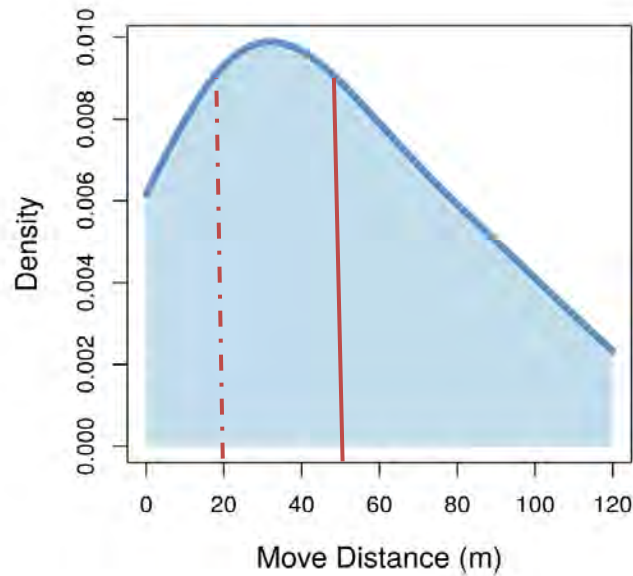


Figure 9. Distributions of Movement Distances. Lines Represent Mean (Solid) and Lower 90% Confidence Interval (Dashed).

The linear regression modeling showed a general pattern similar to that of CTS but with low slopes and low confidence. Yosemite toads moved shorter distances if they encountered the fence closer to the tunnel system and their initial direction was toward the tunnel system. There was no difference in predicted move distances for the toads that encountered the fence and turned in the “wrong” (away) direction (Figure 10).

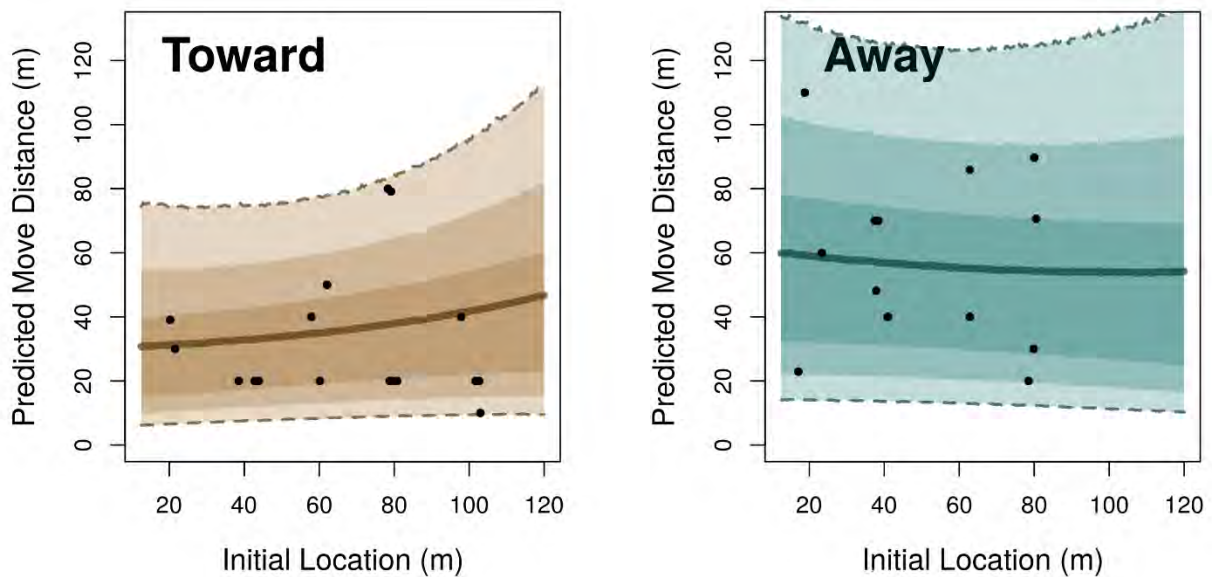


Figure 10. Movement Distance by Initial Location and Direction of Travel (Toward or Away from Underpass) with 90% Confidence Intervals.



The probability that Yosemite toads reached the tunnel system (0 m camera) decreased rapidly with increasing distance from the ERS system and was also highly dependent upon their initial direction choice. Yosemite toads had a high probability of reaching the ERS underpass if they encountered the fence at a distance of 20 m (mesh fencing) to 40 m (solid fencing) and were moving toward the ERS. Probabilities rapidly declined beyond those distances and were low if the toads were moving away from the ERS (Table 2, Figure 11). The estimates close to 1.0 and 0.0 indicated more data is needed to more accurately predict the probabilities of success in this system.

Table 2. Probability of Reaching Underpass by Initial Location, Direction of Travel (Toward or Away from Underpass), and Fence Type.

Initial Location (m)	Solid Fencing				Mesh Fencing			
	TOWARD Underpass		AWAY from Underpass		TOWARD Underpass		AWAY from Underpass	
	Probability of Success	90% CI	Probability of Success	90% CI	Probability of Success	90% CI	Probability of Success	90% CI
10	1.00	1.00- 1.00	.48	.21- .75	1.00	.99- 1.00	.01	.00- .06
20	1.00	1.00- 1.00	.44	.20- .70	.91	.41- 1.00	.01	.00- .05
40	.65	.00- 1.00	.37	.14- .63	.02	.00- .11	.01	.00- .04
60	.04	.00- .27	.32	.07- .63	.00	.00- .00	.01	.00- .03
80	.00	.00- .00	.28	.04- .68	.00	.00- .00	.00	.00- .02
100	.00	.00- .00	.25	.01- .72	.00	.00- .00	.00	.00- .02

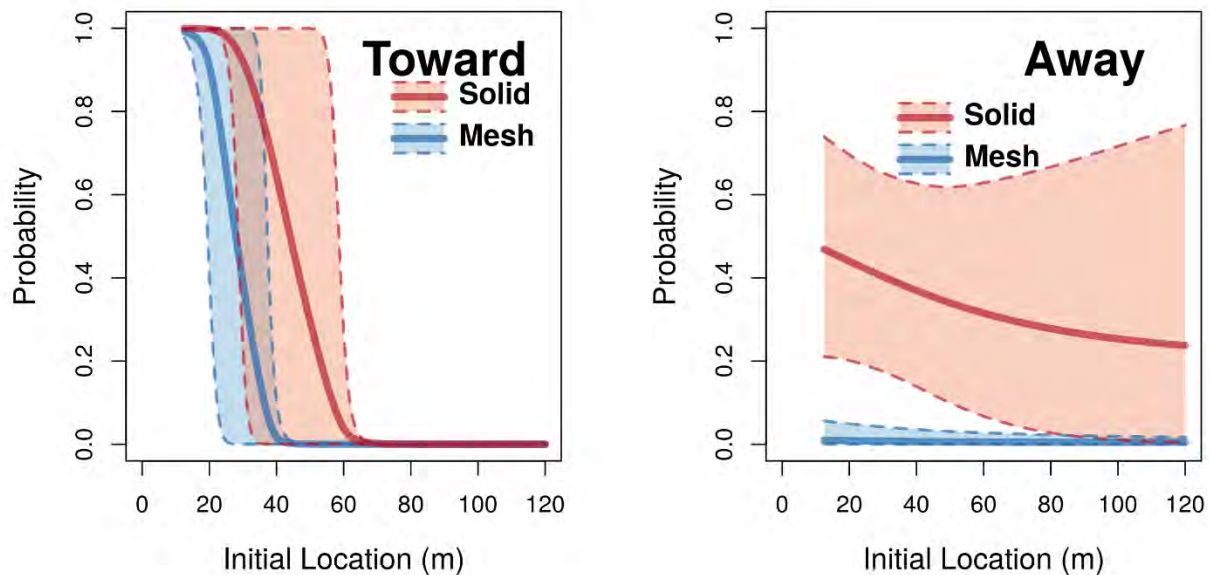


Figure 11. Probability of Reaching Underpass by Initial Location, Direction of Travel (Toward or Away from ERS), and Fence Type with 90% Confidence Intervals. Note that more samples are needed to better inform the models.

### Underpass Permeability

Of the eight Yosemite toads that were tracked moving toward the ERS system at one of the “0 m” cameras (~5 m from the ERS entrance), three moved underneath at the first immediate right/left turn from the barrier fencing into the ERS and two moved along the length of the ERS (not underneath) to the barrier fencing on the other side. It is possible the other three toads moved under the bridge but not across a HALT trigger. Toads were detected on the time lapse cameras during the periods of their activity but could not be identified to individual.

Twenty-four other Yosemite toads that moved under the ERS were detected by one of the two HALT triggers (16 toads) or by a time lapse camera (8 toads). These data represent only a subsample of available linear width of the ERS system, so we suspect many more Yosemite toads passed under the crossing. At an average movement speed of 1 m/min and a field of depth of about 1 m, we estimate the eight time-lapse cameras subsampled toads across approximately 40% of the linear length of the ERS for 20% of the time. Because of this, we expect the total number of toads that moved under the ERS was likely closer to 100 during the time periods monitored.

The relative activity of Yosemite toads immediately inside vs. outside (~5 m from opening) of the ERS crossing system was almost equal (20 vs. 19 events; Table 3). The relative activity of other animals varied by species and groups. In general, mammals were detected at greater rates underneath vs. outside the ERS system (ratio 3.1), while reptiles and amphibians were detected at slightly lower rates underneath vs. outside the ERS system (ratios 0.70 and 0.83).

			RELATIVE ACTIVITY		
			Outside	Inside	Ratio
A	Pacific Treefrog	<i>Hyla regilla</i>	209	174	0.83
M	<b>Yosemite Toad</b>	<b><i>Anaxyrus californica</i></b>	<b>20</b>	<b>19</b>	<b>0.95</b>
P	Sierra Nevada Ensatina	<i>Ensatina eschscholtzii platensis</i>	12	4	0.33
H	Unknown salamander		0	3	na
Subtotal Amphibians			241	200	0.83
	Mountain Gartersnake	<i>Thamnophis elegans elegans</i>	25	14	0.56
R	Rubber Boa	<i>Charina bottae</i>	6	4	0.67
E	Sierra Alligator Lizard	<i>Elgaria multicarinata</i>	6	7	1.17
P	Western Fence Lizard	<i>Sceloporus occidentalis</i>	6	2	0.33
T	Unknown lizard		1	4	4.00
Subtotal Reptiles			44	31	0.70
	Mice/Rats	<i>Family Rodentia</i>	165	534	3.24
	CA ground squirrel	<i>Otospermophilus beecheyi</i>	19	38	2.00
M	Long-tailed Weasel	<i>Mustela frenata</i>	0	1	>1.0
A	Spotted skunk	<i>Spilogale putorius</i>	0	4	>1.0
M	American marten	<i>Martes americana</i>	0	2	>1.0
A	Chipmunk	<i>Neotamias spp.</i>	3	1	0.33
L	CA Vole	<i>Microtus californicus</i>	2	1	0.50
S	Shrew	<i>Sorex spp.</i>	1	16	16.00
	Yellow-bellied Marmot	<i>Marmota flaviventris</i>	1	1	1.00
Subtotal Mammals			191	598	3.13

Table 3. Relative Activity by Species Immediately Inside vs. Outside Elevated Road Segment.

## Discussion

Although the sample size was low due to seasonal weather and sampling constraints, we found similarities between the fence movement behavior of Yosemite toads and CTS (Chapter 4). On average, Yosemite toads moved a distance of 52 m along barrier fencing before “giving up” and their probability of making it to the crossing decreased rapidly with increasing distance from the ERS. This is very close to the 50 m average that Ottberg and van der Grift (2019) reported for *Bufo bufo* in the Netherlands. Many individuals moved back and forth along the fencing and the average of 52 m represents the average span of total fence distance moved. Therefore, approximately half moved greater distances and half moved smaller distances with approximately 90% of toads estimated to move 20 m or more. Because our cameras were set 20 m apart, we were unable to estimate the specific distances with high confidence. However, these preliminary results suggest that passages spaced within 20 m of one another along Yosemite toad migratory pathways should provide connectivity to 90% of the population.

As with CTS, the likelihood that only some animals will reach a passage informs planning and monitoring of crossing systems for migratory amphibians and other migratory species. Without considering this in planning for distances between crossings, there is a potential for crossing systems constructed to reduce road mortality to become a barrier to population level movements.

In addition to distance moved, the direction Yosemite toads turned when reaching the barrier fencing was a large factor in whether they reached the crossing. Toads that reached the barrier fencing and then travelled in the wrong direction (away from the tunnels) were significantly less likely to reach the crossing than toads that made the correct initial direction choice. In fact, it appeared that, as with CTS, toads that made the correct initial direction choice were also more likely to travel longer distances to reach the tunnels.

It is possible that not all Yosemite toads were making migratory movements during our study, as they may have been foraging. However, in that case we would expect to document the same individuals on multiple dates along the fence line which was rare in our study.

The transparency of fencing (mesh vs. solid) did not significantly affect the movement distances or probability of making it to the underpass system, although the estimated probabilities were slightly less for the semi-transparent fencing. Unlike CTS, there was no apparent difference in speed or turnaround rates (moving back and forth) by fence type in the preliminary data for Yosemite toads.

We caution that a greater sample size is needed to accurately predict the probability of success by initial distance from passage, direction choice, and effects of fence type and age class on Yosemite toad movements along the fence lines. Continued data collection in future years and placement of additional cameras at 10 m along the fence lines will allow for higher confidence in these estimates.

Finally, initial results showed that the ERS crossing has a high potential to provide increased connectivity for Yosemite toads and a wide range of other amphibian, reptile, and small mammal species while greatly reducing road mortality (no road mortality of Yosemite toads has

been documented in the project footprint since installation of the ERS; S. Barnes, USFS, pers. comm.). This new prototype crossing can be made to any length, creating a wide passage without constricting migratory movements to small tunnels. The prototype ERS also allows natural light, moisture and rainfall to permeate the length of the passage so that climate and moisture underneath is similar to that outside. The large width of the passage does present challenges in monitoring successful crossings due to the wide monitoring area. We are exploring the use of different camera systems, additional cameras, and wildlife tracking techniques to better monitor movements near and underneath the passage in the future.

## Acknowledgements

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## Chapter 6. Effect of Fence Opacity on the Movement of Reptiles and Amphibians and the Effectiveness of Two Jump-out Designs.

Authors: Cheryl Brehme<sup>1</sup>, Jeff A. Tracey<sup>1</sup>, Jennifer Kingston<sup>1</sup>, Jeremy Sebes<sup>1</sup>, Tristan Edgarian<sup>1</sup>, Robert Fisher<sup>1</sup>

<sup>1</sup>USGS Western Ecological Research Center

### Introduction

Options for road barrier materials vary greatly from solid concrete, composites, and plastics to transparent and semi-transparent wire and plastic meshes. Meshes are typically easy to work with and are permeable to water and air movement; however, there is some evidence that animals may spend more time trying to climb or get through transparent fencing than solid fencing (Milburn-Rodriguez et al. 2016). Thus, opacity could influence both barrier effectiveness and the probability and speed with which an animal finds a wildlife crossing.

“Jump-outs” are commonly built along road barrier fencing to ensure that large animals can escape if they get caught within the road barrier sections (Clevenger and Huijser 2011, van der Ree et al. 2015, Hopkins et al. 2018). However, few jump-outs have been designed, tested, or used for allowing the escape of herpetofauna back into the habitat if they become trapped along a road with barrier fencing on both sides.

We conducted studies at the Rancho Jamul Ecological Reserve (RJER) in Jamul, California, to compare the behavior and movement speed of herpetofauna in relation to transparent, semi-transparent, and solid fencing. In addition, we tested the effectiveness of two jump-out designs. The results of these studies will help to inform transportation agencies on these important components of road barrier and crossing systems.

Herpetofauna Groups Targeted: Snakes, lizards, toads

Research questions:

1. Are transparent, semi-transparent mesh, and solid barriers equally effective as barriers to movement?
2. How quickly do individuals travel along barriers of differing opacity?
3. Are jump-outs of differing designs effective in allowing herpetofauna to escape if trapped within the roadway?

### Methods

#### *Field Study*

At Rancho Jamul Ecological Reserve, we set up a multi-faceted fenced enclosure to study the behavior and speed of animals along different fence materials and the effectiveness of jump-outs (Figure 1). The fenced behavioral enclosure was installed along a habitat edge between riparian scrub and coastal scrub habitat in the reserve. The behavioral enclosure consisted of a 12 m long, 45 cm wide linear “runway” with 2 m long alternating segments of hardware cloth, black

plastic mesh (ERTEC® rigid polymer matrix fence with climbing barrier at top), and solid black (Animex® high-density polyethylene (HDPE-2)) barrier fencing 60 inches in original height buried to a depth of 10–15 cm. The alternating segments contained the same barrier fencing on both sides of the runway and each fence type was randomly repeated two times along the runway. To prevent bias based upon the location of the fencing, the order of the fencing types was changed during the middle of the study. The bare soil floor of the enclosure was tamped down with a steel dirt tamper to prevent digging and hiding behaviors. We also buried 1 in. PVC pipes  $\frac{3}{4}$  in. deep along the floor in between each fence segment perpendicular to the runway to provide a white strip between segments. This allowed us to easily discern when an animal moved from one segment to another.

We built a 4 m introduction section made of white solid fencing for introduction and habituation of test animals before they made the decision to start moving along the test runway. At the end of the runway, we built an exit section with four jump outs. Two “high” jump outs were built as earthen ramps leading up to the top of the fence, with an approximate 50 cm drop to jump out into the habitat. Two “low” jump-outs were modified rectangular cones (ERTEC®) with a diameter of 22 cm installed halfway up the barrier fencing with a small earthen ramp and an approximate 20 cm drop into the habitat (Figure 2). The cones were modified by increasing the size of the opening on the exit side to a diameter of approximately 10 cm. An outer fence around the exit section allowed us to capture animals once they exited the jump-out and return them to the original place of capture. The entire behavioral enclosure was covered on top at a height of approximately 1.5 m with shade sail cloth to prevent spots of sunlight and shade from influencing animal behaviors.

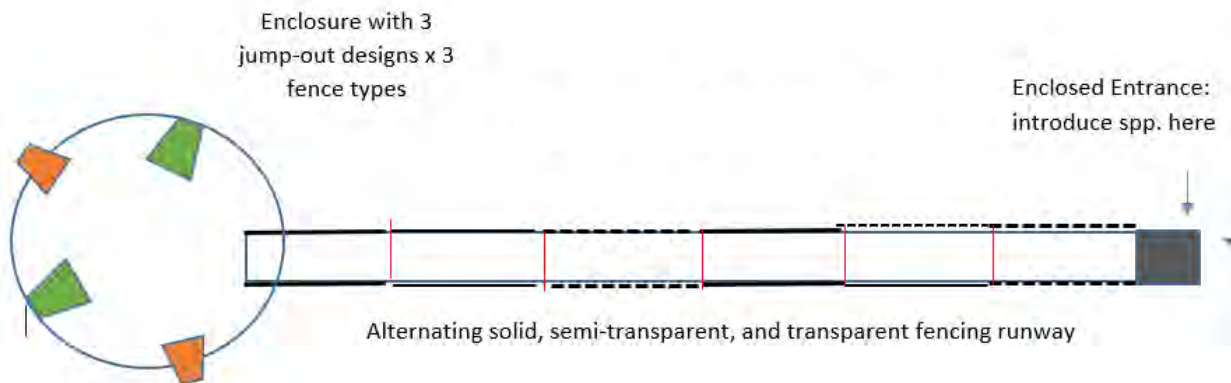


Figure 1. Graphic of Behavioral Enclosure

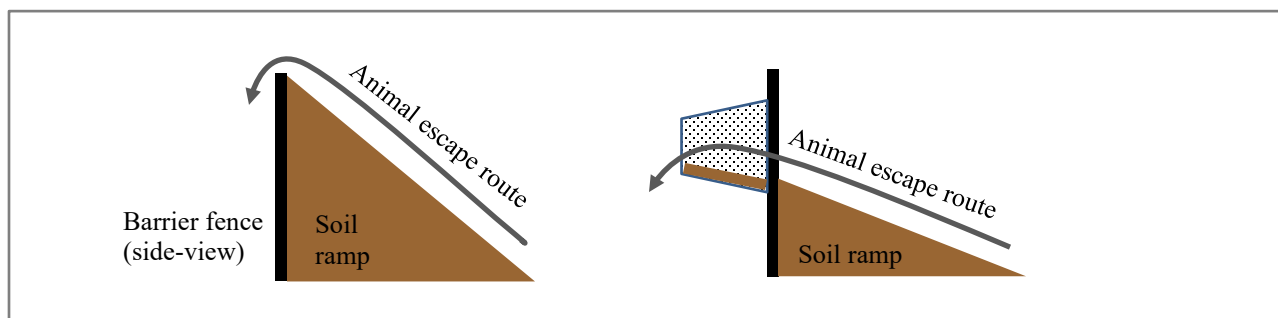


Figure 2. Diagram of Jump-Out Configurations a) Over Fence and b) Through Fence.

Trials were run in spring and summer months from June through September in 2018 and March through June in 2019. To determine if animals would respond differently to the transparent and semi-transparent fencing in the presence of a visual barrier, from late August through September of 2018 and June of 2019, we placed black duct tape along the bottom of the first segments of hardware cloth and mesh fencing approximately 15 cm (6 in.) in height.

We captured animals using visual searching and linear trap arrays with pitfall traps and snake traps within 150 m of the behavioral enclosure as described in Fisher et al. (2008). The traps were set in the early morning, checked throughout the day, and closed at mid-day. Some snakes were also opportunistically collected if observed while checking the pitfall arrays. Each animal included in the trials was weighed, measured, temporarily marked with ink (Sharpie®), placed into a holding bag (snake bag/pillowcase) and brought to the enclosure.

Captured animals were placed one at a time within the introduction section approximately 2 m from the first fence segment. Observers were stationed behind camouflage netting at the entrance and exit sides of the behavioral enclosure. The first observer on the exit side operated a stationary video camera on a tripod to record all animal movements within the enclosure and was behind camouflage netting throughout the entire trial. The second observer gently released each animal from its holding bag or snake trap into the enclosure approximately 2 m from the first fence trial segment while behind the camouflage netting. Each animal was then observed until it left the behavioral enclosure or for 30 minutes (if it did not complete the trial). Examples of reptiles moving through the enclosure are provided in Figure 3. After the trial, each animal was immediately released to its original place of capture. Once back at the field office, the observers uploaded videos and recorded the following:

- Direction and pathway of all movements
- Time spent along each fence segment
- Whether a solid visual barrier was present (on mesh or HC fencing)
- Behaviors observed at each fence segment: Poking, climbing, moving back and forth, sitting
- Number of fence segments completed
- Whether animals escaped by climbing over fencing
- What exits were approached and used





Figure 3. Photos of A) California Striped Racer (*Masticophis lateralis*) Poking at Hardware Cloth, B) Orange-Throated Whiptail (*Aspedoscelis hyperythrus*) Poking at Hardware Cloth, C) Rosy Boa (*Lichanura trivirgata*) Moving Through Runway Toward Exit Structures, D) Orange-Throated Whiptail Exiting High Ramp and E) Red-Diamond Rattlesnake (*Crotalus ruber*) Exiting Escape Funnel.



## *Analysis*

Only data from individual animals that completed at least three fence segments (one of each type) were used in the analysis. Many animals turned around one or more times during their trial and travelled by the same fence lines on repeated occasions. We used all data where a complete pass was made and accounted for this with a covariate “FirstSegment” indicating whether it was the individuals first encounter with that fence type.

### *Movement Time along Fence Types: Logistic Regression:*

We first modelled the probabilities of fence interaction behaviors using logistic regression. For this we only used the individuals first encounter with each fence type (Hardware Cloth, Mesh, Solid +/- Visual Barrier). To determine whether the probability of fence interaction behaviors differed across fence types and by taxonomic group (lizards, snakes, toads) and the effect of a visual barrier, we fitted a general linear model with a binomial distribution and logit-link function (Program R):

$$\text{Fence Interaction Behavior (0/1)} \sim \text{FenceType*VisualBarrier} + \text{TaxonomicGroup}$$

### *Movement Time along Fence Types: Linear Regression:*

Individuals of different species and taxonomic groups had widely varying times along the fence lines within the behavioral enclosure. To minimize this variation and to determine whether speed of movement was affected by fence type, we did two things. First, we removed records of segment passes where the behavior “sitting” was recorded. This behavior was not considered an interaction with the fence but represented varying, and sometimes long, periods of time where an animal would “freeze.” Second, we standardized all time data to z-distributions by individual (mean= 0, data as number of standard deviations from the mean). As an example, an individual with times of 5, 10, and 15 min across fences A, B, and C would be transformed to -1, 0, 1. Likewise, another individual with times of 1, 2, and 3 min across fences A, B, and C would be transformed to -1, 0, 1. This allowed us to account for the wide variability of speed among individuals and focus on their relative responses to the different fence types.

We then modelled the data using linear regression fitted by least squares to determine whether time differed across fence types and if the installation of a visual barrier affected time spent along the fence types by taxonomic group (lizards, snakes, toads)(Program R):

$$\text{Standardized Time} \sim \text{FenceType*VisualBarrier} + \text{TaxonomicGroup} + \text{FirstSegment}$$

For both types of models described, we also ran mixed model versions based on maximum likelihood with the individual as a random variable; the mixed models had convergence issues due to the large number of parameters (i.e. overparameterization). However, the model coefficients and standard error estimates were very similar between the general linear and mixed model types. Further analyses of this study will be conducted using Bayesian methods for a manuscript.

## Results

We captured a total of 174 individuals to use in our trials. Of these, 66% (114) completed at least one full set of fence types and thus were used in the behavioral modelling. Eighty individuals completed moving through all fence lines to the exit arena and of these, 87.5% (70) exited using one of the jump-outs (Table 1).

Table 1. Numbers of Species Used in Trials with Outcomes

Taxon	Species	Number Escaped	Fence lines passed (out of 6)			Number exited
			<3	3-5*	6*	
Frog	<i>SubTotal</i>			1		
	<i>Pseudacris regilla</i>			1		
Lizard	<i>SubTotal</i>		46	24	57	49
	<i>Aspidoscelis hyperythrus</i>		23	7	42	38
	<i>Aspidoscelis tigris</i>		1	2	2	2
	<i>Elgaria multicarinata</i>		2	1	2	1
	<i>Sceloporus occidentalis</i>		11	13	6	5
	<i>Sceloporus orcutti</i>				1	
	<i>Uta stansburiana</i>		9	1	3	2
	<i>Plestiodon skiltonianus</i>	1	1		0	
Snake	<i>SubTotal</i>		6	6	21	20
	<i>Crotalus ruber</i>				3	3
	<i>Crotalus oreganus</i>				2	2
	<i>Lampropeltis getula</i>				2	2
	<i>Lichanura trivirgata</i>				1	1
	<i>Coluber fuliginosus</i>				2	1
	<i>Coluber lateralis</i>		3	2	5	5
	<i>Pituophis catenifer</i>		2	3	5	5
	<i>Tantilla planiceps</i>		1		0	
	<i>Thamnophis hammondi</i>			1	2	2
Toad	<i>SubTotal</i>		6	3	2	1
	<i>Anaxyrus boreas</i>		2	2	2	1
	<i>Spea hammondi</i>		4	1	0	
	<b>Grand Total</b>	<b>1</b>	<b>59</b>	<b>34</b>	<b>80</b>	<b>70</b>

\*used in modelling

All behavioral models showed that fence type was significant in predicting the probability that herpetofauna would exhibit fence interaction behaviors (Tables 2–4, Figures 4–6). Poking, moving back and forth, and climbing behaviors were more common as the transparency of the fence increased (solid > mesh > hardware cloth). Across taxonomic groups, toads showed higher probabilities of fence interaction behaviors than lizards and snakes, although the variability in the data was greater for toads. Along with the greater probability of these behaviors, the time it took for herpetofauna to pass each fence type increased as the transparency of the fence increased (Table 5, Figure 7).

The addition of a 15 cm (6 in) visual barrier along the bottom of the mesh and hardware cloth fencing reduced the probability of poking and back and forth movements among all taxa and was particularly significant in reducing poking behaviors of lizards and snakes. When a visual barrier was present, there was little difference in the probability of fence interaction behaviors among the fence types. Similarly, a visual barrier significantly reduced the time it took for individuals to move along the mesh and hardware cloth fencing so that there was little difference in individual speed among all fence types.

Table 2. Effect of Fence Type on Animal Behavior: Poking and Looking

Coefficients:	Estimate	Std. Error	t-value	Pr(> t )	
(Intercept= Solid)	-3.215	0.412	-7.811	5.65E-15	***
FenceTypeMesh	2.482	0.425	5.847	5.01E-09	***
FenceTypeHC	3.582	0.430	8.325	< 2e-16	***
VB011	-1.228	1.150	-1.067	0.286	
TypeSnake	0.281	0.262	1.074	0.283	
TypeToad	3.044	0.734	4.150	3.32E-05	***
FirstSegType1	0.232	0.252	0.918	0.359	
FenceTypeMesh:VB011	-0.885	1.313	-0.674	0.500	
FenceTypeHC:VB011	-0.640	1.236	-0.518	0.604	

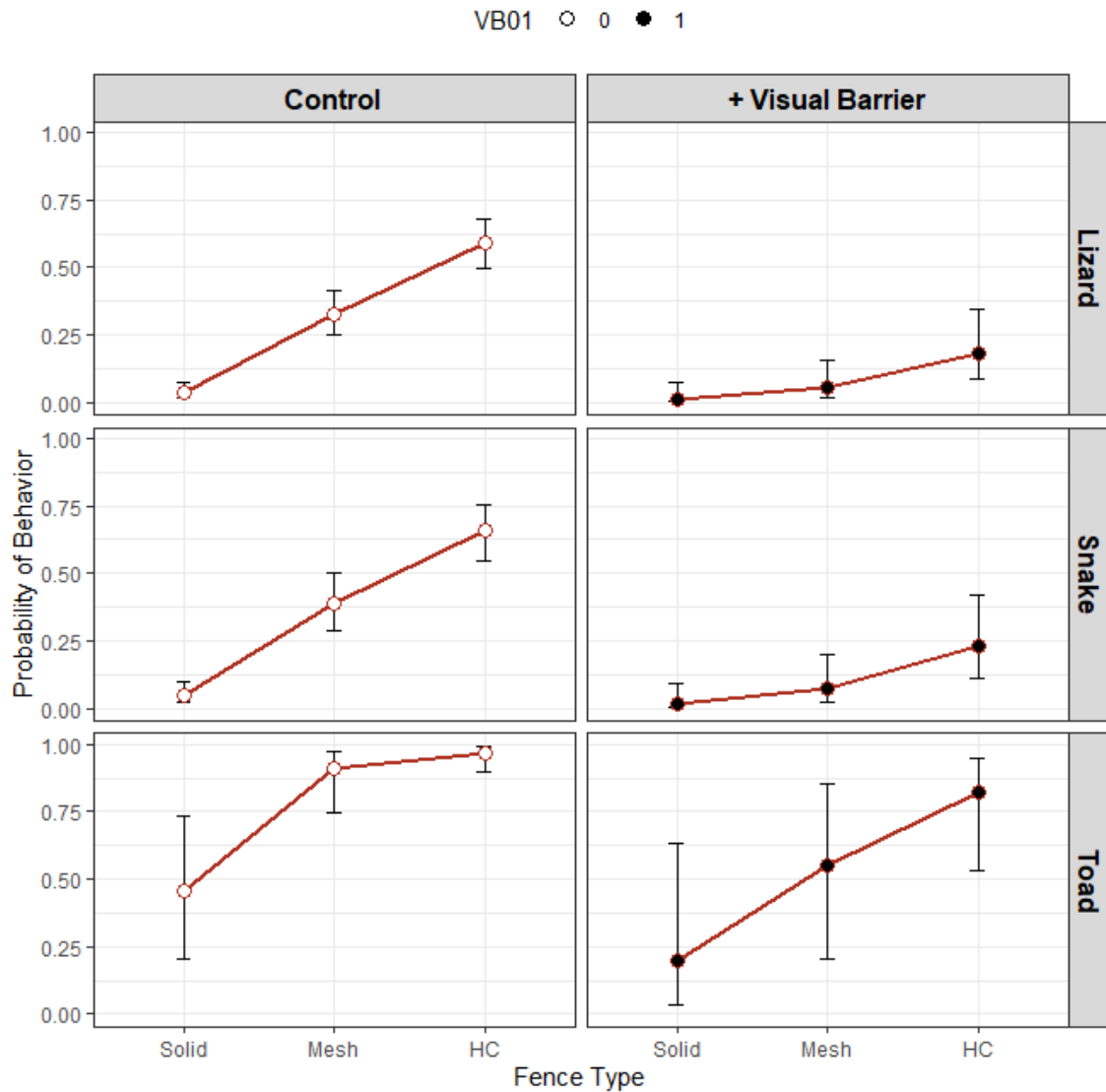


Figure 4. Effect of Fence Type on Animal Behavior: Poking and Looking

VB= visual barrier, HC= hardware cloth

Table 3. Effect of Fence Type on Animal Behavior: Back and Forth Movements

Coefficients:	Estimate	Std. Error	t-value	Pr(> t )	
(Intercept= Solid)	-2.928	0.418	-7.001	2.53E-12	***
FenceTypeMesh	1.606	0.452	3.552	3.83E-04	***
FenceTypeHC	2.245	0.444	5.053	4.36E-07	***
VB011	-0.715	1.102	-0.649	0.516	
TypeSnake	-0.752	0.338	-2.225	0.026	*
TypeToad	1.076	0.742	1.451	0.147	
FirstSegType1	0.075	0.284	0.265	0.791	
FenceTypeMesh:VB011	0.020	1.235	0.016	0.987	
FenceTypeHC:VB011	-1.265	1.334	-0.948	0.343	

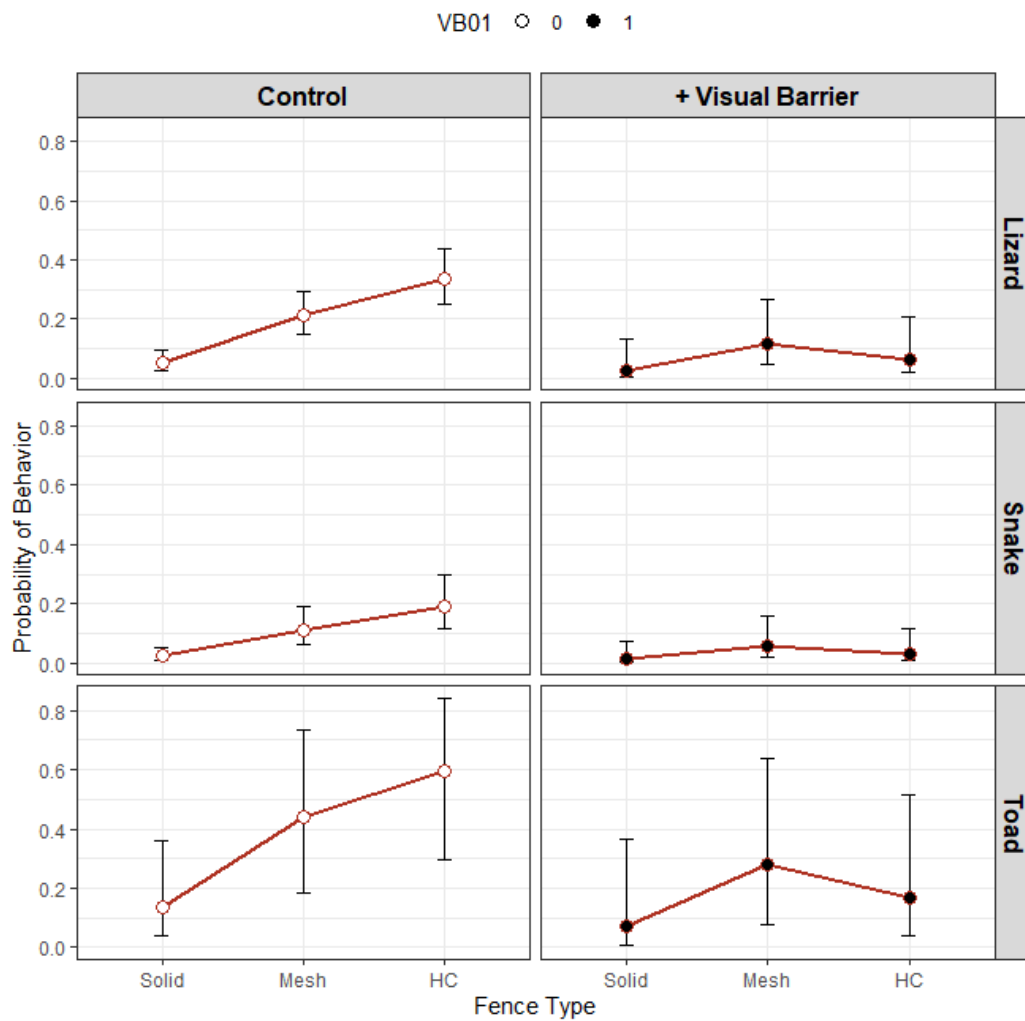


Figure 5. Effect of Fence Type on Animal Behavior: Back and Forth Movements

VB= visual barrier, HC= hardware cloth



Table 4. Effect of Fence Type on Animal Behavior: Climbing

Coefficients:	Estimate	Std. Error	t-value	Pr(> t )	
(Intercept= Solid)	-3.319	0.521	-6.373	0.000	***
FenceTypeMesh	1.105	0.576	1.917	0.055	.
FenceTypeHC	1.662	0.561	2.963	0.003	**
VB011	-16.458	1711.284	-0.010	0.992	
TypeSnake	-1.850	0.745	-2.484	0.013	*
TypeToad	2.020	0.790	2.558	0.011	*
FirstSegType1	0.102	0.390	0.261	0.794	
FenceTypeMesh:VB011	-0.938	2465.362	0.000	1.000	
FenceTypeHC:VB011	14.523	1711.284	0.008	0.993	

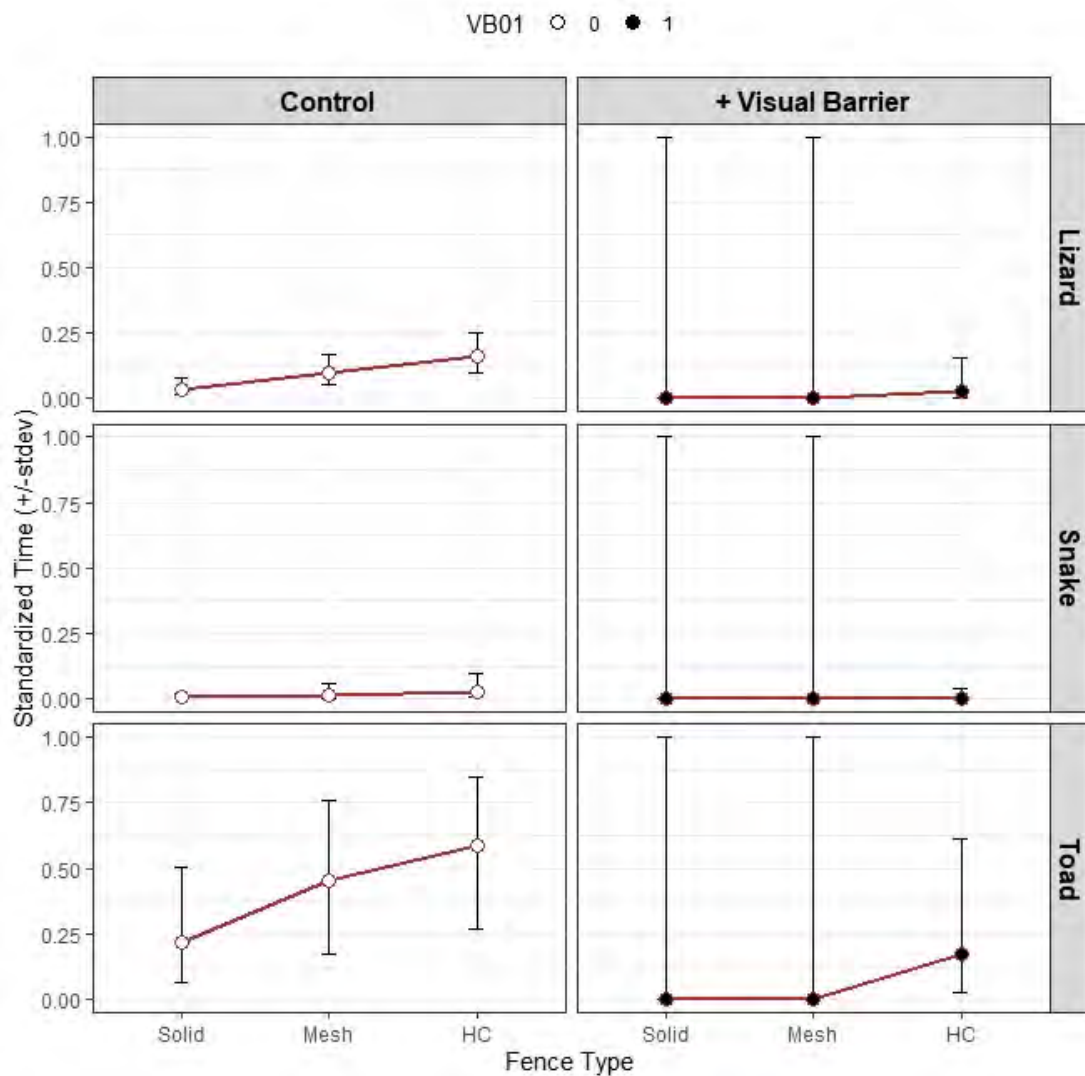


Figure 6. Effect of Fence Type on Animal Behavior: Climbing

VB= visual barrier, HC= hardware cloth

Table 5. Effect of Fence Type on Relative Movement Time

Coefficients:	Estimate	Std. Error	t-value	Pr(> t )	
(Intercept= Solid)	-0.31719	0.06641	-4.776	2.11E-06	***
FenceTypeMesh	0.24439	0.09012	2.712	0.00683	**
FenceTypeHC	0.72434	0.09106	7.955	5.71E-15	***
VB011	0.56038	0.1081	5.184	2.72E-07	***
TypeSnake	0.04315	0.08091	0.533	0.59394	
TypeToad	-0.02768	0.17773	-0.156	0.87626	
FirstSegType1	-0.13039	0.07296	-1.787	0.07427	.
FenceTypeMesh:VB011	-0.4652	0.16574	-2.807	0.00512	**
FenceTypeHC:VB011	-1.01179	0.15753	-6.423	2.22E-10	***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

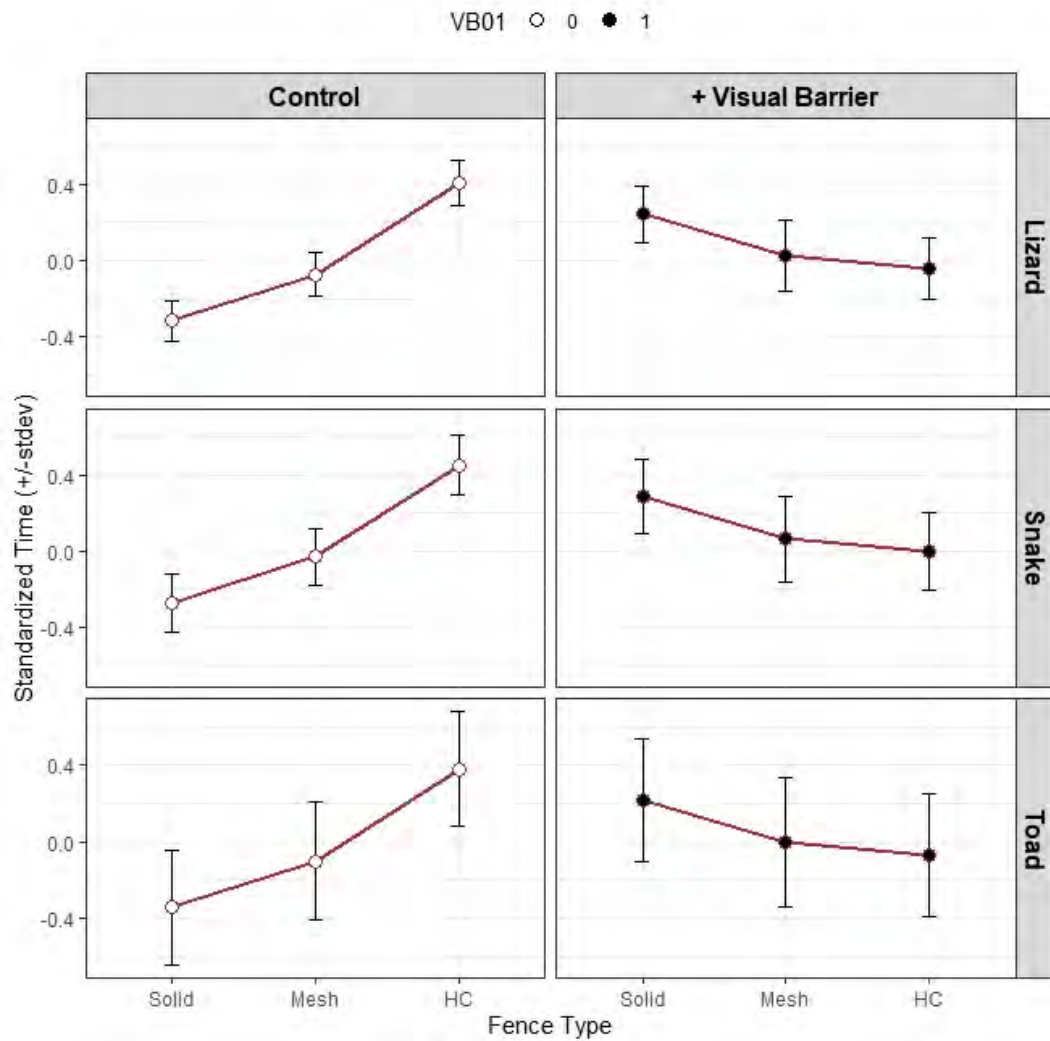


Figure 7. Effect of Fence Type on Relative Movement Time

## Effectiveness of jump-outs

A total of 75% of lizards (43/57), 95% of snakes (20/21), and 50% of toads (1/2) used a jump-out to escape the enclosure. There was little difference between the use of the high ramp and low funnel jump-outs by lizards and snakes (Figure 8). We observed that lizards often sat on top of the high ramp for long periods of time before jumping to the ground, whereas there was little hesitation with the low jump-outs. A higher proportion of lizards (16–23%) did not exit via the jump-outs. Many of these sat in the exit arena until they timed out or moved back in the direction of the entrance.

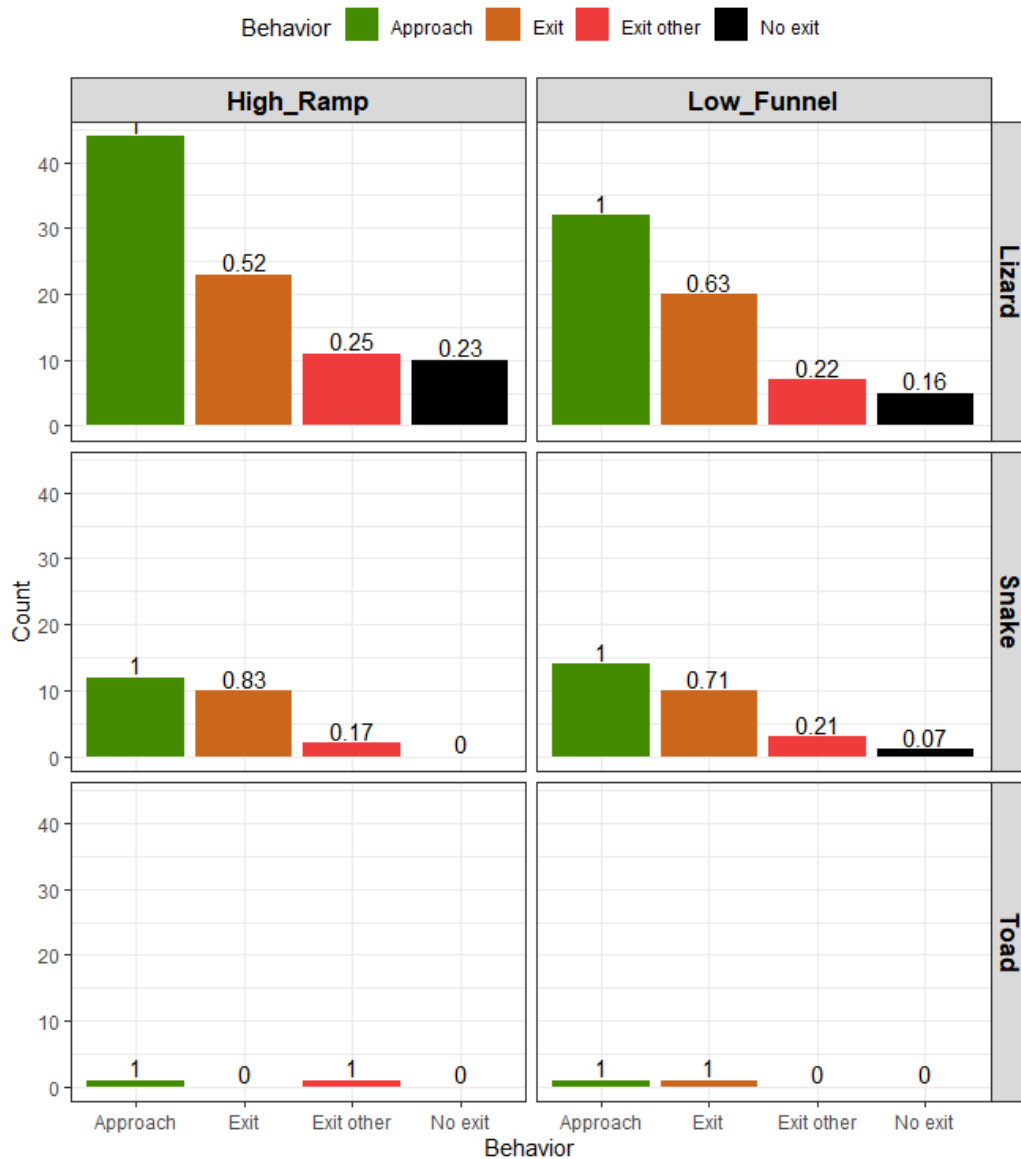


Figure 8. Proportion of Herpetofauna Groups that Approached and Used 2 Jump-Out Designs.

## Discussion

Our results provide evidence that herpetofauna are more likely to interact with the transparent and semi-transparent fences by poking it with their noses, pacing back and forth, and attempting to climb. The transparent and semi-transparent fencing types used in this study are not only see-through but are permeable to the movement of air. Because sight and chemoreception senses are typically well developed in reptiles, it is not clear to what extent these different senses are driving fence interaction behaviors. However, animals exhibiting these behaviors appear to be trying to find a way through the fence to the other side.

Although fence interaction behaviors have been documented elsewhere in comparing hardware cloth and solid fencing (Ruby et al. 1994, Milburn-Rodríguez et al. 2016), our study shows a gradation of response from solid to semi-transparent to transparent fencing in all taxa studied. In addition, our study shows that these behaviors result in animals moving slower, or spending more time, along transparent/permeable fencing in comparison to solid fencing. This may not be a concern when the purpose of the fence is primarily to exclude animals. However, effect of fence opacity on movement rates should be considered when a dual objective is to lead species toward a road crossing structure, particularly when high permeability and population connectivity across the structure is desired (Simlitsch 2008, Hamer et al. 2015, Brehme et al. 2018).

There are reasons why hardware cloth, mesh, or solid barriers may be desirable in particular landscapes, habitats, and climates with considerations that include rain and wind permeability, durability, and aesthetics (Langton and Clevenger 2020). Our study is the first to show that addition of a simple visual barrier at ground level (6 inches our study) can result in substantial decreases in fence interaction behaviors and in increased rates of movement. For most response measures, herpetofauna responses to mesh and hardware cloth fencing with a visual barrier were not significantly different than to the solid barrier. This may allow for more flexibility in the decision-making and planning processes for barrier systems for herpetofauna. With any barrier or fencing system, proper maintenance is extremely important for its continued success (Hamer et al. 2015, Baxter-Gilbert et al. 2015, Langton and Clevenger 2020).

Finally, we showed that two jump-out configurations were largely effective in allowing animals trapped on the wrong side of the barriers to escape back into the habitat. Animals can easily get trapped on the wrong (road) side of barrier fencing by entering through a tear or opening in the fencing or by entering the roadway at the end of the exclusion fencing. Although jump-outs are commonly built structures along wildlife fencing for large mammals, they have not commonly been incorporated into transportation planning for small animal barriers. Jump-outs for herpetofauna can be provided at regular intervals along barriers with interval distances determined by target species movement distances. It is also important that any jump-out design for herpetofauna consider the safety of other wildlife. For short barrier fencing, most other wildlife can simply jump over the barrier. For larger barrier systems, escape routes may include multiple size jump-outs for a wider variety of species.

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# Chapter 7. Effectiveness of Turnarounds in Changing the Trajectory of Reptiles and Amphibians in San Diego, CA.

Authors: Cheryl Brehme<sup>1</sup>, Jeff A. Tracey<sup>1</sup>, Jennifer Kingston<sup>1</sup>, Jeremy Sebes<sup>1</sup>, Tristan Edgarian<sup>1</sup>, Robert Fisher<sup>1</sup>

<sup>1</sup>USGS Western Ecological Research Center

## Introduction

It is common practice to install ‘turnarounds’ at fence ends and where barriers are unable to span across private road entries and easements (e.g. Clevenger and Huijser 2011, Ontario Ministry of Natural Resources and Forestry 2016, Langton and Clevenger 2020). For this, road barriers end in a “U” shape and are designed to redirect animals back in the opposite direction at fence ends and keep them off the roadway. Although they are recommended in many countries and in guidance documents (e.g. Iuell et al. 2003, Clevenger and Huijser 2011, Gunson et al. 2016), there are no systematic studies to our knowledge that have addressed the relative effectiveness of turnarounds (Langton and Clevenger 2017).

We conducted studies at the Rancho Jamul Ecological Reserve in Jamul, California to test the effectiveness of turnarounds in changing the trajectory of movement for herpetofauna and small mammals. We also compared effectiveness and time spent within the turnarounds based upon fence type: transparent, semi-transparent, and solid fencing. The results of these studies will help to inform transportation agencies on these important components of road barrier and crossing systems.

Research questions:

1. Are fence end turnarounds effective in redirecting the trajectory of animal movement?
2. Is the effectiveness of turnarounds influenced by the opacity of barrier fencing?

## Methods

We installed three 20 m segments of solid barrier fencing within coastal sage scrub habitat in RJER adjacent to a dirt road. At the ends of each segment, we installed another 4 m of fencing and a turn-around approximately 1.5 m long and 1 m wide. The turnarounds ended approximately 0.4 m from the fence lines and extended another 0.4 m parallel to the fence (Figure 1). We used three materials with increasing opacity; hardware cloth (0.25 inch), mesh (ERTEC® rigid polymer matrix E-Fence), or solid fencing (Animex® high-density polyethylene (HDPE-2)). The placement of the turnarounds was mixed so that each segment ended with two of the different fence type materials. At the opening of each turnaround, we installed a HALT® active infrared trigger and camera system that allowed us to document animals going into and out of the turnarounds, as well as determine their trajectory upon leaving the turnaround. The cameras were placed 4.25 m from the end of the turnaround (2.25 m from trigger) with a frame of view that allowed us to follow the

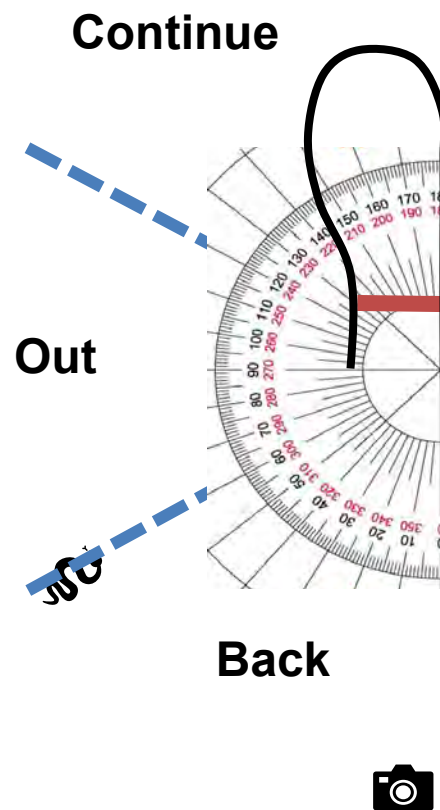
movement of animals for approximately 1 m in any direction and were set to record video for 25 seconds upon an animal activating the trigger. Cameras were set with 32-64GB SD cards and left on and checked on a weekly or biweekly basis from March 1 to Sept. 8, 2019.

## Analysis

We watched all videos and recorded the following:

- Turnaround Fence Type and Segment number
- Species
- Time of entry and exit
- Distance and direction of travel

Individuals were only included in the analysis if the animals moved at least 0.7 m away from the end of the turnaround. If the same individual moved in and out of the turnaround more than once, only their final trajectory was recorded. Final direction of travel was recorded as three categories: Continue, Out, and Back (Figures 1 and 2). We also did not include data where an individual encountered another individual that may have affected the direction of travel.



Note: Extra stakes in ground to keep cows away from turnaround

Figure 1. Example of A) Turnaround with Camera and Trigger Set Up and B) Direction of Movement Categories.

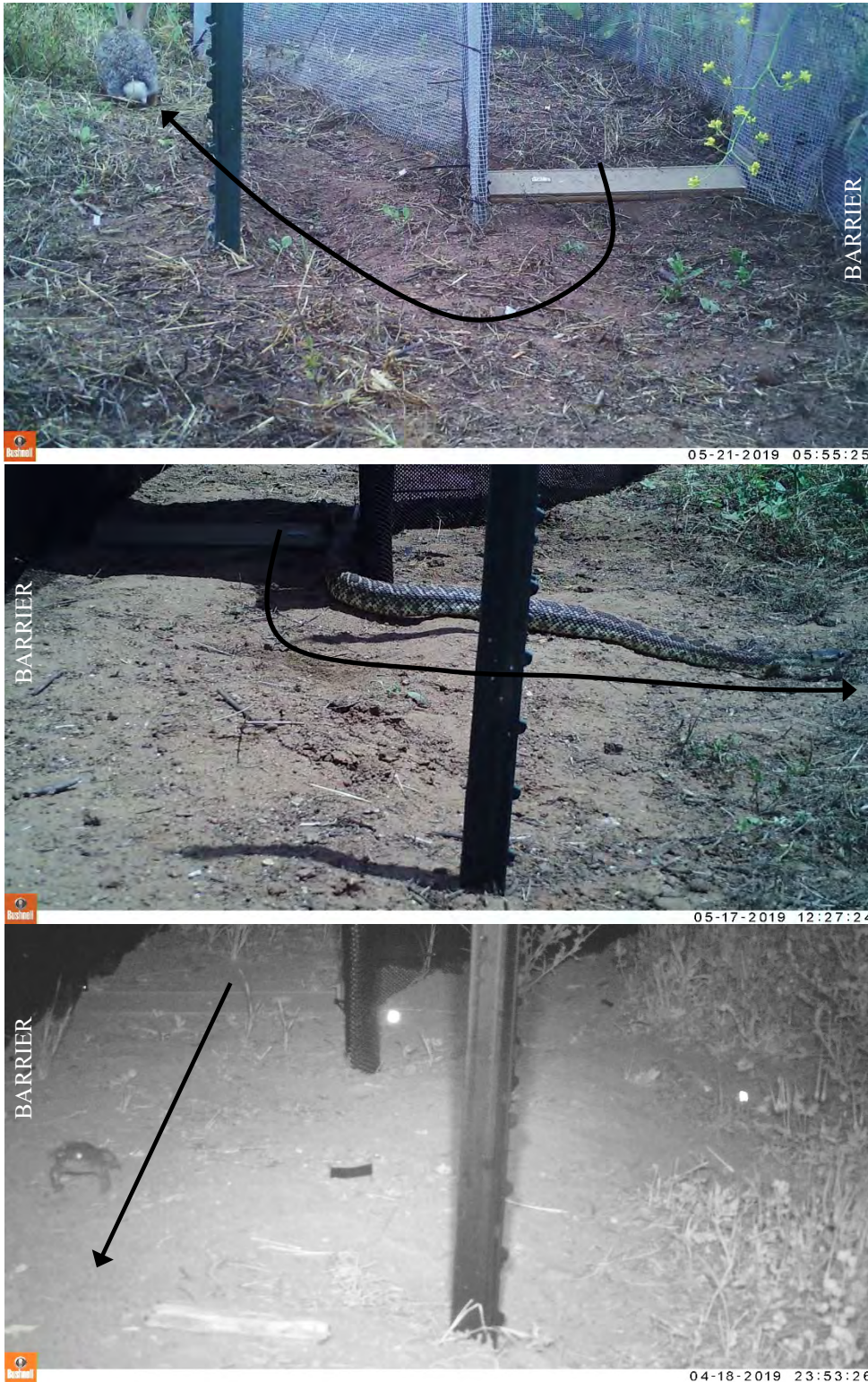


Figure 2. Example of A) Cottontail Rabbit (*Sylvilagus audubonii*) Continuing in the Same Direction, B) Red-Diamond Rattlesnake (*Crotalus ruber*) Moving Away into the Habitat, and C) Western Toad (*Anaxyrus boreas*) Moving Back along the Fenceline after Leaving the Turnaround. Screenshots taken from Videos Showing Animals Continuing in the Same Direction Out of View.



To determine if the turnarounds were successful in changing the trajectory of movement among taxonomic groups and fence types, we analyzed the choice made by each subject after they reached the turnaround using a multinomial logit choice model (Figure 3). Each individual had a choice of turning back (1, “back”), exiting out of the structure (2, “out”), or continuing in the same direction of travel (3, “continue”). This model is a multinomial generalization of the logistic model which models a binomial response (with one trial, hence a Bernoulli random variable). For each choice, we first calculate a “probability potential.” The first choice (back) is a “reference” and is assigned a probability potential of “1” in all cases. The remaining two responses have probability potentials that are an exponential (i.e. rate =  $\exp(y)$ ) function of the linear component of the model that depend on two predictor variables that encode fence type and three variables for taxonomic group, a response-specific intercept and two regression coefficients. The final probabilities for each choice were calculated as the probability potential for that choice divided by the sum of all the probability potentials. This ensured that sum of the probabilities for the choice made for each observation added to one. The taxon-specific parameters were drawn from normal distributions with means and precisions based on parameters drawn from “all taxa” hyper-prior distributions. The hyperprior means were drawn from a normal distribution with mean 0 and 0.001 precision. The precisions were calculated as one over a squared standard deviation, with the standard deviation drawn from a uniform distribution on an interval from 0 to 1000. The parameters were sampled from their posterior distributions using MCMC (as described above) and described by mean, median, and quantiles of their marginal distributions. This allowed us to assess the effect of turn around fence type on the choice made by each subject.

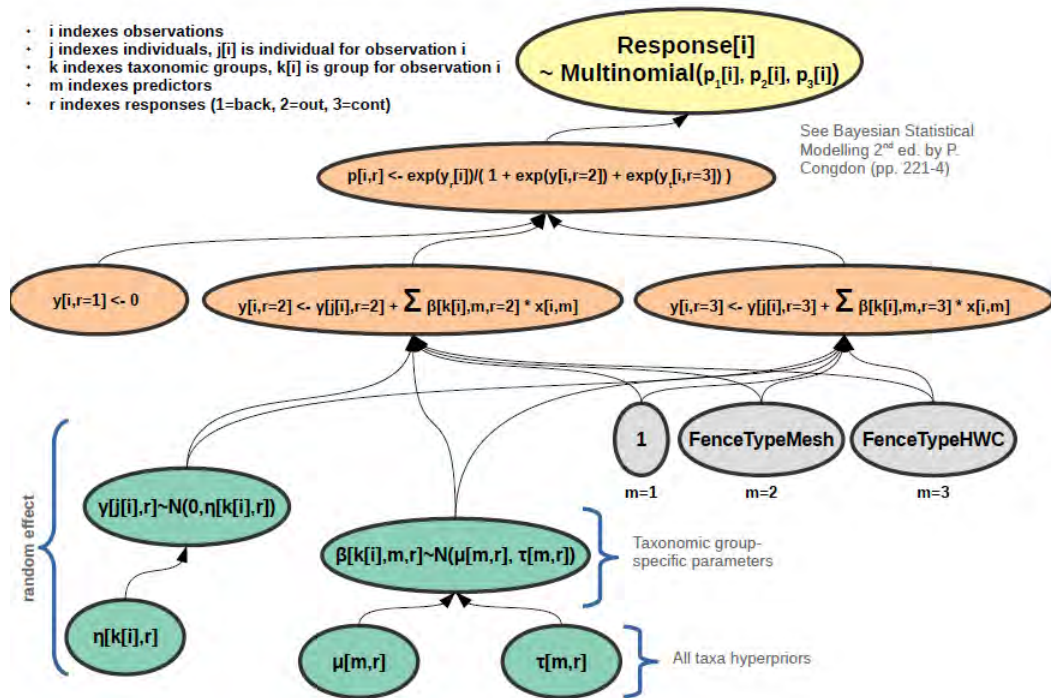


Figure 3. Turn Around Study: Multinomial Logit Choice Model for Response to Turn Around Structure

### Time Spent in Turnarounds: Linear Regression:

We modelled time spent in the turnarounds using linear regression fitted by least squares to determine if time differed across fence types and taxonomic group (lizards, snakes, toads, and small mammals)(Program R):

$$\text{Time} \sim \text{FenceType} * \text{TaxonomicGroup}$$

### Results

We captured useable video of 790 individual turnaround encounters that met our distance criteria. This represented 264 lizard, 96 snake, 59 toad, one frog, and 370 small mammal movements (Table 1). Among all herpetofauna, 92% changed course back toward the fence line or back out into the habitat. A total of 64% of lizard, 68% of snake, 80% of toads and 43% of small mammal movements were made back along the original fence line after encountering a turnaround.

Table 1. Species Documented Using Turnarounds and Movement Trajectory Results

Taxon	Species	Fence lines passed (out of 6)			Proportion Back+ Out
		Continued	Out	Back	
Lizard	<i>SubTotal</i>	26	69	169	0.90
	<i>Aspidoscelis hyperythrus</i>	12	53	69	0.91
	<i>Aspidoscelis tigris</i>			2	1.00
	<i>Elgaria multicarinata</i>			1	1.00
	<i>Plestiodon gilberti</i>			1	1.00
	<i>Plestiodon skiltonianus</i>		1		1.00
	<i>Sceloporus occidentalis</i>	3	1	15	0.84
	<i>Uta stansburiana</i>	11	14	79	0.89
	<i>Unknown lizard</i>			2	1.00
Snake	<i>SubTotal</i>	1	30	65	0.99
	<i>Coluber fuliginosus</i>		2	12	1.00
	<i>Coluber lateralis</i>	1	9	23	0.97
	<i>Coluber flagellum</i>		6	9	1.00
	<i>Crotalus oreganus</i>		6	5	1.00
	<i>Crotalus ruber</i>		2	1	1.00
	<i>Lampropeltis getula</i>		2	3	1.00
	<i>Pituophis catenifer</i>		2	11	1.00
	<i>Salvadora hexalepis</i>		1		1.00
	<i>Unknown snake</i>			1	1.00
Toad/Frog	<i>SubTotal</i>	5	8	47	0.92
	<i>Anaxyrus boreas</i>	4	5	31	0.90
	<i>Pseudacris regilla</i>			1	1.00
	<i>Unknown anuran</i>	1	3	15	0.95
Small Mammal	<i>SubTotal</i>	120	91	159	0.68
	<i>Chaetodipus spp.</i>	3	15	33	0.94
	<i>Dipodomys simulans</i>	29	22	36	0.67
	<i>Microtus californicus</i>	3	2	2	0.57
	<i>Neotoma spp.</i>	5	2		0.29
	<i>Notiosorex crawfordii</i>	1	1	2	0.75
	<i>Otospermophilus beecheyi</i>	41	16	35	0.55
	<i>Peromyscus spp.</i>	37	30	47	0.68
	<i>Reithrodontomys megalotis</i>		1	1	1.00
	<i>Thomomys bottae</i>		2	1	1.00
	<i>Unknown rodent</i>	1		2	0.67
	<i>Grand Total</i>	152	198	440	0.81



Across fence types, results of the multinomial logit choice model showed high probabilities ( $\rho$ ) that lizards, snakes, and toads changed their trajectory of movement (back, out) after encountering and exiting a turnaround (Lizard  $\rho= 0.88$ , 90% CI 0.70–1.00, Snakes  $\rho= 0.98$ , 90% CI 0.77–1.00, Toad  $\rho= 0.90$ , 90% CI 0.62–1.00). Responses by lizards and toads, but not snakes, varied by fence type (Figure 4). Lizards and toads were generally more likely to change their trajectory (back, out) after encountering mesh and hardware cloth turnarounds in comparison to solid turnarounds.

Mammals had an overall lower probability than herpetofauna of changing their trajectory after exiting turnarounds (back and out  $\rho= 0.59$ , 90% CI 0.41–0.84). By fence type, mammals were more likely to change their trajectory (back, out) after encountering hardware cloth turnarounds in comparison to solid and mesh turnarounds.

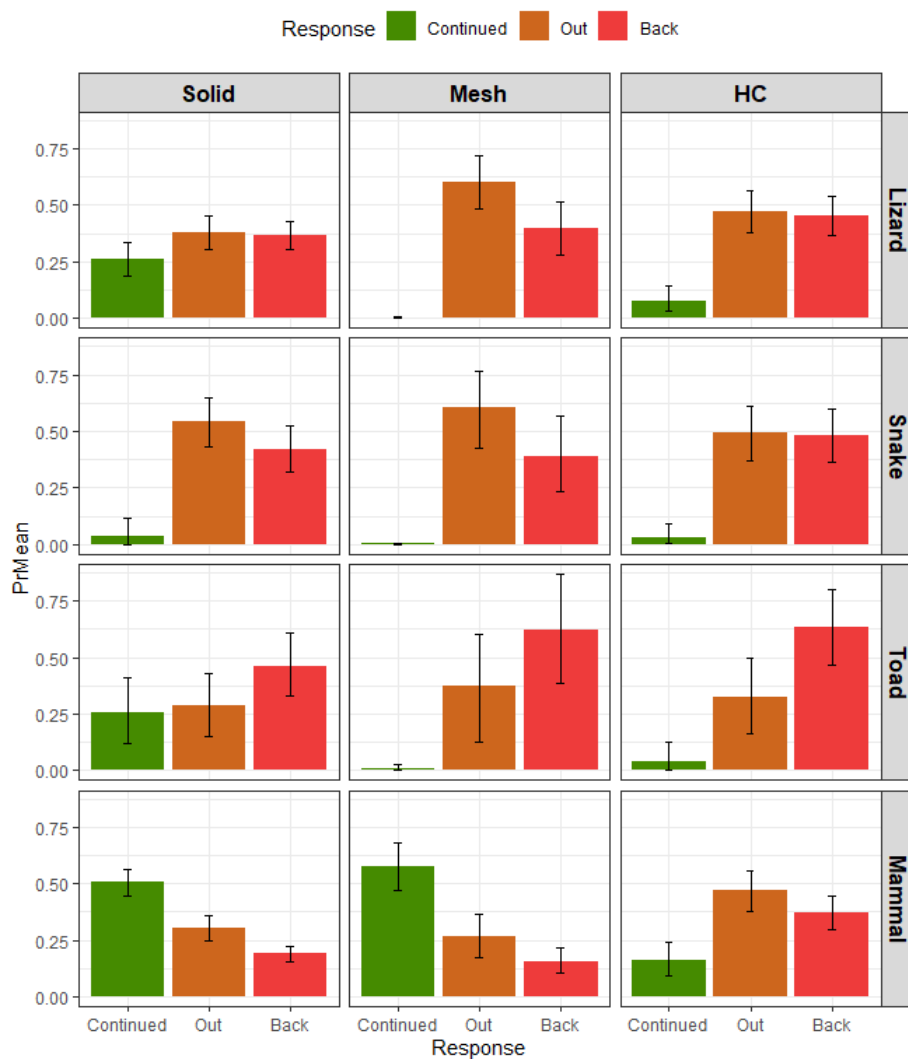


Figure 4. Directional Probabilities After Exiting Turnaround by Taxonomic Group and Fence Type (+/- 90% CI)

By Fence Type, all groups except toads spent significantly less time in the solid turnarounds than in the hardware cloth turnarounds ( $p < 0.001$ ; Table 2, Figure 5). Overall by taxon, mammals spent the least time in turnarounds (ave. model estim.=0.4 min), followed by snakes (ave. model estim.=1.9 min), lizards (ave. model estim.= 2.7 min), and toads (ave. model estim.=3.0 min).

Table 2. Effects and Interactions of Fence Type and Taxon on Time spent in Turnaround

Coefficients:	Estimate	Std. Error	t-value	Pr(> t )	
(Intercept= Solid/Lizard)	0.105	0.136	0.777	0.437	
FenceTypeMesh	1.083	0.286	3.788	1.65E-04	***
FenceTypeHC	1.240	0.218	5.683	1.96E-08	***
TaxGroup1Mammal	-1.424	0.177	-8.063	3.31E-15	***
TaxGroup1Snake	-0.009	0.275	-0.032	0.974	
TaxGroup1Toad	0.698	0.307	2.271	0.023	*
FenceTypeMesh:TaxGroup1Mammal	-0.926	0.371	-2.498	0.013	*
FenceTypeHC:TaxGroup1Mammal	-0.587	0.298	-1.971	0.049	*
FenceTypeMesh:TaxGroup1Snake	-0.699	0.560	-1.248	0.212	
FenceTypeHC:TaxGroup1Snake	-0.263	0.400	-0.658	0.511	
FenceTypeMesh:TaxGroup1Toad	-0.498	0.665	-0.748	0.454	
FenceTypeHC:TaxGroup1Toad	-1.030	0.500	-2.059	0.040	*
(Intercept= Solid/Lizard)	0.105	0.136	0.777	0.437	

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

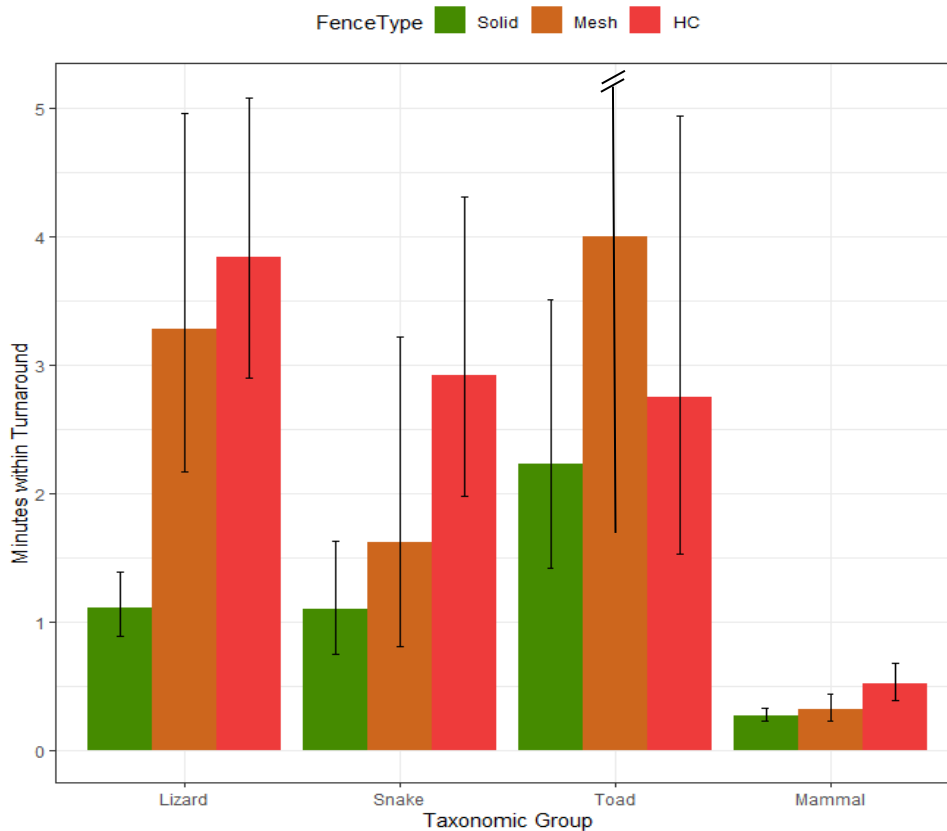


Figure 5. Estimated Time Spent in Turnaround by Taxonomic Group and Fence Type (+/- 90% CI)

## Discussion

Our study is the first to show that small turnarounds at fence ends can be effective in changing the trajectory of movement for a majority of herpetofauna and small mammals. We documented that over 90% of herpetofauna (lizards, snakes and toads), as well as 69% of small mammals, changed course after leaving the turnaround. Of these 67% of herpetofauna and 43% of small mammals moved back along the original fence line. We (Chapter 5), and others (Ruby et al. 1994, Milburn-Rodríguez et al. 2016) have shown that animals spend more time interacting with fencing that they can see and smell through (e.g. poking, back and forth movements, climbing). We observed this in the turnaround study as well, as lizards, snakes and small mammals spent increased amounts of time in transparent/permeable and semi-transparent/permeable turnarounds than solid turnarounds.

Turnarounds made of solid fencing appeared to be less effective in changing the movement trajectory of lizards and toads in comparison to mesh and hardware cloth fencing. In addition, both solid and semi-transparent mesh fencing appeared to be less effective in changing the trajectory of small mammals in comparison to more transparent hardware cloth. These results could be related to animals interacting with the fencing and spending more time in the more transparent turnarounds, so that they were less likely to remember and continue on their original trajectory. The results may also be related to the different types of spatial learning and memory used for navigation when animals are subjected to solid barriers (egocentric) in comparison to transparent barriers (allocentric) as has been shown in maze-food trials with rodents (Violle et al. 2009, Vorhees and Williams 2014). Validation of these findings in other locations and possibly more specific research studies addressing spatial learning and movement responses in reptiles, amphibians, and small mammals in their natural environments would be needed to further our understanding of these results.

We did not compare different sizes or shapes of turnarounds in our study; however, we hypothesize that having the end of the turnaround close to the original fence line (or turning back in toward the fence line) may help to steer animals back to the original barrier in the other direction. We chose not to install large turnarounds as we wanted to reduce the probability of animals becoming stressed or ‘trapped’ in the turnarounds for long periods of time. However, longer turnarounds or larger turnarounds encompassing smaller turnarounds may increase the probability that animals do not make it onto the roadways (Langton and Clevenger 2020). Our study also suggests the use of transparent or semi-transparent fencing for turnarounds may potentially increase their effectiveness.

In this study, we only documented animal movement for up to 1 m (3.4 feet) after leaving the turnaround. It is entirely possible that animals changed course again after they left the field of view of the video camera. In our Stanford and Sierra movement studies (Chapters 3 and 4), two out of three CTS that presumably reached a turnaround at the fence end were subsequently documented on another camera 25-125 m away moving back along the fence line. Preliminary results suggest seven out of 10 Yosemite toads changed course at a turnaround, while three continued in the direction past the fence ends. Of the seven toads that changed course, four were

subsequently documented on another camera 40-80 m away moving back along the fence line toward the passage. Further studies using more cameras and/or tracking methods are needed to better understand how turnarounds affect movement of animals over a longer distances and time frames. Higher mortality of herpetofauna has been well documented at fence ends even with turnarounds (Gunson et al. 2014, Langton and Clevenger 2017, Helldin and Petrovan 2019). However, the high proportion of herpetofauna that changed directions in our study supports the use of turnarounds in attempts to reduce the chances that small animals go out onto the roadway at fence ends and potentially to help ‘steer’ them back toward to a crossing structure.

In our migrating California tiger salamander (Chapter 4) and Yosemite toad studies (Chapter 5), we also found that these amphibian species were much less likely to encounter a crossing structure if they started out in the ‘wrong’ direction (i.e. moving away from the crossing after encountering a barrier). Many animals “gave up” before reaching the fence ends. These results suggest that more regularly placed turnarounds along the fence lines may allow them to correct their trajectory sooner and possibly increase their chances of making it to crossing structures. If effective, this strategy may help to increase the permeability of crossing structures to individual and population movements of reptiles and amphibians (and small mammals). These studies are currently in the planning stages.

## Acknowledgements

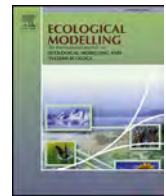
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# Population persistence in landscapes fragmented by roads: Disentangling isolation, mortality, and the effect of dispersal

Ana Ceia-Hasse<sup>a,b,c,d,\*</sup>, Laetitia M. Navarro<sup>a,b</sup>, Luís Borda-de-Água<sup>c,d</sup>, Henrique M. Pereira<sup>a,b,c,d</sup>

<sup>a</sup> German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher Platz 5e, 04103 Leipzig, Germany

<sup>b</sup> Institute of Biology, Martin Luther University Halle-Wittenberg, Am Kirchtor 1, 06108 Halle (Saale), Germany

<sup>c</sup> Infraestruturas de Portugal Biodiversity Chair, CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Campus Agrário de Vairão, Universidade do Porto, 4485-661 Vairão, Portugal

<sup>d</sup> CEABN/InBio, Centro de Ecologia Aplicada “Professor Baeta Neves”, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal

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## ABSTRACT

Linear infrastructures, one of several forms of land-use, are a major driver of biodiversity loss. Roads impact populations at many levels, with direct road mortality and barrier effect contributing to decreased population abundance, higher isolation and subdivision, and therefore to increased extinction risk. In this paper, we compared the effect of road mortality and of the barrier effect on population isolation, persistence and size, and assessed the interaction of these effects with dispersal. We used a spatially explicit, process-based model of population dynamics in landscapes fragmented by varying levels of road density. We modelled a barrier effect independently from road mortality by varying the probability with which individuals avoid crossing roads. Both road mortality and the barrier effect caused population isolation. While road mortality alone had stronger negative effects than the barrier effect without extra mortality, the latter also resulted in decreased population size. Yet, road avoidance could, in some cases, rescue populations from extinction. Populations with a large dispersal distance were more negatively affected as road mortality increased. However, when there was no road mortality they maintained larger sizes than populations with a short dispersal distance. Our results highlight the much higher relative importance of road mortality than the barrier effect for population size and persistence, and the importance of assessing relevant species traits for effective long-term transportation planning and conservation management. Our model can be used in species-specific situations and with real landscape configurations in applications such as conservation planning.

## 1. Introduction

The current biodiversity crisis is mainly driven by land-use change (Pereira et al., 2012; Maxwell et al., 2016). Roads, one of many forms of land-use, cause major impacts on populations. As the road network is predicted to strongly increase in the coming years (van der Ree et al., 2015), it is crucial to assess its impact on populations, in order to apply suitable mitigation measures, and improve conservation and road planning.

Roads cause habitat loss and fragmentation, and decrease habitat quality. Roads also cause direct mortality through wildlife collisions with vehicles, and act as a barrier to movement (van der Ree et al., 2015). These direct and indirect impacts of roads can contribute to population isolation and subdivision, to decreases in population abundance, and therefore can increase population extinction risk (van der

Ree et al., 2015; Ascensão et al., 2016), although there are also positive effects for some species (e.g., see Rytwinski and Fahrig, 2012, 2013).

Species traits can also influence population-level responses to land-use change (Pereira and Daily, 2006), and should be considered when assessing the effects of roads. Specifically, dispersal has been identified as an important factor but its influence on population persistence is still not fully understood. For example, while the role of dispersal is beneficial in metapopulation models (e.g., Hanski, 1998), because more patches can be colonized if dispersal is large, in source-sink models or reaction-diffusion models (e.g., Skellam, 1951; Pulliam, 1988) dispersal affects populations negatively, because it can lead to colonization of habitats where population growth rates are negative (sink habitats) (Pereira and Borda-de-Água, 2013). Moreover, dispersal can be associated with increased mortality risk (e.g., Nathan et al., 2012), with some studies suggesting there is an optimal intermediate dispersal rate

\* Corresponding author at: German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher Platz 5e, 04103 Leipzig, Germany.

E-mail addresses: [ana.ceia\\_hasse@idiv.de](mailto:ana.ceia_hasse@idiv.de) (A. Ceia-Hasse), [laetitia.navarro@idiv.de](mailto:laetitia.navarro@idiv.de) (L.M. Navarro), [lbagua@cibio.up.pt](mailto:lbagua@cibio.up.pt) (L. Borda-de-Água), [hpereira@idiv.de](mailto:hpereira@idiv.de) (H.M. Pereira).

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for persistence in disturbed habitats (Casagrandi and Gatto, 1999).

The detrimental effect of dispersal in disturbed habitats is supported by several empirical studies (e.g., fragmented forests: Gibbs, 1998; Van Houtan et al., 2007). In the specific case of roads, a higher mobility has been related to negative effects of roads in mammal and bird species (Rytwinski and Fahrig, 2012). Furthermore, using a theoretical approach, Borda-de-Água et al. (2011) predicted that the larger the mean dispersal distance in a population, the larger would be the minimum area necessary for this population to persist in a landscape fragmented by roads.

In this paper we focus on dispersal movement as the process whereby individuals leave their initial location, move across a more or less suitable environment, and settle in a new location (Clobert et al., 2012; Matthysen, 2012). Our model does not currently include other types of movement (such as daily movements).

Direct road mortality introduces an additional source of mortality besides natural mortality. In addition, roads can also act as a barrier that does not introduce additional mortality, when the animals do not cross the roads. This barrier effect can be due to physical structures (such as fences) or to road avoidance behavior (e.g., Jaeger and Fahrig, 2004; Grilo et al., 2012), and for simplicity in this paper we refer to it simply as barrier effect. Although this can rescue individuals from road mortality to some extent, the negative consequences of habitat loss and fragmentation may be higher when such barrier effect is present, since road avoidance can lead to population isolation and to higher exposure to demographic and environmental stochasticity (Rytwinski and Fahrig, 2012; Ascensão et al., 2016). Moreover, the effects of road mortality and of road avoidance can be confounded and are still to be properly disentangled. For example, reduced population abundance near roads may be due to direct road mortality, or due to road avoidance behavior (e.g., Fahrig et al., 1995).

Although there is evidence that the effects of roads on population abundance are in general negative (Rytwinski and Fahrig, 2015), the impact of roads on population persistence has not been so commonly addressed (but see, for example Borda-de-Água et al., 2014 and Ceia-Hasse et al., 2017).

The key issue addressed in this paper was to disentangle the influence of an additional source of mortality (direct road mortality) versus the influence of a barrier effect to movement that does not introduce such additional mortality on population isolation, persistence and size, as well as the influence of dispersal, in fragmented landscapes. We addressed this using roads. We use a spatially explicit, process-based model of population dynamics. Our questions were: (1) What is the importance of road mortality versus isolation, for population persistence and size in landscapes fragmented by roads?; (2) How does dispersal influence the size and the persistence of populations under varying levels of road mortality and of a barrier effect?

## 2. Materials and methods

We used an individual-based toy model of population dynamics to perform a theoretical study on the effects of road mortality, barrier effect and dispersal on population isolation, size and persistence of a virtual species. Our study is not based on any empirical data and thus is more appropriately considered under the virtual ecology rationale (e.g., Grimm, 1999; Zurell et al., 2010).

### 2.1. Model description

The model description follows the ODD (Overview, Design concepts, Details) protocol for describing agent-based models (Grimm et al., 2006, 2010). The model was implemented as an ANSI C++ program, which can be downloaded from <https://github.com/anaceiahasse/landsim>.

#### 2.1.1. Purpose

The purpose of the model is to simulate population dynamics in fragmented landscapes. Specifically, in this study, the model simulated population dynamics in landscapes fragmented by roads, with special emphasis on the effects of road mortality, of a barrier effect without mortality, and on the influence of dispersal distance.

#### 2.1.2. Entities, state variables, and scales

The entities of the model are the landscape and the individuals, i.e., the model keeps track of the features of the landscape and of the female population (the model only considers female individuals for simplicity).

The landscape is a two-dimensional grid of  $N \times N$  square cells with reflecting boundaries. An alternative approach to deal with edge effects would have been to consider periodic boundary conditions (i.e., torus geometry) instead of reflecting boundaries. However, given a dispersal step size of only one cell and the large size of the grid, both approaches can lead to similar outcomes. Each cell of the landscape is assigned to one of  $n$  possible types with values varying between 0 and 1. In the present case, each cell belongs to one of two possible types, "high-quality" habitat (non-road) or "road", with values of "1" and "0", respectively. We generated several landscapes with different proportions of road cells, where roads were placed perpendicularly to one another (Fig. 1, Table 1). We used simple hypothetical regular road networks because our main objective was to disentangle the effects of sink mortality versus those of a barrier effect that does not introduce additional mortality. Sink mortality here corresponds to road mortality, and it is the probability that an individual dies when crossing a road (see Section 2.1.7.3 below). Our goal was to derive general principles that can be the basis to understanding and model more specific or complex cases.

Individuals are characterized by the following state variables: age, developmental stage (juvenile or adult), position in the landscape; and by the following attributes: fecundity, age at first breeding, natural survival probability, home range size, dispersal distance, road mortality probability, road avoidance probability (Table 1).

#### 2.1.3. Process overview and scheduling

Each simulation time step consists of the following sequential events (Fig. 2, Table 1): reproduction; natural mortality; dispersal of juveniles; juvenile density-dependent mortality. Section 2.1.7 describes the sub-models implementing these processes. Juveniles that establish a home range are inserted into the adult population at the end of each simulation time step, thereby updating population size and landscape cell availability for the following time step. At the beginning of each simulation time step, the age of each individual is updated (increased by 1), and the sequential steps listed above ensue.

#### 2.1.4. Design concepts

**2.1.4.1. Basic principles.** Roads can contribute to population isolation, decreased size and increased extinction risk through direct mortality and barrier effects (e.g., van der Ree et al., 2015; Ascensão et al., 2016). Dispersal can also influence how roads impact populations (e.g., Borda-de-Água et al., 2011; Rytwinski and Fahrig, 2012). The model allows assessing the relative importance of these factors for population isolation, persistence and size, which is not yet fully understood.

**2.1.4.2. Emergence.** Population dynamics emerges from the model (i.e. from the set of rules defined, parameter values used and landscape configuration).

**2.1.4.3. Adaptation.** Juveniles choose the direction in which they disperse according to cell type (road versus high-quality habitat cell) and occupancy (they may avoid dispersing into road cells with a given probability and they do not disperse to occupied cells, respectively).

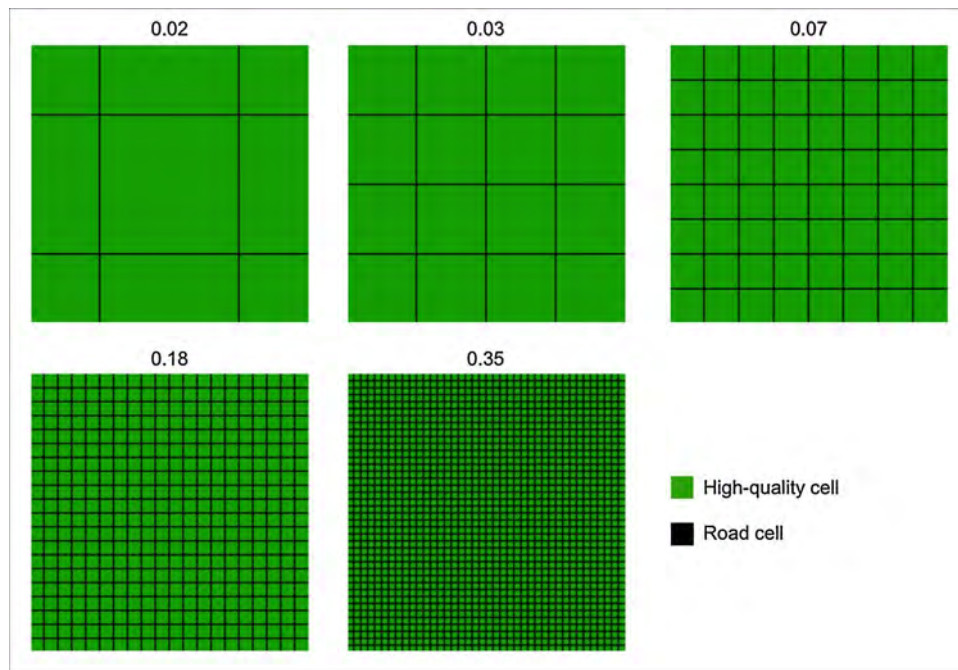


Fig. 1. Landscape configurations used in simulations. Each landscape is a grid of  $200 \times 200$  cells composed of high-quality habitat cells, and road cells. Numbers on top of each panel indicate the proportion of road cells in each landscape.

Table 1  
Model parameters and values used in the simulations.

Parameter	Value	
	1st set of simulations	2nd set of simulations
Landscape size ( $N \times N$ )	$200 \times 200$ cells	
Initial population size	10 individuals	
Number of replicates	100	
Number of time steps	1000	
Fecundity ( $b_i$ )	2	
Survival probability ( $s$ )	0.4	
Dispersal distance ( $d$ )	5 or 50 cells	
Road mortality, Road avoidance ( $m_{RM}, p_{RA}$ )	(0.0, 0.0); (0.0, 1.0); (1.0, 0.0)	varied from 0 to 1 in steps of 0.1
Proportion of road cells in the landscape	0.02, 0.03, 0.07, 0.18, 0.35	0.07, 0.35

2.1.4.4. *Sensing.* During dispersal, juveniles evaluate cell type (road versus non-road cell) and occupancy.

2.1.4.5. *Interaction.* Juveniles do not disperse through cells that are already occupied.

2.1.4.6. *Stochasticity.* Stochasticity was incorporated in several processes (reproduction, natural mortality, dispersal of juveniles); see Section 2.1.7 for details.

2.1.4.7. *Observation.* For each model run, we recorded population size at the end of each simulation and averaged population size across replicates. We calculated the probability of extinction as the proportion of replicates in which populations went extinct before the end of the simulation.

2.1.5. *Initialization*

The model starts by settling an initial population of females at breeding age in the landscape. After the initial population is created, each simulation time step consists of the events described in Section 2.1.7 (Submodels). In all simulations, the initial population size was 10 individuals, set at random in the landscape. See Table 1 for the

remaining parameter values used in the simulations and Fig. 3 for a representation of the settlement of the initial population in the landscape and of the colonization of the landscape.

2.1.6. *Input data*

The model does not import data of driving environmental variables.

2.1.7. *Submodels*

2.1.7.1. *Reproduction.* Females reproduce after one year and once they have established their home range. The number of female juveniles that a breeding female produces follows a Poisson distribution with mean equal to its fecundity  $b_i$ .

2.1.7.2. *Natural mortality.* Adults and juveniles die with probability  $(1 - s)$ . When an individual dies it is removed from the population and its home range cell is made available for dispersing individuals.

2.1.7.3. *Dispersal of juveniles.* In our model adults do not move, and do not get killed by direct road mortality. Only juveniles disperse. Each juvenile disperses a fixed number of cells from its mother cell. A dispersal step is always to one of the four neighboring cells (von Neumann neighborhood), and is composed of the following events (Fig. 2b): (1) the individual evaluates whether its four neighboring cells are occupied or free, and does not disperse to occupied cells; (2) the individual evaluates whether the free neighboring cells correspond to roads or not, and can avoid dispersing through road cells with probability  $p_{RA}$ ; (3) if the individual disperses through a road cell, sink dispersal mortality (road mortality) is applied with probability  $m_{RM}$ . The dispersal process is not stopped when the individual finds a first suitable empty cell; instead it continues until the individual either dies (due to road mortality), or disperses over his dispersal distance,  $d$ . An individual is allowed to move back to a cell it has previously visited. Therefore, two neighboring unoccupied cells are sufficient for an individual to survive over any number of dispersal steps. Moreover, each juvenile disperses from its mother cell, but given natural mortality that cell may be freed, and in that case it can be occupied by a juvenile. The default probability of dispersing to any neighboring cell is 1. However, if all four neighboring cells are occupied, and since

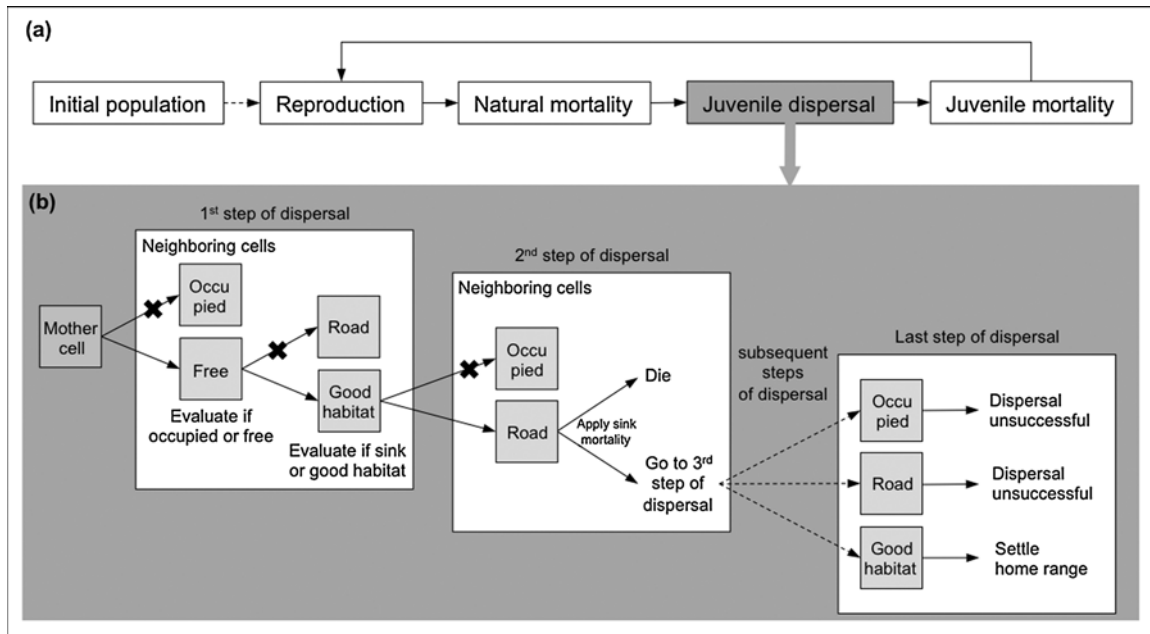


Fig. 2. Scheme of the model. (a) Schematic representation of the complete model simulation steps. (b) Schematic representation of juvenile dispersal. The x in (b) indicate that the individual does not disperse to occupied cells, and that it will disperse to a good habitat cell over a road cell.

individuals do not disperse to occupied cells, then the individual cannot move and dispersal is unsuccessful. If the cell in which the individual is at the end of dispersal is a road, dispersal is also unsuccessful. If dispersal is successful, the individual can settle a home range. In this

study, we set the home range size to one cell and only one individual can establish its home range in each cell.

2.1.7.4. Juvenile density-dependent mortality. Following unsuccessful

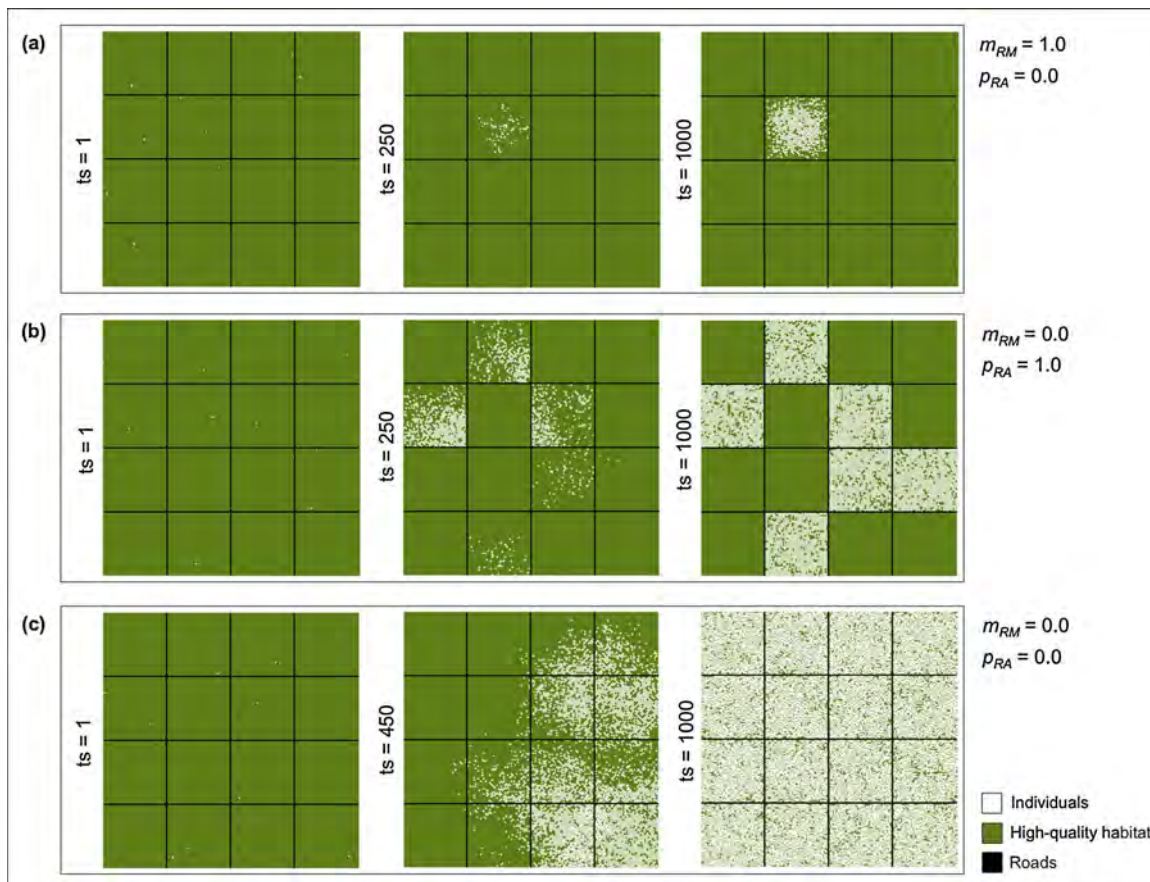


Fig. 3. Representation of the colonization of the landscape by a population under different combinations of values of road mortality probability ( $m_{RM}$ ) and of road avoidance probability ( $p_{RA}$ ), in different time steps ( $ts$ ) of a model run. In the example shown, the dispersal distance is set to 50 cells (i.e. large dispersal) and the proportion of road cells in the landscape is 0.03.



dispersal, juveniles that did not establish their home range are removed from the population.

## 2.2. Simulations

We created five landscapes of  $200 \times 200$  cells with perpendicular roads, each with a different proportion of road cells (Fig. 1, Table 1). We used two dispersal distances: short (5 cells), and large (50 cells), the latter of which we deemed reasonable considering the total size of the grid (40,000 cells). We modelled a barrier effect independently from sink mortality by varying the probability with which individuals do not cross roads while dispersing.

We performed two sets of simulations. In the first set of simulations, we assessed the effect of different extreme scenarios of road mortality and of road avoidance in landscapes with different proportions of road cells: (i) road mortality probability was one and there was no road avoidance; (ii) road avoidance probability was one and there was no road mortality; (iii) road mortality and road avoidance probabilities were both zero, for each dispersal distance and each road density. To assess the combined effects of road mortality and of road avoidance, in the second set of simulations we varied road mortality and road avoidance probabilities both at the same time independently from 0 to 1 in steps of 0.1 (i.e., using all combinations possible), for each dispersal distance (Table 1).

In all simulations, we used fixed values of the remaining parameters (Table 1), simulating the dynamics of hypothetical animal populations in hypothetical landscapes, because our main objective was to obtain general predictions on the differential effects of road mortality versus a barrier effect that did not introduce additional mortality (due to road avoidance behavior or physical structures such as fences), under different levels of dispersal.

We ran each simulation for 1000 time steps, to ensure that population size did not vary by more than 10% between consecutive simulation time steps, for at least the last 10 simulation time steps, and ran 100 replicates for each combination of values of parameters (Table 1).

Our computer program was extensively debugged, thus we are confident that the program is reproducing accurately the intended model. Being an individual-based model computer simulation, we performed our simulations under a set of assumptions that we deemed reasonable, and we tested them for a wide range of parameter values, obtaining the expected results.

Our model takes as input the model parameters and a two-dimensional matrix with the landscape. It produces a file containing the location of the home range of each adult in the landscape at each time step, and the population age structure at each time step. To apply the model to other species and landscape configurations, users can choose the values of the parameters specific to the species or population of interest, and a matrix with the desired landscape configuration.

## 3. Results

In our simulations, isolation occurred due to road mortality or to road avoidance (Fig. 3). With complete road mortality and no avoidance (Fig. 3a), or with complete avoidance and no road mortality (Fig. 3b), the landscape was only partially occupied. In contrast, when there was no mortality and no avoidance (Fig. 3c), the whole landscape was occupied.

When there was no road mortality and no road avoidance, the probability of extinction was higher and the population size was smaller at higher road densities, suggesting an effect due to habitat loss (Fig. 4). Nevertheless, with no road mortality and no road avoidance, the probability of extinction was zero or close to zero, even with high road density (Fig. 4a); and the population size was considerably larger than with either complete road avoidance, or complete road mortality (Fig. 4b). These results suggest that in such cases there was an effect of road avoidance or of road mortality, respectively.

The probability of extinction was higher and the population size was smaller when there was road mortality alone, than when there was road avoidance alone, except at the highest road density (Fig. 4). However, population size was much smaller at all road densities when there was road avoidance than in the case with no road avoidance and no road mortality (Fig. 4b).

When assessing the combined effects of road mortality and of road avoidance for different dispersal distances at the highest road density, the probability of extinction increased and the population size decreased with increasing road mortality (horizontal lines in Fig. 5). For a constant value of road mortality (vertical lines in Fig. 5), probability of extinction decreased and population size increased with increasing road avoidance. However, at this road density, the good habitat patches delimited by roads were small (16 cells), and populations went extinct when road avoidance was complete, even without road mortality.

The role of dispersal varied with road mortality. The probability of extinction increased and the population size decreased much faster with increasing road mortality for the large than for the short dispersal distance. However, when there was no road mortality, the probability of extinction was higher (Fig. 5a) and the population size was smaller (Fig. 5b) for the short dispersal distance.

Similar patterns were observed when assessing these effects at a lower road density (proportion of road cells in the landscape = 0.07; Fig. S1 in Appendix). However, they were less obvious than in the case of high road density, especially for the short dispersal distance: the probability of extinction was low, and the population sizes varied less. Nevertheless, population size strongly decreased with complete road avoidance, or with complete road mortality, for both dispersal distances, as in the case of high road density (Fig. 5).

Note that for the short dispersal distance and also for most of the large dispersal distance simulations in Fig. S1, while the probability of population extinction is close to zero, the population size is low, both when road mortality is one, and when road avoidance is one. This is because many individuals die on roads (when road mortality is one), or the population can only occupy part of the landscape (when road avoidance is one).

## 4. Discussion

Our results allow to make inferences about the differential effects of sink mortality versus those of a barrier effect without additional mortality, and the role of dispersal, on population persistence, isolation and size, which were the goals of this study. While habitat amount was kept constant when road mortality probability and road avoidance probability were varied with a same road density, it should nevertheless be taken into account that by generating landscapes with habitats and roads as grid cells, and by using a regular road network pattern, landscapes with higher road densities have lower total habitat amount and smaller habitat patches. In this sense, there were three effects present (i.e., road mortality, road avoidance, and habitat amount change).

### 4.1. Importance of road mortality versus a barrier effect without mortality for population persistence and size

Road mortality alone had a stronger negative effect on the probability of persistence and on population size than road avoidance alone. Road avoidance could also in some cases rescue populations under low to moderate road mortality from extinction, as suggested by other authors, since road avoidance decreases the probability that individuals cross roads, therefore reducing mortality caused by collision with vehicles (Jaeger and Fahrig, 2004; Rytwinski and Fahrig, 2013). Previous studies also suggest that the genetic effects of road mortality are stronger than those of the barrier effect without road mortality (e.g., Jackson and Fahrig, 2011; Ascensão et al., 2013).

In our simulations, population isolation occurred both when there was road mortality, or when there was a barrier effect without



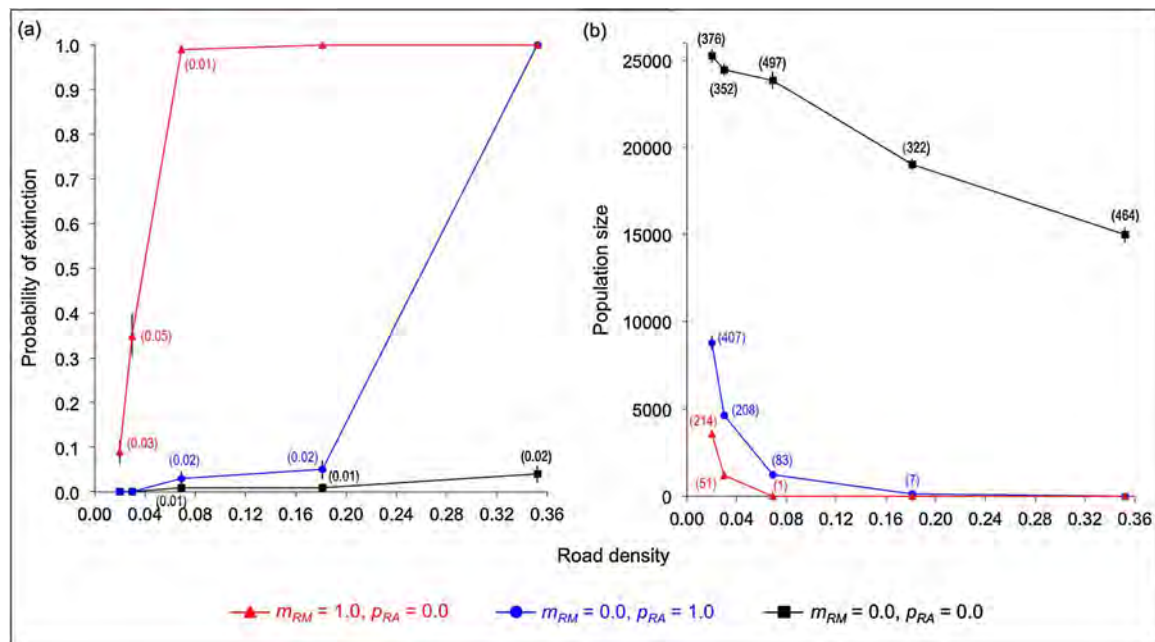


Fig. 4. Probability of population extinction (a) and population size (b) for the different proportions of road cells in the landscape, for different combinations of values of road mortality probability ( $m_{RM}$ ) and of road avoidance probability ( $p_{RA}$ ). Results shown are for the large dispersal distance (50 cells). Error bars correspond to the standard error of the mean, whose values are indicated in brackets (when different from zero).

additional mortality. Populations persisted even when road avoidance was very high, provided that the road mortality was low to moderate. Only complete road avoidance led populations to extinction, when road density was the highest. In those cases, individuals were isolated within the small patches of good habitat that were bounded by roads, and the resulting small populations exhibited an increased extinction risk due to demographic stochasticity (Lande, 1993).

Habitat fragmentation impairs species persistence and ecosystem functions. Moreover, the several effects of fragmentation are interlinked and can operate over long time scales (Haddad et al., 2015). In our analysis, population sizes were negatively affected when road avoidance was complete regardless of the road density, even if there was no road mortality. Population sizes were much smaller when compared to the cases with no road avoidance (and no road mortality). This may influence population persistence in the long-term, especially if other factors of disturbance come into play. For example, we did not vary habitat quality (all non-road cells had maximum habitat quality), because our aim was to obtain general predictions on the differential effects of road mortality versus those of a barrier effect without mortality. However, habitat quality can influence how roads affect populations (e.g., Grilo et al., 2014) and therefore the habitat quality of the non-road cells could be varied in more detailed studies, for example by including species-specific information on habitat preferences.

Moreover, although not included explicitly in our analysis, traffic volume is also important to consider when assessing the effects of roads on populations and in landscape connectivity studies, since traffic intensity may influence both road mortality and road avoidance, and thus population persistence (Jaeger et al., 2006; Jaeger, 2007; Charry and Jones, 2009; van Langevelde and Jaarsma, 2009; van Strien and Grêt-Regamey, 2016). Several studies suggest that road mortality may be higher at intermediate traffic volumes than high traffic volumes, because at higher traffic volumes road avoidance will be higher for many species (e.g., Seiler 2005; Grilo et al., 2015).

However, the focus of our analysis was on comparing the effects of road mortality vs. those of a barrier that does not introduce additional mortality, which can be due to road avoidance behavior but also due to physical structures such as fences (e.g., Jaeger and Fahrig, 2004; Grilo

et al., 2012). Hence we modeled these directly as the probability of an individual dying on a road while crossing it, and the probability of an individual not crossing a road, regardless of the cause (e.g., road surface avoidance behavior, road avoidance due to traffic, fences), and therefore we did not consider traffic volume explicitly.

Additionally, while in our simulations individuals only evaluated their immediate neighboring cells in each step of dispersal, some species avoid roads from a distance (e.g., Jaeger et al., 2005), which may exacerbate the effects of habitat loss and fragmentation. Including microevolution in our individual-based model, which is fundamental to capture the response of organisms to changing conditions (Grimm and Berger, 2016), would also allow analysing eco-evolutionary responses to fragmentation (Haddad et al., 2015).

#### 4.2. Influence of dispersal distance on population persistence and size

The role of dispersal distance varied depending on the values of road mortality. In fragmented landscapes, as was the case in all our simulations since roads were always present, populations with a larger dispersal distance showed a lower probability of extinction and maintained larger sizes, provided an additional source of mortality due to roads was not present. However, a large dispersal distance was detrimental for population size and persistence as road mortality increased.

We used fixed dispersal distances in our simulations. However, dispersal distance is usually stochastic (e.g., Nathan et al., 2012), and therefore it would not only be interesting but also add realism to the model by implementing dispersal kernels to determine dispersal distances (e.g., Austerlitz et al., 2004; Chipperfield et al., 2011), instead of using fixed dispersal distances.

Furthermore, in our simulations, dispersing individuals only evaluated their immediate four neighboring cells in each dispersal step, which can be considered as a biased random walk (e.g., Turchin 1998). While this has been a common choice to model movement with an orientation component (e.g., Börger et al., 2008), expanding the perceptive range of dispersing individuals would increase the realism and facilitate the transferability of the model to concrete situations.

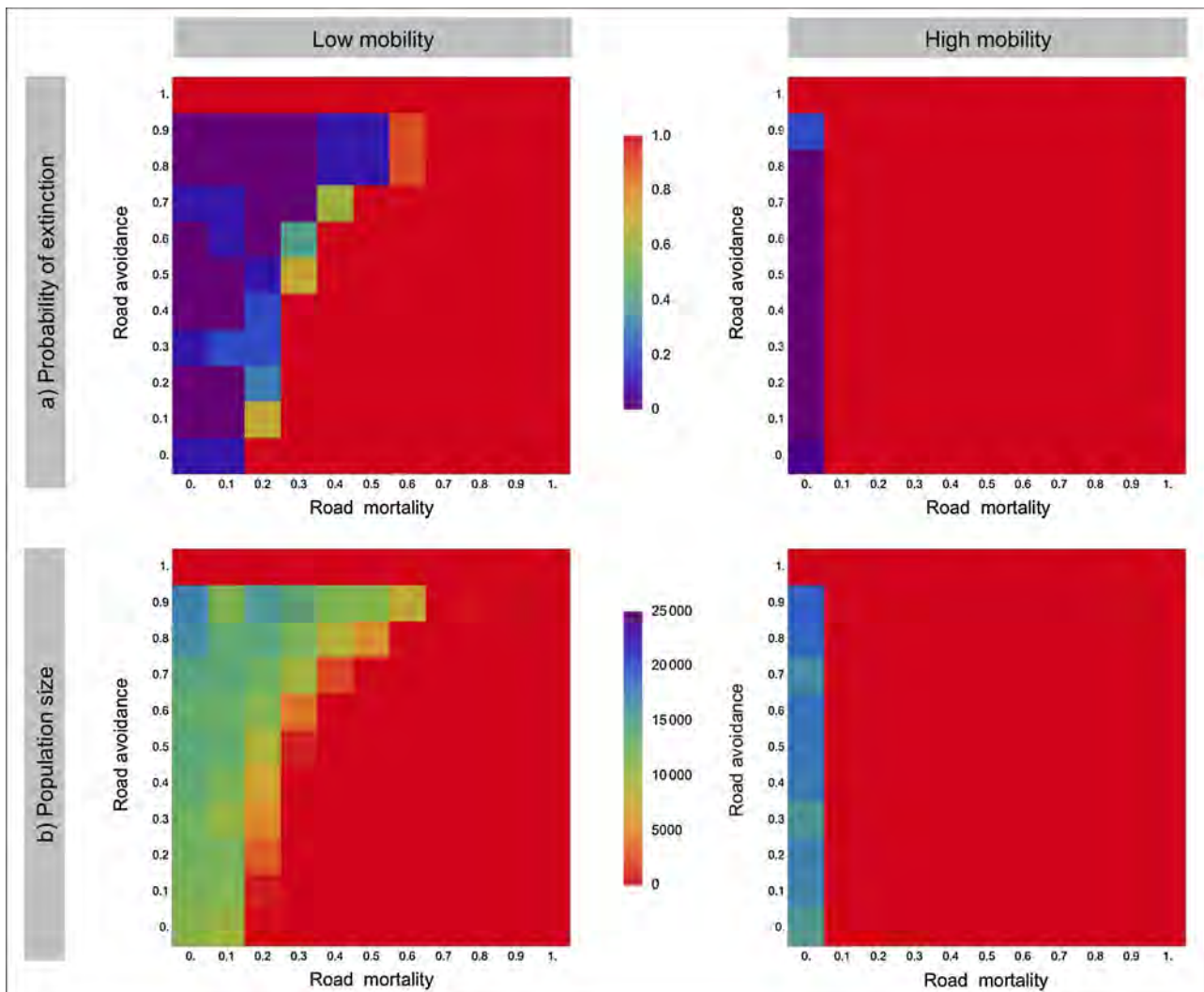


Fig. 5. Probability of population extinction (a) and population size (b) as a function of road mortality and road avoidance, for different dispersal distances (Low mobility = 5 cells; High mobility = 50 cells) in the landscape with the highest proportion of road cells in the landscape (0.35).

#### 4.3. Limitations

The type of movement (juvenile dispersal) considered in our paper can have a large influence on individual fitness and population structure (Matthysen, 2012). However, our model does not currently include other types of movement (such as daily movements), and thus adults do not get killed due to road mortality. This is a simplification, because in real contexts animals will encounter roads during other types of movement as well. Therefore, it would be important to include such types of movement in the analysis.

Furthermore, in our model each juvenile disperses over a fixed number of cells, which implies that individuals may end their dispersal movement on a road (or right of way). This could correspond to situations where there are no other options for dispersal, e.g., all neighboring areas already occupied or corresponding to unsuitable habitat, but it should be considered as a simplification of real cases.

We used two dispersal distances in our simulations because we wanted to ensure that we were comparing the roles of contrasting dispersal distances, i.e., a short vs. a large dispersal distance. Including a wider range of dispersal distances could help further understand the role of dispersal in these fragmented landscapes, as some studies suggest there is an optimal intermediate dispersal rate for persistence in disturbed habitats (Casagrandi and Gatto, 1999).

We used a virtual species and simple hypothetical regular road

networks because our main goal was to disentangle the effects of road mortality versus those of a barrier effect without such mortality. However, this implies that our results hold for the virtual species in the regular road network used.

#### 4.4. Conclusions and future research directions

Our results highlight the much higher relative importance of road mortality than the barrier effect (without road mortality), and of assessing relevant species traits such as dispersal distance. We emphasize three results of our study: first, that even though population persistence was not impaired when road avoidance was complete (except when suitable habitat patches became too small to sustain viable populations), population size was considerably decreased, which is important to consider in long-term conservation management; secondly, that a large dispersal distance is not necessarily always detrimental for population size and persistence in fragmented landscapes if mortality in unsuitable habitats is low, which calls for further investigation; and thirdly, that population isolation occurred in extreme cases (i.e., complete road mortality or a complete barrier effect without road mortality). These may be especially important for species expected (Rytwinski and Fahrig, 2013) or observed (e.g., some snakes and turtles; Shepard et al., 2008) to avoid roads, and for species for which road avoidance increases with increasing traffic volume (e.g., carnivores and

ungulates; Dyer et al., 2002; Alexander et al., 2005; Leblond et al., 2013).

Finally, our model can stimulate other studies, either theoretical or empirical. Our results hold for the virtual species in the regular road network used, but our model can be applied to species-specific situations, by using the specific trait values of the species or population of interest. Information on model parameter values (initial population size, fecundity, age at first breeding, survival probability, home range size, dispersal distance, road mortality, or road avoidance) can be obtained from published databases, individual studies, or derived from related or ecologically similar species, and using allometric relationships (e.g., Jones et al., 2009; Borda-de-Água et al., 2014; Salguero-Gómez et al., 2016; Ceia-Hasse et al., 2017). For example, data on population density can be used to determine the initial population size. Data availability is usually higher for vertebrates and within these for mammals, followed by birds. This is also true for data on road mortality, and especially on road avoidance behavior, for which species-specific information is lacking for many species (Rytwinski and Fahrig, 2012).

Furthermore, although we used only simple hypothetical regular road networks in our simulations, the modelled landscape can represent real landscapes with real road configurations, and can hence also be used to evaluate the impact of different mitigation options for increasing population persistence, in environmental impact assessments, and for conservation planning.

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## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.ecolmodel.2018.01.021>.

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1                   **Reducing Wildlife Vehicle Collisions by Building Crossings:**  
2                   **General Information, Cost Effectiveness, and Case Studies from the U.S.**

3  
4                   *Written and researched by the Center for Large Landscape Conservation*  
5                   *Commissioned by The Pew Charitable Trusts*  
6

7   **Impacts of Wildlife-Vehicle Collisions (WVCs):**

8   A 2008 Report to Congress found that WVCs “are a growing problem and represent an increasing percentage of  
9   accidents on our roads”.<sup>1</sup> At the time of the report, over the most recently reported 15-year period, WVCs had  
10   increased by 50%, from less than 200,000 to 300,000, even though the overall number of collisions remained  
11   roughly steady over the same period.<sup>1</sup> These collisions pose a serious safety hazard for people and wildlife and are  
12   economically costly. WVCs often result in substantial damage to vehicles, injury to their occupants, and are  
13   almost always lethal to the animal. WVCs occur when a vehicle strikes an animal, but animals on roads may also  
14   be the secondary cause of additional crashes, such as when a vehicle swerves to avoid an animal in the roadway  
15   and instead drives off the road or into the oncoming lane.<sup>2</sup> Reported collisions between motorists and wildlife  
16   cause more than 200 human fatalities and over 26,000 injuries each year, at an annual cost to Americans of more  
17   than \$8 billion.<sup>1</sup> In addition to the human toll, an estimated 1-2 million large animals are killed by motorists every  
18   year, and these numbers do not include smaller species that do not present a threat to human safety.<sup>1</sup>

19   Roads also fragment the landscape and create a barrier to wildlife moving to locate water, food, mates, shelter and  
20   to fulfill other needs. Roads that are barriers may reduce gene dispersal and undermine long-term population  
21   viability.<sup>1</sup> Road mortality is documented as one of the major threats to the survival of 21 federally-listed  
22   threatened or endangered species in the U.S; and, every one of the 11 states covered by the U.S. Department of  
23   Interior Secretarial Order 3362, *Improving Habitat Quality in Western Big-Game Winter Range and Migration*  
24   *Corridors*, concluded that roads were an impediment to the migration and movement of iconic western big game  
25   species such as elk, pronghorn, and mule deer.<sup>1,3</sup>

26   Researchers have conservatively estimated that the average cost of a deer-vehicle collision is \$8,190, an elk-  
27   vehicle collision is \$25,319 and a moose-vehicle collision is \$44,546 in 2018 U.S. dollars.<sup>4,5</sup> These estimates are  
28   based solely on property damage, human injuries and fatalities, and the lost revenue from a hunting license for the  
29   species involved.<sup>4</sup> They do not factor in any other values such as those associated with biodiversity conservation  
30   or lost revenues from wildlife-related tourism and recreation. Thankfully, there are well-researched and effective  
31   solutions to mitigate WVCs.<sup>1,6,7,8</sup> The most effective method to reduce WVCs, while at the same time maintaining  
32   or improving habitat connectivity, is to construct wildlife crossing structures – overpasses and/or underpasses -  
33   that allow them to cross safely under or over roads.<sup>1,2</sup> When combined with wildlife fencing to keep animals off  
34   the road and funnel them towards the structures, wildlife crossings have consistently resulted in >80% reductions  
35   in WVCs.<sup>1,6,7,8</sup>

36   Although costly, properly sited wildlife crossings can pay for themselves where situated along highways that  
37   experience 1) an average of five or more collisions between motorists and deer per mile per year, 2) an average of  
38   two or more collisions with elk per mile per year, or 3) an average of one or more collisions with moose per mile  
39   per year.<sup>4</sup> In those cases, in which the total economic costs associated with wildlife-vehicle collisions along a  
40   given highway segment exceed the expense of building a structure that allows animals to safely cross the road, **it**  
41   **actually costs society less to solve the problem of WVCs than it costs to do nothing.**<sup>4</sup>

42   In addition to constructing new wildlife crossings, enlarging existing deficient culverts and bridges to allow for  
43   terrestrial safe passage along the riparian areas not only benefits wildlife, but also makes our infrastructure more



resilient to climate change and extreme weather events, such as flooding. This protects our infrastructure investments in the long-term and ultimately saves taxpayers money. Dedicating federal funding to infrastructure projects that at the same time reduce wildlife-vehicle collisions and maintain or improve ecological connectivity provide benefits in the form of job creation, infrastructure resiliency, and sustainable natural resources.<sup>9,10</sup>

## Costs of WVCs to States

Many states collect data on (large animal) WVC incidences. Some collect only the number of crashes reported by their state’s law enforcement agencies (these are typically only crashes resulting in significant property damage or human injuries/fatalities), others also record carcass data collected by their transportation agency’s maintenance personnel when they remove carcasses from the roadside. Another source of data used by some states is motor vehicle insurance claim records. A study of deer-vehicle collisions (DVCs) from Virginia found that, according to deer carcass removal records, the number of DVCs in the evaluated areas was up to 8.5 times greater than what was documented in police crash reports.<sup>11</sup> Most likely the total number of WVCs is actually much higher than carcass records indicate, since not all carcasses are retrieved, and by some estimates as many as 50 percent of animals struck by vehicles leave the road or right-of-way before dying and so are never recorded.<sup>2,12</sup>

There are two different values that states and others have used to determine the costs associated with WVCs: 1) the estimates produced in the analysis by Huijser et al. 2009 (as seen in the previous section), or, 2) United States Department of Transportation (USDOT) equivalency values for different types of crash severities (e.g., property damage only vs. major injury).

In the table below, we have compiled WVC cost information from several states using these methodologies. The values for Washington state and Montana were calculated by the authors of this report using the state’s WVC records, while the values for Wyoming, Virginia, and California were calculated and documented in reports by researchers in the respective states.<sup>16,11,17</sup> In addition, State Farm Insurance publishes annually statistics on the likelihood of a licensed driver being involved in a collision with an animal by state – we also report this ranking as a reference (NOTE: this is the likelihood of hitting an animal, so it is influenced by the number of drivers in the state; for reference 1/50 is the state with the highest likelihood of hitting an animal).<sup>13</sup>

State	Records Used for Analysis	Species Included	Value of Incident Huijser et al. 2009* values -or- USDOT equivalency values by crash severity	State Farm Ranking 2019 <sup>13</sup>	Total Cost Annual Cost Estimate
Washington <sup>14</sup>	Carcass Only	Deer, Elk	Huijser et al. 2009	44/50	\$46 Million
Montana <sup>15</sup>	Carcass Only	Deer, Elk, Moose	Huijser et al. 2009	2/50	\$42 Million
Wyoming <sup>16</sup>	Crash and Carcass (duplicates removed)	Deer	Wyoming DOT cost estimates	6/50	>\$50 Million
Virginia <sup>11</sup>	Insurance claims	Deer	USDOT equivalency values	12/50	\$533 Million
California <sup>17</sup>	Crash and Carcass (duplicates removed)	All large wildlife	USDOT equivalency values	47/50	\$232 Million

\*The values from this paper were adjusted to reflect their equivalency in 2018 dollars. They were originally reported in 2007 dollars.<sup>5</sup>

1           **COST-EFFECTIVENESS OF WILDLIFE CROSSINGS: CASE STUDIES FROM THE U.S.**

2           The following case studies are some recent examples of large-scale wildlife mitigation projects in the  
3           U.S. These are cases in which crossing structures are combined with fencing throughout the project area  
4           with other mitigation measures such as gates and/or cattle-guards to keep animals from entering the right-  
5           of-way at access roads. In order for wildlife crossings to be most effective they must be combined with  
6           fencing to keep animals from entering the right-of-way and coming into contact with traffic.

7           **Case Study 1: State Highway 9, Grand County, Colorado**

8           In 2015-2016 the Colorado Department of Transportation constructed seven large wildlife crossings with  
9           wildlife funnel fencing along over 10 miles of State Highway 9 in the Lower Blue Valley in Grand  
10          County, Colorado as part of a larger road improvement project. The wildlife mitigation measures  
11          consisted of 2 overpasses, five large arch underpasses, and 10.4 miles of wildlife fencing and other design  
12          features on both sides of the road at a cost of roughly \$10M (Julia Kintsch/CDOT, personal  
13          communication). During the five winters previous to the start of construction in 2015, WVCs with mule  
14          deer and elk were the most common type of accident on this stretch of highway, accounting for 60% of all  
15          accidents reported to law enforcement. Four percent of the reported WVCs during this timeframe resulted  
16          in human injuries. During the same 5 years before construction, carcass counts conducted by Colorado  
17          Parks and Wildlife and the Blue Valley Ranch reported an average of 56.4 mule deer and elk carcasses  
18          each year, at a cost of over \$500,000/year depending on the ratio of deer vs. elk. Since construction of the  
19          mitigation measures, the number of carcasses within the project area has decreased by 89%, and the  
20          project is projected to pay for itself in approximately 22 years, long before the end of the structures'  
21          projected 75-year lifespan.



22           **Case Study Sources:**

23           Kintsch, J., Cramer, P., Singer, P., Cowardin, M., & Phelan, J. (2019). *State Highway 9 Wildlife Crossings*  
24           *Monitoring–Year 3 Progress Report*. Colorado Department of Transportation Study Number 115.01.

25           Huijser, M. P., Duffield, J. W., Clevenger, A. P., Ament, R. J., & McGowen, P. T. (2009). Cost–benefit analyses of  
26           mitigation measures aimed at reducing collisions with large ungulates in the United States and Canada: a decision  
27           support tool. *Ecology and Society*, 14(2).

1 **Case Study 2: Highway 191, Trapper’s Point, Wyoming**  
2

3 In 2012, the Wyoming Department of Transportation completed construction of wildlife crossing  
4 infrastructure on Highway 191 outside of Pinedale, WY. The project was built to address a wildlife-  
5 vehicle collision hotspot for pronghorn and mule deer, as well as to protect connectivity along the Path of  
6 the Pronghorn, a millennia-old pronghorn migration route and the first federally designated wildlife  
7 corridor. The project consisted of two overpasses, six underpasses, and wildlife funnel fencing along a 12-  
8 mile stretch of the highway at a cost of roughly \$11M. By the third year following construction, the total  
9 number of wildlife-vehicle collisions dropped by 81%, and pronghorn-vehicle collisions were completely  
10 eliminated. In addition, habitat connectivity was improved, and back-and-forth movements increased by  
11 >60% for mule deer and >300% for pronghorn.  
12

13 Before construction, Wyoming Department of Transportation estimated that wildlife-vehicle collisions at  
14 Trapper’s Point were costing over \$500,000 each year. Now, the crossing structures are used by over  
15 5,000 pronghorn and mule deer as they move from winter to summer range, and the state estimates that  
16 the crossings will pay for themselves in about 17 years, 50+ years before their estimated 75-year lifespan  
17 concludes.  
18



19 Photo: One of the Overpasses at Trapper’s Point with Highway 191 running underneath.  
20  
21 Credit: Renee Callahan

22 Case Study Sources:  
23

24 Sawyer, H., Rodgers, P. A., & Hart, T. (2016). Pronghorn and mule deer use of underpasses and overpasses along  
25 US Highway 191. *Wildlife Society Bulletin*, 40(2), 211-216.

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27 <http://www.pinedaleonline.com/news/2012/11/Newcrossingshelpwild.htm>

1 **Case Study 3: US Highway 30, Nugget Canyon, Wyoming**

2  
3 US Highway 30 in Nugget Canyon, Wyoming bisects crucial winter range and an important  
4 migration route for mule deer, and had long been recognized as a problem for human and  
5 wildlife safety due to WVCs. In 2001, WY Department of Transportation constructed one  
6 underpass and seven miles of wildlife-exclusion fencing to address the issue, and in 2008  
7 expanded the mitigation by constructing an additional six underpasses and an additional seven  
8 miles of wildlife exclusion fencing. The completed project now consists of seven large  
9 underpasses and over 13 miles of exclusion fencing at a cost of roughly \$5M. Previous to any  
10 mitigation, an average of 9.75 deer carcasses were reported each month in the project area (117  
11 DVCs/year). After mitigation was completed the number of deer carcasses dropped by 81% to an  
12 average of 1.82/month (~21DVCs/year). The cost savings resulting from the drop in DVCs  
13 amounts to over \$500,000/year, meaning that the mitigation measures would pay for themselves  
14 in less than 10 years, long before the estimated 75-year lifespan of the crossing structures.  
15



16  
17 Photo: Mule deer using one of the underpasses on US 30 in Nugget Canyon.  
18 Credit: Hall Sawyer

19 Case Study Sources:

20  
21 Sawyer, H., Lebeau, C., & Hart, T. 2012. Mitigating roadway impacts to migratory mule deer—a case study with  
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# Performance indices to identify attributes of highway crossing structures facilitating movement of large mammals

Anthony P. Clevenger<sup>a,b,\*</sup>, Nigel Waltho<sup>c</sup>

<sup>a</sup> Western Transportation Institute, Montana State University, Bozeman, MT 59717, USA

<sup>b</sup> Faculty of Environmental Design, University of Calgary, Calgary, Alta., Canada T2N 1N4

<sup>c</sup> Faculty of Environmental Studies, York University, North York, Ont., Canada M3J 1P3

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## Abstract

Studies assessing the efficacy of wildlife crossing structures often lead to spurious results because of their failure to address masking effects of confounding variables. Confounding variables include variation in human activity, density of crossing structures along the highway corridor, and equality of species' perceived access to each crossing structure. We investigated these issues for wide-ranging large carnivores and their prey species in Banff National Park, Alberta, using data obtained from systematic, year-round monitoring of 13 newly constructed crossing structures for wildlife (underpasses and overpasses) for 34 months post-construction. We standardized the first confounding variable by selecting crossing structures remote from areas of human activity. The second confounding variable we standardized by developing probability models of crossing structure usage assuming habitat homogeneity. We standardized the third confounding variable by developing species-specific, performance indices of crossing structures (= observed through passage usage–expected through passage usage). We regressed the species performance indices against 13 crossing structure variables encompassing structural, landscape, and human activity. Our results suggest that in absence of high human activity structural attributes best explained the performance indices for both large predator and prey species, while landscape and human-related factors were of secondary importance. Crossing structures that were high, wide and short in length strongly influenced passage by grizzly bears *Ursus arctos*, wolves *Canis lupus*, elk *Cervus elaphus*, and deer *Odocoileus* sp. More constricted crossing structures were favoured by black bears *Ursus americanus* and cougars *Puma concolor*. Distance to cover was the most important crossing structure landscape attribute for cougars (negative correlation) and was a significant factor determining passage for grizzly bears, elk and deer (all positive correlations). Our findings underscore the importance of: (a) integrating temporal and spatial variability a priori when addressing the efficacy of crossing structures, and; (b) demonstrate that species respond differently to crossing structure features. In light of these results, we suggest that to maximize connectivity across roads for multiple large mammal species, road construction schemes should include a diversity of crossing structures of mixed size classes. Mitigation planning in a multiple-species ecosystem is likely to be a challenging endeavour and long-term research will aid in the decision-making process. © 2004 Elsevier Ltd. All rights reserved.

**Keywords:** Banff National Park; Habitat fragmentation; Mammals; Road ecology; Wildlife crossing structure

## 1. Introduction

Over the last decade, federal land management and transportation agencies have become increasingly aware of the effects that roads have on wildlife (Bennett, 1991; Canters, 1997; Transportation Research Board, 1997). Significant advances in understanding these impacts have been made; however, the means to adequately

mitigate these impacts are slower in coming (Evink, 2002; Transportation Research Board, 2002a).

In order to mitigate the effects of roads, crossing structures for wildlife are being designed and incorporated into road construction and improvement projects (Keller and Pfister, 1997; Spellerberg, 2002; Forman et al., 2003; Cain et al., 2003). Although federal land management and state transportation agencies are building costly structures for wildlife connectivity, long-term monitoring to determine the most effective approaches has not taken place (Evink, 2002). Currently

\* Corresponding author. Tel.: +403-760-1371; fax: 403-762-3240.  
E-mail address: [tony.clevenger@pc.gc.ca](mailto:tony.clevenger@pc.gc.ca) (A.P. Clevenger).

there is limited knowledge of effective and affordable crossing structure designs for most wildlife species (Romin and Bissonette, 1996; Underhill and Angold, 2000; Transportation Research Board, 2002b).

One reason for the lack of available information is because few mitigation programs have implemented monitoring programs incorporating sufficient experimental design into pre- and post- construction evaluation. Thus, results obtained from most studies remain observational at best. Furthermore, those studies that collected data in more robust manners generally failed to address the need for wildlife habituation to such large-scale landscape change (Opdam, 1997). Habituation periods may take several years depending on the species as species experience, learn, and adjust their own behaviours to the wildlife structures (Clevenger et al., 2002a). The short monitoring periods frequently implemented are simply insufficient to draw reliable conclusions from (Forman et al., 2003).

Further, many earlier studies focused primarily on crossing structure relationships of single species, paying limited attention to multispecies or community level responses (see Forman et al., 2003 for review). Because poor crossing structure designs have the potential to decouple ecosystem level processes, for example, in the formation of prey-refuge zones in predator-prey relations (Woods et al., 1996; Clevenger and Waltho, 2000), most crossing structure designs are “selectively permeable”. The apparent success of monitoring programs aimed at single species may fail to recognize the barrier effects imposed on other non-target species. Thus, systems can be severely compromised if land managers and transportation planners rely on simple extrapolation from data on individual species. To date we are unaware of any monitoring program that addresses this issue specifically.

Information deficiencies may also be due to the masking effects of confounding variables not considered in study designs (Underwood, 1997). Confounding variables are sources of variation that may bias or even mask the efficacy of one crossing structure design over another. Such variables include the variation in human use of the crossings (Clevenger and Waltho, 2000), density of crossing structures along the highway corridor, and the equality of species’ perceived access to each crossing structure. If, for example, a species perceives crossing structure A as good, but not accessible, then it may choose crossing structure B (whose design is not favoured) for accessibility reasons alone. To control for these factors a robust experimental design requires a sufficiently large number of crossing structures - much larger than is realistically feasible for a public works project to finance.

In this paper, we investigate these issues using data obtained from systematic, year-round monitoring of 13 newly constructed crossing structures (underpasses and

overpasses) for 34 months post-construction. These new crossing structures are sufficiently remote from centres of human activity (e.g., the town of Banff) that human use is significantly reduced and therefore not expected to be a dominant factor (Clevenger and Waltho, 2000). We standardized against the remaining confounding variables by developing species-specific, performance indices, and then tested for significant correlations against each of the crossing structure attributes. We then rank-ordered the significant coefficient of determinations and assumed that the higher the coefficient the greater importance that attribute had in influencing species passage (positive or negative). A multivariate analysis of this type allowed us to explore the extent and influence of numerous attributes associated with the crossing structures independent of confounding variables.

Our design allowed us to address relevant and current questions concerning the efficacy of crossing structures; specifically: (i) How to ascertain the strengths and weaknesses of design characteristics for a multiple large mammal species? and, (ii) What are the requirements for effective crossing structures designed for wide-ranging large carnivores and their prey species? Information on the effectiveness of mitigation measures in reducing barrier effects will provide critical information needed for future mitigation planning in the Bow Valley transportation corridor in Banff National Park.

## 2. Study area and methods

### 2.1. Study area

Our study was situated in the Bow River Valley along the Trans-Canada Highway (TCH) corridor in Banff National Park (BNP), Alberta, located approximately 120 km west of Calgary (Fig. 1). The TCH is the major transportation corridor through the park (park length = 76 km) carrying an estimated annual average daily traffic volume of 14,940 vehicles per day in 1999 and increasing at a rate of 3% per year (Highway Service Centre, Parks Canada, Banff, Alberta).

Upgrading the TCH from two to four lanes progressed in phases. The first 45 km of the TCH from the eastern park boundary is four lanes and bordered on both sides by a 2.4 m high wildlife exclusion fence (phases 1, 2 and 3A). Phase 1 and 2 (= 27 km), beginning at the eastern boundary, was completed in 1988 and has 11 wildlife underpasses. The phase 1 and 2 underpasses were the focus of our previous study of factors influencing underpass use (Clevenger and Waltho, 2000). Phase 3A (= 18 km) is a continuation of the two previous phases, was completed in late 1997, and has 11 wildlife underpasses and two wildlife overpasses. The remaining 30 km to the western park boundary (Alberta – British Columbia border, phase 3B) is two

lanes and unfenced. Plans are to upgrade phase 3B to four lanes with mitigation within the next five years.

## 2.2. Wildlife crossing structures and monitoring

Our current study involved the 13 crossing structures recently constructed within phase 3A (Fig. 1). These crossing structures constituted four different structural designs: (1) two creek bridge underpasses (3 m high and 11 m wide expanded bridges that span creeks and rivers); (2) five elliptical, metal culvert underpasses (4 m high, 7 m wide); (3) four prefabricated concrete box underpasses (2.5 m × 3.0 m), and; (4) two 50-m wide wildlife overpasses.

Each crossing structure was characterized according to 13 independent variables encompassing structural, landscape and human activity attributes (Table 1). Structural variables included crossing structure width, height, length (including central median), openness = width × height/length (Reed and Ward, 1985); and noise level = mean of A-weighted decibel readings taken at the centre-point within the crossing structure and 5 m from each end. Landscape variables included distances to: nearest forest cover, closest major drainage, Canadian Pacific Railway (CPR), townsite, and the next nearest crossing structure. Human activity was quantified at the passages (as for wildlife described below) by counts of people on foot, bike, horseback. Crossing structure configuration was characterized as

divided (separated structures with central median) or undivided (one structure with no central median).

We quantified large mammal use of crossing structures using methods described by Bider (1968). Specifically, to record evidence of crossing structure use (= observed data) tracking sections (2 × 4 m) were set at both ends of each structure. Tracking material consisted of a dry, loamy mix of sand, silt and clay, 3–4 cm deep. At 3–4 day intervals each crossing structure was visited and the tracking medium classified as adequate or inadequate depending on our ability to read tracks clearly. Species presence (wolves *Canis lupus*, cougars *Puma concolor*, black bears *Ursus americanus*, grizzly bears *Ursus arctos*, deer *Odocoileus* sp., and elk *Cervus elaphus*), species abundance, and human activity counts were recorded at each tracking section during each crossing structure visit. Observed through-passages were recorded for individuals if tracks in the same direction were present on both tracking sections. Tracking sections were then raked smooth in preparation for the next visit. At the wildlife overpasses, infra-red operated 35 mm cameras (Trailmaster™, Goodson and Associates, Inc., Lenexa, Kansas, USA) were used to supplement, rather than to replace, the track pad monitoring (Kucera and Barrett, 1993). The construction of all crossing structures was completed in October 1997; data were collected from November 1997 to August 2000 (34 months). Of 4494 crossing structure monitoring visits, 157 (3.5%) were classified as incomplete for data analyses.

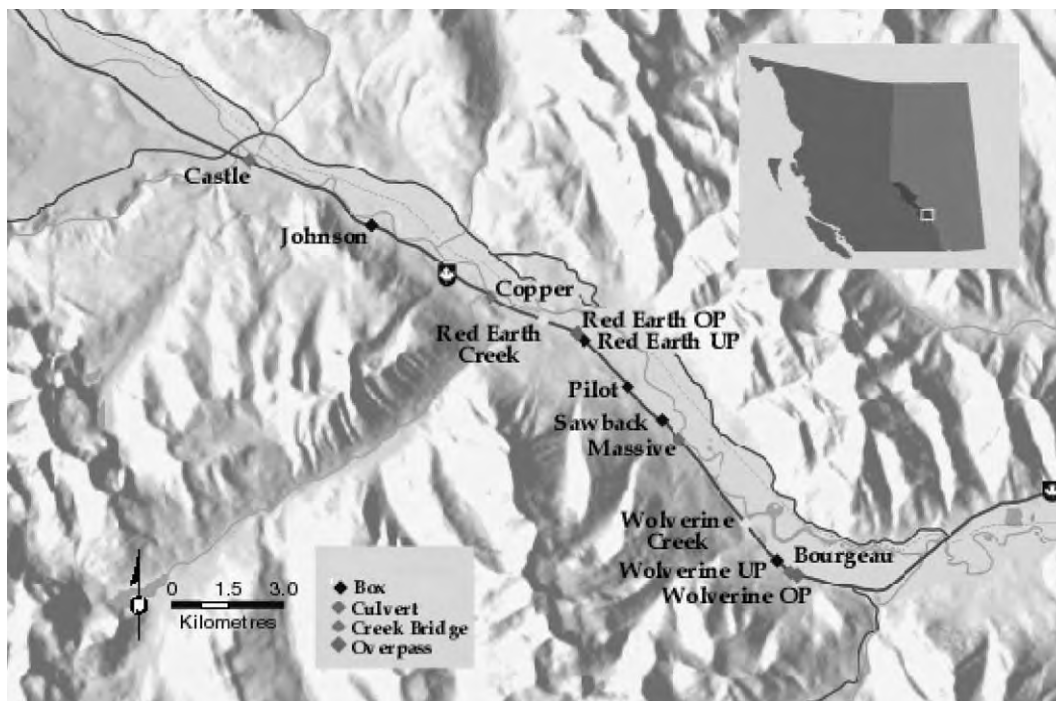


Fig. 1. Map of the study area in Banff National Park, Alberta, Canada, showing the location and type of wildlife crossing structures on phase 3A of the Trans-Canada Highway.

Table 1  
Attributes of 13 wildlife crossing structures used in analysis of factors influencing wildlife passage in Banff National Park, Alberta

Attributes	Wildlife crossing structure												
	Wolverine OP	Wolverine UP	Bourgeau	Wolverine creek	Massive	Sawback	Pilot	Red Earth UP	Red Earth OP	Red Earth Creek	Copper	Johnson	Castle
Structural													
Width (m)	50.0	7.3	2.0	11.5	7.2	3.0	3.0	3.0	50.0	11.4	7.2	3.0	7.3
Height (m)	7.8	3.4	1.8	2.5	3.6	2.4	2.4	2.4	7.8	2.2	3.9	2.4	3.5
Length (m)	72.0	62.5	170.0	83.0	51.0	58.0	66.0	78.0	72.0	56.5	57.4	58.0	56.5
Openness	5.41	0.39	0.02	0.34	0.51	0.12	0.11	0.09	5.41	0.44	0.49	0.12	0.45
Noise level	52.7	55.4	74.7	66.1	54.3	58.3	56.6	56.8	54.8	71.2	54.1	55.3	64.1
Landscape (distance to)													
Crossing structure (km)	0.2	0.2	0.8	1.0	0.5	0.5	1.6	0.4	0.4	1.0	1.6	3.5	4.6
Forest cover (m)	27.0	9.0	4.0	22.0	32.0	6.0	9.0	12.0	42.0	24.0	7.5	10.5	35.4
Drainage (km)	1.64	1.41	0.63	0.0	0.0	0.37	1.77	1.25	0.86	0.0	1.0	1.77	0.3
CPR (km)	1.25	1.3	1.18	1.13	0.88	0.91	0.98	0.66	0.53	0.29	0.53	0.87	0.63
Townsite (km)	10.0	10.2	11.1	12.1	14.8	15.3	16.9	18.5	18.9	19.9	21.4	25.0	29.6
Human activity	15	9	5	4	8	14	19	22	8	97	5	7	70
Configuration	1	1	2	2	1	1	1	2	1	2	1	1	1

Notes: Height for overpasses equal to double maximum underpass height (= 3.9 m). CPR, Canadian Pacific Railway; Configuration (1 = undivided, 2 = divided); OP, overpass; UP, underpass.



With appropriate multivariate analyses (e.g., canonical and partial canonical correlation analysis), meaningful ecological relations may be teased out from the track and camera data (Sarakinos and Rasmussen, 1998). Such analyses, however, require: (a) adequate experimental design to control our confounding variables, and; (b) sufficient sampling replicates to obtain statistically meaningful results – some authors argue 30 replicates per variable (Morrison et al., 1992; Norman and Streiner, 1999). In our study both requirements were absent, i.e. manipulation or control of test variables in such a large-scale ecosystem-level study was unfeasible, and there were only 13 statistical replicates (crossing structures). We addressed both issues by developing species-specific performance indices and testing the indices against each of the crossing structure attributes.

### 2.3. Performance indices

We define species performance indices as the ratio of observed through-passage use to expected through-passage use. Performance indices function in such a way that the higher the index, the more effective the crossing structure appears to facilitate that species crossing. Our expected through-passage use, however, is more complex as it is defined within the context of two confounding variables: (i) variation in the density of crossing structures along the highway corridor (spatial variation), and; (ii) equality of species' perceived access to each crossing structure (spatial and seasonal variation). We address each confounding variable accordingly.

If the crossing structures were equally spaced along the length of the TCH, and the habitat template was continuously homogeneous, then we suggest the probability of large mammal species choosing any particular crossing structure in the absence of design differences to be 7.7% (i.e.  $N_{\text{crossing structures}} = 13$ ;  $P = 100/N_{\text{crossing structures}} = 0.077$ ). However, the distance between consecutive crossing structures is highly variable ranging from 0.24 to 3.7 km (mean distance = 1.5 km). In areas of TCH where the density of crossing structures is high, we suggest the absolute probability of any one structure being chosen is compromised by its close proximity to other nearby structures. By comparison, where crossing structures are relatively isolated from each other, we suggest the absolute probability of any one structure being chosen increases because each crossing structure approaches the only choice for the area. We therefore developed “absolute probabilities” as a function of distances between consecutive structures using the following equation:

$$P_{CS_n} = 100 \times ((CS_{n-1} + CS_{n+1})/2)/CS_{\text{total}},$$

where  $P_{CS_n}$  was the absolute probability for crossing structure (CS)  $n$ ;  $(CS_{n-1} + CS_{n+1})$  was the distance from

crossing structure  $n - 1$  to  $n + 1$ ; and  $CS_{\text{total}}$  was the highway distance from the first crossing structure to the last (= 20.12 km). The absolute probabilities for any chosen crossing structure ranged from 2.7% to 18.1% (Table 2).

With respect to the second confounding variable, if the habitat template were continuously homogeneous (i.e. both spatially and temporally) then each species may have equal access to each of the crossing structures. However, the habitat template is not continuously homogeneous, but instead is fragmented and highly heterogeneous on multiple spatiotemporal scales. Mountain barriers and the seasonal flow of rivers versus ice cover divide the landscape into some permanent and some temporally isolated habitat fragments. Forest fires, meadows, aspen (*Populus tremuloides*) groves, and lodgepole pine (*Pinus contorta*) and spruce (*Picea* sp.) stands further contribute to habitat heterogeneity generating spatially and temporally dependent mosaics of shelter and food availability. Seasonal changes from winter and accumulated snow depth to summer may exacerbate habitat heterogeneity even further by limiting foraging abilities in deep snow (Telfer and Kelsall, 1984; Huggard, 1993).

Such spatial and temporal heterogeneity may be more significant when choosing an appropriate crossing structure to cross the TCH than any design features of the crossing structures themselves. If for example a crossing structure deemed favourable by design is isolated from a species' preferred habitat, then the perceived risks to use the crossing structure may dominate the decision making process of whether to use the crossing structure or not. Conversely, if the habitat quality surrounding a second inferiorly designed crossing structure is good then, by comparison to the first structure, the probability of the second structure being chosen may be significantly higher.

We approached this latter issue of spatial and temporal habitat heterogeneity with the aid of a geographic information system analysis (Environmental Systems Research Institute, 1998). From the center of each crossing structure we created buffers from 0 to 500 m, 500–1000 m, 1000–1500 m, 1500–2000 m, 2000–2500 m and 2500–3000 m. For each buffer we overlaid an ecological land classification map with five possible habitat suitability ratings (0, nil; 1, low; 2, moderate; 3, high; 4, very high) for each species per ecosite polygon (Holroyd and Van Tighem, 1983; Kansas and Raines, 1990). For a given buffer each habitat rating was multiplied by the absolute area it occupied to derive a “relative species occurrence” value. This was repeated for each buffer, at each crossing structure, for each of the six large mammal species in our study. We used seasonal habitat suitability data (winter and/or summer) to address temporal variation in the habitat template. Thus, for a given species, structures with a high proportion of high quality habitat surrounding them generate greater relative species

Table 2  
Absolute and realized probabilities

Wildlife crossing structure	Absolute probabilities	Realized probabilities (as a function of buffer size)						
		0 m	500 m	1000 m	1500 m	2000 m	2500 m	3000 m
Wolverine OP	0.041	1.00	0.60	0.60	0.36	0.36	0.20	0.20
Wolverine UP	0.027	1.00	0.40	0.24	0.24	0.13	0.13	0.13
Bourgeau	0.045	1.00	1.00	0.27	0.22	0.22	0.22	0.22
Wolverine Creek	0.094	1.00	1.00	0.67	0.67	0.57	0.45	0.33
Massive	0.081	1.00	0.61	0.61	0.61	0.61	0.38	0.26
Sawback	0.052	1.00	0.39	0.39	0.39	0.24	0.24	0.24
Pilot	0.080	1.00	1.00	1.00	1.00	0.44	0.27	0.22
Red Earth UP	0.051	1.00	0.60	0.60	0.35	0.22	0.22	0.14
Red Earth OP	0.034	1.00	0.40	0.23	0.23	0.23	0.10	0.10
Red Earth Creek	0.062	1.00	1.00	0.65	0.42	0.22	0.22	0.17
Copper	0.129	1.00	1.00	1.00	1.00	0.68	0.57	0.47
Johnson	0.181	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Castle	0.126	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Absolute probabilities are the chance that any one wildlife crossing structure is selected as a function of all crossing structures present in the study. Realized probabilities are the chance opportunity that a given crossing structure is selected as a function of those crossing structures found only within the buffer.

occurrences compared to crossing structures without high quality habitat (Clevenger and Waltho, 2000).

The two confounding variables thus described occur independently of each other; however, by modelling the effects of the first variable into the second we can generate the “expected through passage usages”.

If within a 500 m buffer zone a second crossing structure was found, we suggest the relative species occurrence for the target crossing structure is compromised by the probabilities of the second crossing structure being chosen instead (i.e. our first confounding variable). Thus for the Wolverine Overpass at 500 m, we expect 60% relative species occurrences because of the influence of the nearby Wolverine Underpass (Table 2; realized probabilities). At 3000 m, we expect only 20% relative species occurrence because of the further chance effect of the Bourgeau and Wolverine Creek Underpasses being used. By comparison, at Castle Underpass we expect 100% relative species occurrence even at 3000 m because no other crossing structures occur nearby. Thus, for each buffer we adjust the expected through-passage usages by the probability that, everything else being equal, the target crossing structure will be the one chosen. This step generated 78 data points (= 6 buffer zones  $\times$  13 crossing structures) for each species for each season (i.e. the “expected through-passage uses”).

The ratio of observed through-passage use to expected through-passage use completes the performance indices. The indices function in a way that the higher the index the more effective the wildlife crossing structure appears to facilitate that species crossing.

#### 2.4. Analyses

Using regression analyses (Jandel Scientific, 1994) we compared species performance indices against each of

the crossing structure attributes, adjusting for multiple tests using Bonferroni adjustments (Waltho and Kolasa, 1996; Clevenger and Waltho, 2000). This generated 13 coefficients of determination for each species for each season. We rank ordered the coefficients of determination keeping only those that were statistically significant. We assumed that for each significant analysis ( $P < 0.05$ ) the higher the coefficient of determination the higher the relative importance that crossing structure attribute had in influencing the passage by a particular species (positive influence or negative).

### 3. Results

We observed 4209 large mammal and human use through-passes (human use = 8%) from the 13 crossing structures monitored continuously from November 1997 to August 2000 (Table 3). The range in observed through-passage usage was high – the minimum observed was at Bourgeau Underpass ( $n = 31$  through-passage usages) to a maximum at Red Earth Overpass ( $n = 1099$ ). Through-passage use was effective to 91% of all approaches.

For each species, we tested species performance indices against each crossing structure attribute (seasonally dependent when applicable). The resultant statistically significant coefficients of determination are provided in Table 4.

#### 3.1. Carnivores

At the guild level, carnivore models included summer analyses for black bear and grizzly bear, and summer and winter analyses for wolves and cougar. From these six models, 15 of 36 (42%) possible structural attributes

Table 3  
Seasonal observed use of wildlife crossing structures by large mammal species in Banff National Park, Alberta, 1997–2000

Season/species	Wildlife crossing structure													
	Wolverine OP	Wolverine UP	Wolverine UP	Bourgeau	Wolverine Creek	Massive	Sawback	Pilot	Red Earth UP	Red Earth OP	Red Earth Creek	Copper	Johnson	Castle
Summer														
Black bear	7	5	14	4	6	3	19	16	3	2	5	11	18	
Grizzly bear	7	0	0	0	1	0	1	1	2	2	0	0	1	
Wolf	4	2	0	0	0	0	0	6	1	6	3	8	2	
Cougar	4	8	11	18	5	1	5	8	0	9	8	10	0	
Elk	92	79	1	127	128	51	64	81	435	69	140	8	407	
Deer	397	56	3	5	101	16	22	27	506	22	65	6	169	
Winter														
Wolf	3	0	0	0	0	0	0	4	0	0	0	0	12	
Cougar	8	4	2	2	0	1	0	0	0	3	6	5	0	
Elk	51	5	0	17	5	0	12	2	62	2	18	3	83	
Deer	93	1	0	21	10	2	2	3	90	1	8	1	2	

were found significant as were between 18 of 40 (45%) possible landscape variables (Table 4). Human influence had high explanatory power in only one of the models (i.e. wolves in summer).

At the species level, four crossing structure attributes were significantly correlated with black bear passage (Table 4). Distance to nearest drainage was the most important attribute facilitating passage and was positively correlated with crossing structure use ( $r^2 = 0.120$ ,  $P = 0.002$ ). Crossing structure openness was negatively correlated with black bear passage ( $r^2 = 0.083$ ,  $P = 0.011$ ), whereas structure length ( $r^2 = 0.067$ ,  $P = 0.022$ ) and distance to CPR tracks ( $r^2 = 0.064$ ,  $P = 0.025$ ) were both positively correlated with use.

For grizzly bears, six attributes were significantly correlated with crossing structure use. Five of the variables had high explanatory power. Crossing structure width ( $r^2 = 0.534$ ,  $P = 0.001$ ), height ( $r^2 = 0.476$ ,  $P = 0.001$ ), and openness ( $r^2 = 0.544$ ,  $P = 0.001$ ) were all positively correlated with passage, whereas noise levels were negatively correlated ( $r^2 = 0.282$ ,  $P = 0.001$ ). Grizzly bear passage was positively correlated with the distance to forest cover ( $r^2 = 0.474$ ,  $P = 0.001$ ).

Seasonality of wolves suggested correlation with eight attributes during the summer months, and two attributes during the winter months (Table 4). Specifically, crossing structure width ( $r^2 = 0.138$ ,  $P = 0.001$ ), height ( $r^2 = 0.139$ ), openness ( $r^2 = 0.142$ ,  $P = 0.001$ ), distance to nearest townsite ( $r^2 = 0.193$ ,  $P = 0.001$ ) and amount of human use ( $r^2 = 0.277$ ,  $P = 0.001$ ) were significant factors and all positively correlated with wolf passage during summer. Wolves also tended to use structures that were near the CPR tracks ( $r^2 = 0.121$ ,  $P = 0.002$ ), far from drainages ( $r^2 = 0.112$ ,  $P = 0.003$ ) and relatively short in length ( $r^2 = 0.097$ ,  $P = 0.006$ ). During winter, distance to nearest townsite ( $r^2 = 0.132$ ,  $P = 0.001$ ) and nearest crossing structure ( $r^2 = 0.238$ ,  $P = 0.001$ ) had the highest explanatory power and were both positively correlated with passage.

Seasonality of cougars suggested correlation with nine attributes during the summer months and three during the winter (Table 4). Cougar passage in summer was negatively correlated with crossing structure height ( $r^2 = 0.205$ ,  $P = 0.001$ ), openness ( $r^2 = 0.161$ ,  $P = 0.001$ ), distance to forest cover ( $r^2 = 0.494$ ,  $P = 0.001$ ) and townsite ( $r^2 = 0.262$ ,  $P = 0.001$ ) and positively correlated with distance to CPR tracks ( $r^2 = 0.202$ ,  $P = 0.001$ ). Cougars demonstrated a negative relationship between passage and crossing structure width ( $r^2 = 0.117$ ,  $P = 0.002$ ) and distance to next structure ( $r^2 = 0.093$ ,  $P = 0.007$ ) but a positive relationship with crossing structure length ( $r^2 = 0.074$ ,  $P = 0.016$ ). Cougars had a tendency to use divided structures more than undivided structures ( $t = 5.44$ ,  $P = 0.002$ ). Winter passage by cougars was explained by fewer variables. Cougars tended to use crossing structures near forest

Table 4

Mean coefficient of determinations, their slope and level of significance for species models explaining wildlife crossing structure interactions in Banff National Park, Alberta (CS, crossing structure; CPR, Canadian Pacific Railway; HA, human activity)

Attributes	Black bear	Grizzly bear	Wolf		Cougar		Elk		Deer	
	Summer	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
<b>Structural</b>										
Width	ns	+0.534**	ns	+0.138**	ns	-0.117**	+0.574**	+0.487**	+0.434**	+0.433*
Height	ns	+0.476**	ns	+0.139**	ns	-0.205**	+0.584**	+0.469**	+0.576**	+0.604**
Length	+0.067*	ns	ns	-0.097**	ns	+0.074*	ns	-0.247**	ns	-0.078*
Openness	-0.083*	+0.544**	ns	+0.142**	ns	-0.161**	+0.569**	+0.483**	+0.617**	+0.514**
Noise	ns	-0.282**	ns	ns	ns	ns	-0.177**	-0.164**	-0.271**	-0.226**
<b>Landscape (distance to)</b>										
CS	ns	ns	+0.238**	ns	ns	-0.093**	ns	ns	ns	ns
Forest	ns	+0.474**	ns	ns	-0.227**	-0.494**	+0.510**	+0.364**	+0.344**	+0.350**
Drainage	+0.120**	ns	ns	+0.112**	ns	ns	ns	ns	ns	ns
CPR	+0.064*	-0.094**	ns	-0.121**	+0.266**	+0.202**	ns	ns	ns	ns
Townsite	ns	ns	+0.132**	+0.193**	-0.277**	-0.262**	ns	ns	ns	ns
<b>HA winter</b>										
HA winter	-	-	ns	ns	ns	-	ns	-	ns	-
<b>HA summer</b>										
HA summer	ns	ns	+0.096**	+0.277**	-	ns	-	+0.101**	-	+0.093**
<b>Configuration</b>										
Configuration	ns	ns	ns	ns	ns	1 < 2**	ns	ns	ns	1 > 2**

Note: ns, not significant.

\*  $0.01 > P < 0.05$ .

\*\*  $0.001 > P < 0.01$ .

cover ( $r^2 = 0.227$ ,  $P = 0.001$ ), townsites ( $r^2 = 0.277$ ,  $P = 0.001$ ) and far from CPR tracks ( $r^2 = 0.266$ ,  $P = 0.001$ ).

### 3.2. Ungulates

At the guild level, ungulate models included both summer and winter analyses for elk and deer. Structural attributes were found significant on 19 occasions (52 maximum possible = 4 models  $\times$  13 variables); landscape variables were found significant in four models (Table 4).

At the species level, seven attributes were correlated with summer crossing structure use by elk (Table 4). Elk passage was positively correlated and explained by structure width ( $r^2 = 0.487$ ,  $P = 0.001$ ), height ( $r^2 = 0.469$ ,  $P = 0.001$ ) and openness ( $r^2 = 0.483$ ,  $P = 0.001$ ). Crossing structure length ( $r^2 = 0.247$ ,  $P = 0.001$ ) and noise levels ( $r^2 = 0.164$ ,  $P = 0.001$ ) also were negatively correlated with elk passage. Elk passage showed a positive relationship with distance to forest cover ( $r^2 = 0.364$ ,  $P = 0.001$ ) and human use ( $r^2 = 0.101$ ,  $P = 0.005$ ). During winter, elk passage was positively correlated with crossing structure width ( $r^2 = 0.574$ ,  $P = 0.001$ ), height ( $r^2 = 0.584$ ,  $P = 0.001$ ), openness ( $r^2 = 0.569$ ,  $P = 0.001$ ) and negatively correlated with noise levels ( $r^2 = 0.177$ ,  $P = 0.001$ ). Elk tended to use crossing structures far from forest cover ( $r^2 = 0.510$ ,  $P = 0.001$ ) in winter.

Seasonality of deer use correlated with crossing structure attributes similarly (Table 4). During summer, deer passage was positively correlated with crossing structure width ( $r^2 = 0.433$ ,  $P = 0.001$ ), height ( $r^2 =$

$0.604$ ,  $P = 0.001$ ), openness ( $r^2 = 0.514$ ,  $P = 0.001$ ) and negatively correlated with noise levels ( $r^2 = 0.226$ ,  $P = 0.001$ ). The amount of human use was positively correlated with deer passage ( $r^2 = 0.093$ ,  $P = 0.006$ ). Undivided structures were selected by deer over divided ones ( $t = 5.17$ ,  $P = 0.001$ ). Structural variables were strongest variables influencing winter deer passage and positively correlated with crossing structure openness ( $r^2 = 0.617$ ,  $P = 0.001$ ), height ( $r^2 = 0.576$ ,  $P = 0.001$ ), width ( $r^2 = 0.434$ ,  $P = 0.001$ ) and negatively correlated with noise levels ( $r^2 = 0.271$ ,  $P = 0.001$ ). Deer had a tendency to use crossing structures far from forest cover ( $r^2 = 0.344$ ,  $P = 0.001$ ) in winter.

## 4. Discussion

A review of the literature suggests that there have been mixed results concerning the relative importance of factors affecting crossing structure efficacy. Some studies have argued that the location of a crossing structure, particularly in relation to habitat quality, is the most important feature (Foster and Humphrey, 1995; Yanes et al., 1995; Land and Lotz, 1996; Clevenger and Waltho, 2000; Ng et al., 2004). Other research has shown that structure design can be the most influential (Reed et al., 1975; Ballon, 1985; Norman et al., 1998; Cain et al., 2003). These discrepancies in how animals respond to crossing structures may largely be explained by taxon- and/or habitat-specific factors.

Contrary to our earlier analysis (Clevenger and Waltho, 2000), in this study, structural attributes largely

explained performance indices for both predator and prey species, whereas landscape and human-related factors were of secondary importance. In Clevenger and Waltho (2000), we suggested that the overall weakness of structural attributes to explain species performance indices was due to confounding variables such as high levels of human use at the 12-year old phase 1 and 2 underpasses. As large mammal species learn to avoid underpasses with high human use, i.e., those close to the town of Banff, our results suggested structural attributes were then of secondary importance in determining crossing structure usage.

In the current study, we find structural attributes dominate species performance indices. We attribute the loss of human use influence to the fraction of human use activity found in phase 3A (97 human passes during 34 months monitoring) compared to phase 1 and 2 (894 passes during 35 months monitoring). The difference in human use activity results from the proximity of crossing structures in phase 1, 2 and 3A relative to Banff and hiking and bike trails. The average distance ( $\pm$ SD) in phase 1 and 2 is  $3.0 \pm 2.5$  km; the average distance in phase 3A is  $17.2 \pm 5.9$  km. It becomes apparent that in high human density settings, such as phase 1 and 2, human activity can clearly be a deterrent to wildlife passage at the crossing structures. However, in low human density settings (i.e., the present study), such confounding variables can be minimized.

A second explanation that may contribute to the different results was standardizing against spatial heterogeneity. As in Clevenger and Waltho (2000), we assumed each crossing structure was surrounded by its own unique habitat differentially preferred by the different species summer and winter. Such variance may bias the results towards crossing structure attributes associated with structures located in preferred habitats – independent of the structure attributes themselves. In this study, we assumed a second source of spatial heterogeneity – that is, variance in distances between consecutive crossing structures. We suspect such distances (mean distance  $\pm$  SD =  $1.5 \text{ km} \pm 1.1 \text{ km}$ ) bias the results towards structure attributes most closely associated with isolated structures because they have an expected higher frequency of use by chance alone. For example, consider three crossing structures that serve two independent populations of equal size: the first crossing structure serves one population, and the second two crossing structures serve the second population. Everything else being equal, we expect the first single crossing structure to serve the first population by 100%, whereas the second two crossing structures to serve the second population by 50% each. Such degrees of isolation and proximity we believe can mask whatever ecological significance structural and landscape attributes may hold themselves.

We found it necessary therefore to perform our analyses not in the context of observed through-passage usage alone, but in the context of observed through-passage usage as a function of expected through-passage usage, i.e., the performance indices. Our performance indices thus were modelled to minimize the confounding biases of both sources of spatial heterogeneity.

With minimal human use activity confounding our analyses, and having standardized against the two sources of spatial heterogeneity, we assumed we were better able to assess how different species respond to structural and landscape attributes. Our results showed that at the guild level, structural and landscape factors were equally important in explaining carnivore passage, whereas structural attributes were the most dominant features affecting ungulate passage. For structural attributes, two clear patterns emerged from the analysis. First, crossing structures with high openness ratios (i.e. short in length, high and wide) strongly influenced passage by grizzly bears, wolves, elk and deer. Second, more constricted crossing structures (i.e. long in length, low, narrow and low openness ratios) best explained passage by black bears and cougars.

These patterns conform with evolved behaviours and life history traits for large mammals. Studies by others suggest grizzly bears and wolves, for example, are highly vulnerable to human-related disturbance and structures, and particularly roads (Noss et al., 1996; Mattson et al., 1996; Mladenoff et al., 1999; Gibeau et al., 2002). However, at the individual level, such vulnerability may be individually specific – a function of at least in part, sex and duration of habituation (Clevenger et al., 2002a). Reed et al. (1975) and Ward (1982) also observed that deer, elk and other ungulate prey species were reluctant to use confining structures. There is some evidence that crossing structures can be used by predators to capture prey (Hunt et al., 1987; Foster and Humphrey, 1995; see review by Little et al., 2002). Structures could potentially increase prey vulnerability by reducing the effectiveness of mechanisms available to prey species to avoid detection or escape. Such structures are generally exposed, restricted, and often narrow environments (Reed et al., 1975; Yanes et al., 1995; Clevenger et al., 2002b).

The more constricted crossing structures favoured by black bears and cougars might be explained by these species' requirements for hiding cover and avoidance of exposed, sparsely wooded habitats (Weaver et al., 1996). We suspect that affinity for cover may be heightened as these species enter inhospitable environments such as the TCH corridor and are faced with the task of traversing it. When given the option of crossing the highway at the exposed wildlife overpasses or adjacent underpasses (<200 m away), there is a greater tendency for both species to select the latter (Clevenger et al., 2002a).



Although we argue that structural attributes are most closely correlated with large mammal use, we do find two landscape variables repeatedly identified as being significant. Distance to cover was the most important landscape attribute for cougars (negative correlation) and was a significant factor determining passage for grizzly bears, elk and deer (all positive correlations). The presence or amount of vegetative cover at passage entrances has been considered an essential component for designing effective tunnels (Hunt et al., 1987; Rodríguez et al., 1996; Pfister et al., 1997). Increased cover provides greater protection and security for animals approaching the passages. Evolved life-history traits and behaviour of cougars confirms that increased cover near passages would be important for them. Conversely, open areas near passages would facilitate effective mechanisms for predator avoidance or escape by prey species such as elk and deer, and characterizes the preferred habitat of grizzly bears.

Noise appears to be an important attribute influencing species performance indices. Noise from vehicle traffic can stress animals and potentially restrict habitat use and their movements (Bowles, 1995; Wasser et al., 1997). In all of our models where noise was a significant factor, it negatively affected passage. Although repeated exposure to high noise levels can result in habituation (Valkenburg and Davis, 1985; Krausman et al., 1986), we do not suspect high noise levels enhance the function and performance of crossing structures.

The results from our two analyses provided a different suite of variables that were important in explaining passage by large mammals at the crossing structures in BNP. We might expect that at the level of individual structures, the importance of variables may differ. However, the variables differed at a larger scale, such as between the Lower and Middle Bow Valley. Although these two environments are relatively close geographically, there are considerable differences, particularly in the level of human disturbance. Further, if crossing structures are built along phase 3B in the future and a similar crossing-structure analysis is carried out, we might expect the key factors influencing passage to be different from the phase 1, 2 and phase 3A crossing structures.

An important outcome of our research is the demonstration that different large mammal species respond differently to structural and landscape-level attributes of crossing structures and that spatial and temporal scales are important in determining the efficacy of the measures. We caution that the results from our work are not universal in their application, as the influence of factors related to the efficacy of crossing structures might be expected to vary between landscapes and faunal communities. Additional long-term research of crossing structure performance from a range of landscapes with complex wildlife–human interactions will help develop a general model for land managers and transportation planners.

We suggest that because species respond differently to the features of crossing structures, mitigation planning in a multiple-species ecosystem will be a challenging endeavour. Moreover, crossing structures will only be as effective as the land and resource management strategies around them. Crossing structures are in essence small and narrow, site-specific habitat linkages or corridors. Consequently, for these measures to fulfil their function as habitat connectors, mitigation strategies must be contemplated at two scales. Site-level impacts from development and high levels of human activity near crossing structures will decrease habitat quality and likely disrupt animal movements, particularly of large predators (Smith, 1999; Clevenger and Waltho, 2000). Similarly, alteration of landscape elements at a broader regional-scale could impede or obstruct movements towards the structures, preventing animals from using them entirely, thus rendering them ineffective.

To maximize connectivity across roads for multiple large mammal species, road construction schemes in the future should include a diversity of crossing structures of mixed size classes. This strategy will likely provide greater permeability of roads by accommodating a variety of species and behavioural profiles. We believe that mitigating highways for wildlife is a long-term process that will last for many decades and affect individuals and populations alike (Opdam, 1997). Thus, highway mitigation strategies developed around land-use planning should not terminate with the construction process, but need to be proactive at both scales to ensure that crossing structures remain functional over time. This requires continuous long term monitoring, as exemplified in this study.

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# Relative Sensitivities of Mammalian Carnivores to Habitat Fragmentation

KEVIN R. CROOKS\*

Department of Biology, University of California, Santa Cruz, CA 95064, U.S.A.

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**Abstract:** *I examined the effects of habitat fragmentation on the distribution and abundance of mammalian carnivores in coastal southern California and tested the prediction that responses to fragmentation varied with the body size of carnivore species. I conducted track surveys for nine native and two exotic carnivore species in 29 urban habitat fragments and 10 control sites. Fragment area and isolation were the two strongest landscape descriptors of predator distribution and abundance. Six species were sensitive to fragmentation, generally disappearing as habitat patches became smaller and more isolated; three species were enhanced by fragmentation, with increased abundance in highly fragmented sites; and two species were tolerant of fragmentation, with little to no effect of landscape variables on their distribution and abundance. Within urban habitat fragments, the carnivore visitation rate increased at sites with more exotic cover and closer to the urban edge, a pattern driven largely by the increased abundance of fragmentation-enhanced carnivores at edge sites. Finally, body size, in conjunction with other ecological characteristics, partially accounted for the heterogeneity in responses to fragmentation among carnivore species. These differential sensitivities are useful criteria for choosing appropriate focal species for ecological research and conservation planning, a choice that depends on the scale of fragmentation in a region and the commensurate responses of carnivore populations at that scale.*

Sensibilidad Relativa a la Fragmentación del Hábitat de Mamíferos Carnívoros

**Resumen:** *Examiné los efectos de la fragmentación del hábitat sobre la distribución y abundancia de mamíferos carnívoros en la costa del sur de California y evalué la predicción de que las respuestas a la fragmentación variaban con el tamaño corporal de carnívoros. Se realizaron muestreos de huellas para nueve especies nativas y dos exóticas en 29 fragmentos de hábitat urbano y 10 sitios control. El área fragmentada y su aislamiento fueron los dos principales descriptores de la distribución y abundancia de depredadores. Seis especies fueron sensibles a la fragmentación, generalmente las especies desaparecían conforme los fragmentos eran más pequeños y aislados, tres especies fueron favorecidas por la fragmentación, con incremento en su abundancia en sitios altamente fragmentados, y dos especies fueron tolerantes a la fragmentación con poco o ningún efecto de las variables del paisaje sobre su distribución y abundancia. Dentro de los fragmentos de hábitat urbano, las tasas de presencia de carnívoros incrementaron en sitios con mayor cobertura exótica y cercanos al borde urbano, un patrón dirigido principalmente por el incremento en la abundancia de carnívoros favorecidos por la fragmentación en el borde de los sitios. Finalmente, el tamaño corporal, conjuntamente con otras características ecológicas, fueron parcialmente responsables de la heterogeneidad en respuestas a la fragmentación entre especies de carnívoros. Estas sensibilidades diferenciales son un criterio útil para seleccionar especies focales apropiadas para investigaciones ecológicas y la planeación de la conservación, una selección que depende de la escala de fragmentación en una región y de las respuestas apropiadas de las poblaciones de carnívoros a esa escala.*

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\*Current address: Department of Wildlife Ecology, University of Wisconsin, Madison, WI 53706-1598, U.S.A., email [kcrooks@facstaff.wisc.edu](mailto:kcrooks@facstaff.wisc.edu)

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## Introduction

The destruction of habitat has been targeted as one of the most serious threats to biological diversity world-

wide (Wilcove et al. 1998), and in areas with increasing urbanization, the loss and fragmentation of habitat is virtually inevitable. Mediterranean scrub habitats in coastal southern California are particularly threatened. Intensive development in the region over the past century has destroyed all but 10% of the native coastal sage scrub habitat (McCaul 1994). This habitat loss has created a "hotspot" of endangerment and extinction for the highly endemic biota in the region (Dobson et al. 1997). Mammalian carnivores are thought to be particularly vulnerable to local extinction in fragmented landscapes because of their relatively large ranges, low numbers, and direct persecution by humans (Noss et al. 1996; Woodroffe & Ginsberg 1998). The decline and extirpation of top predators from fragmented systems may generate trophic cascades that alter the structure of ecological communities (Crooks & Soulé 1999). Indeed, the persistence of these environmentally sensitive and ecologically pivotal species may be indicative of the integrity of entire ecosystems (Noss et al. 1996). As such, mammalian carnivores can serve as useful tools for the study of ecological disturbances or for conservation planning and reserve design (Soulé & Terborgh 1999).

Mammalian predators are difficult to study, however, because of their low densities, nocturnal and secretive habits, and wariness of humans (Sargeant et al. 1998). As a result, the ecology of many carnivore species and their responses to ecological disturbances such as fragmentation are often poorly understood. Although considered members of the same ecological guild, carnivores may vary in their responses to fragmentation. In particular, differences in body size among carnivore species have been proposed as an important determinant of extinction probability (Brown 1986; Belovsky 1987). The relationship between body size and extinction risk in animals is complex, however, and has been the subject of considerable debate, with studies predicting and reporting positive, negative, or no relation of body size to extinction probability (reviewed by Johst & Brandl 1997). Few studies have evaluated if, how, or why carnivore species differ in their relative sensitivities to fragmentation effects.

My goal was to analyze the effects of the loss and fragmentation of habitat on mammalian carnivores in the urbanizing landscape of coastal southern California. Habitat fragmentation must be viewed as a multiscale problem, with fragmentation effects depending on the scale of fragmentation and the movement patterns of target species (Andren 1994). I therefore surveyed a suite of carnivore species that occur across a range of fragmentation levels and evaluated their responses to fragmentation at two spatial scales: (1) landscape-level heterogeneity among fragments and (2) local heterogeneity at sites within fragments. To allow for a more comprehensive assessment of relative sensitivities to fragmentation, I not only documented the presence or absence of

each carnivore species, but also measured their relative abundance at each site. Finally, I tested the prediction that responses to fragmentation vary with body size in carnivore species, explored other ecological traits of these predators that may contribute to extinction risk, and used these differential sensitivities to evaluate the utility of mammalian carnivores as focal species with which to assess the degree of functional landscape connectivity.

## Methods

### Study Areas

I conducted carnivore surveys in 29 urban habitat fragments in coastal San Diego County from Fall 1995 through Summer 1997. Twenty-eight of these fragments were originally studied by Soulé et al. (1988). The fragments, completely surrounded by human-modified landscapes, are typically dendritic canyons dissecting coastal mesas, although a few also contain mesa-top habitat. The fragments support a mosaic of shrub habitat, including mixed chaparral, chamise chaparral, maritime succulent shrub, and coastal sage scrub, the dominant assemblage in most sites. Disturbed areas within fragments were typically dominated by ruderal weed species, ornamental plants invading from surrounding residences, fire-retardant ground cover such as South African ice-plant (*Carpobrotus edulis*), and non-native trees (e.g., palms and species of *Eucalyptus* and *Acacia*) (Alberts et al. 1993).

From Fall 1995 through Summer 2000, I conducted carnivore surveys in less disturbed areas in coastal southern California to act as controls to the small, urban habitat remnants. These control areas varied in size and degree of isolation (Table 1), ranging from relatively small reserves isolated within urban developments (e.g., Point Loma Ecological Reserve) to large blocks of habitat relatively continuous with larger natural areas (e.g., Miramar Marine Corps Air Station).

### Carnivore Surveys

I assessed the distribution and relative abundance of nine native and two non-native predator species through track surveys. Native species were the mountain lion (*Felis concolor*), bobcat (*Felis rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), badger (*Taxidea taxus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), western spotted skunk (*Spilogale gracilis*), and long-tailed weasel (*Mustela frenata*). Non-native target species were the domestic cat (*Felis catus*) and Virginia opossum (*Didelphis virginiana*), a marsupial introduced to California around 1910 (Jameson & Peeters 1988).



Table 1. Landscape variables and distributions of 11 mammalian carnivore species for 10 control sites and 29 urban habitat fragments in coastal southern California (1, present; 0, absent).

Control sites	Area (ha)	Age (yrs)	Distance Y (m)	Distance Z (m)	Long-tailed weasel	Spotted skunk	Badger	Mountain lion	Bobcat	Coyote	Gray fox	Striped skunk	Raccoon	Opossum	Domestic cat
Miramar Marine Corps Air Station	5806	0	0	0	0	0	0	1	1	1	0	1	1	1	0
Chino Hills State Park	4452	0	200	200	1	0	1	1	1	1	1	1	1	1	0
Limestone Canyon/Whiting Ranch	4450	0	15	15	0	0	1	1	1	1	1	1	1	1	0
San Joaquin Hills	4219	22	5353	2930	0	1	0	0	1	1	1	1	1	1	0
Weir Canyon	1923	0	69	69	0	0	0	1	1	1	1	1	0	1	0
Santa Margarita Ecological Reserve	1763	0	30	30	0	0	0	1	1	1	1	0	1	0	0
Starr Ranch	1548	0	0	0	0	1	0	1	1	1	1	1	1	1	0
Tenaja	1191	0	0	0	1	0	1	1	1	1	1	1	1	1	0
Torrey Pines State Reserve	428	0	68	68	0	0	0	0	1	1	1	1	1	1	0
Point Loma Ecological Reserve	264	45	5700	5700	0	0	0	0	0	1	1	1	1	0	1
Urban fragments															
Florida	102	59	2100	233	0	0	0	0	0	1	1	0	0	0	0
Torrey Pines Extension	74	20	91	91	0	0	0	0	1	1	1	1	1	1	1
Balboa Terrace	56	43	121	117	0	0	0	0	0	1	1	1	1	1	1
Alta La Jolla	34	23	121	93	0	0	0	0	0	1	1	1	1	1	1
Kate Sessions	31	25	121	93	0	0	0	0	0	1	1	1	1	1	1
Zena	15	45	2865	467	0	0	0	0	0	1	1	1	0	1	1
Canon	12	67	1219	1167	0	0	0	0	0	0	1	1	1	1	1
Laurel	10	88	1554	350	0	0	0	0	0	1	1	1	1	1	1
32nd Street South	10	65	304	233	0	0	0	0	0	1	0	0	0	0	1
Pottery	10	23	45	70	0	0	0	0	0	1	1	1	1	1	0
Washington	9	83	365	187	0	0	0	0	0	1	1	1	1	1	1
Syracuse	9	27	40	70	0	0	0	0	0	1	1	1	0	1	1
Baja	8	40	670	70	0	0	0	0	0	1	1	1	1	1	1
Raffee	8	28	61	163	0	0	0	0	0	1	1	1	1	1	1
Solana	8	20	550	187	0	0	0	0	0	1	1	0	1	1	0
Acuna	7	31	110	47	0	0	0	0	0	1	1	1	0	1	1
Juan	7	32	228	70	0	0	0	0	0	1	1	1	1	1	1
Chollas	6	45	1005	467	0	0	0	0	0	1	1	1	1	1	1
Mil Cumbres	6	20	550	23	0	0	0	0	0	1	1	1	0	1	1
Chateau	6	29	110	47	0	0	0	0	0	1	1	0	0	1	1
Oak Crest	6	15	400	140	0	0	0	0	0	1	0	0	0	1	1
54th	4	29	609	187	0	0	0	0	0	1	1	1	1	1	1
60th	4	46	335	350	0	0	0	0	0	1	0	0	0	1	0
Spruce	4	95	1767	93	0	0	0	0	0	1	1	1	1	1	1
Titus	3	86	280	163	0	0	0	0	0	1	1	1	1	1	1
Montanosa	3	11	91	93	0	0	0	0	0	1	0	0	0	1	1
El Mac	2	41	883	163	0	0	0	0	0	1	1	1	1	0	1
Poinsettia	2	59	350	350	0	0	0	0	0	0	1	0	1	1	1
Talbot	2	64	1219	933	0	0	0	0	0	0	1	1	1	1	1
Urban fragment occupancy					2	2	3	7	11	26	25	21	19	26	25
Total occupancy					2	2	3	7	11	36	34	30	28	34	26

I established a series of track-detection stations at approximately 250-m intervals along dirt roads or trails (human and/or wildlife) along the main axis of each study area (Linhart & Knowlton 1975; Conner et al. 1983; Sargeant et al. 1998). Each track station consisted of a 1-m-diameter, 1-cm-deep, circle of freshly sifted gypsum baited with a liquid carnivore scent lure (Russ Carman's Pro-Choice and Canine Call, Sterling Fur & Tool, Sterling, Ohio) every other day. Track transects were checked and reset daily for 5 consecutive days. Tracks on each station were measured and identified to species; tracks with ambiguous identifications were omitted from analyses. Track surveys were conducted once each sampling quarter: fall (September–November), winter (December–February), spring (March–May), and summer (June–August). Each site was sampled for 1–2 years.

The track index of each carnivore species in each quarterly sampling session was expressed as the total number of visits recorded for a species, divided by the total sampling effort. I defined a visit as at least one track of a species on a track station (Conner et al. 1983). Mathematically, the track index ( $I$ ) was calculated as

$$I = \ln[\{v_j/(s_j n_j)\} + 1],$$

where  $v_j$  is the number of stations visited by a species in transect  $j$ ,  $s_j$  is the number of stations in transect  $j$ , and  $n_j$  is the number of nights that stations were operative in transect  $j$ . Thus,  $I$  for each species represents the visitation rate per track station per night in each study area. Although this index cannot be directly translated into numbers of individuals and hence does not measure absolute densities, it does provide an index of the relative abundance of a species at each sampling point (Conner et al. 1983; Sargeant et al. 1998). For each species, I averaged track indices across quarterly sampling sessions to derive a mean index at each study area for the duration of the study. Indices were log-transformed to meet normality assumptions in the statistical analyses. Overall, track surveys totaled 6540 station-nights ( $s_j n_j$ ) among all study sites.

### Landscape Variables

I used area, age, and isolation to assess the effects of landscape-level fragmentation on carnivore populations (Table 1). I measured the total area of each fragment based on digitized images of scaled aerial photographs taken in 1995. Total area of each control site was defined as the reserve boundaries within which the surveys were conducted. Because control sites were often adjacent to unfragmented habitat, area approximations represent minimum estimates.

Fragment age, defined as the number of years since isolation of the habitat fragment by urban development, was based on dated aerial photographs and building permit records (Soulé et al. 1988). Because fragment age is

highly negatively correlated to the proportion of native shrub cover within fragments (Suarez et al. 1998; Crooks et al. 2001), I used age to measure a time effect per se in the fragments and to represent the cumulative loss of native habitat in the entire fragment since isolation. Age was scored as zero for control sites that were directly adjacent to larger natural areas (Miramar Marine Corps Air Station, Starr Ranch Audubon Sanctuary, Tenaja Corridor) or that were separated from such areas by only a roadway and not by urban development (Chino Hills State Parks, Limestone Canyon/Whiting Ranch, Santa Margarita Ecological Reserve, Torrey Pines State Reserve, Weir Canyon).

Two variables were calculated to characterize the degree of isolation of each site: distance  $Y$ , the distance to the closest habitat patch (measured from patch edge to patch edge) of equal or larger size (Soulé et al. 1988), and distance  $Z$ , the shortest distance to any other habitat fragment, reserve, or possible movement linkage to such sites (e.g., riparian channels, power line easements, golf courses). Isolation was scored as zero for control sites directly adjacent to a larger natural area and as the width of the roadway for control sites isolated from larger habitat blocks by a roadway.

All landscape variables were log-transformed to meet normality assumptions in the statistical analyses. When only the urban habitat fragments were considered, fragment age was positively related to distance  $Y$  ( $r = 0.564$ ,  $p = 0.001$ ) and distance  $Z$  ( $r = 0.526$ ,  $p = 0.003$ ), and distance  $Y$  was positively related to distance  $Z$  ( $r = 0.362$ ,  $p = 0.053$ ). When both habitat fragments and control areas were included, area was negatively related to age ( $r = -0.813$ ,  $p < 0.001$ ), distance  $Y$  ( $r = -0.467$ ,  $p = 0.003$ ), and distance  $Z$  ( $r = -0.299$ ,  $p = 0.065$ ); age was positively related to distance  $Y$  ( $r = 0.741$ ,  $p < 0.001$ ) and distance  $Z$  ( $r = 0.597$ ,  $p < 0.001$ ); and distance  $Y$  was positively related to distance  $Z$  ( $r = 0.761$ ,  $p < 0.001$ ).

### SPECIES RICHNESS AND DISTRIBUTION

Island biogeography theory predicts that landscape variables such as size and isolation should help determine the number of species on islands (MacArthur & Wilson 1967). To test this prediction, I calculated two measures of carnivore species richness for each study area: (1) the number of carnivore species detected at the site during the course of the study and (2) the number of native carnivore species detected, excluding the non-native opossum and domestic cat. A species was present in a study area if it was detected on track stations within the site at least once during the course of the study. Presence was verified with a combination of remotely triggered cameras, scat surveys, and opportunistic visual sightings. Presence of a species does not necessarily imply that the site can support resident animals or populations. Like-

wise, failure to detect a species at a site does not indicate that the species has never visited the area, but rather that it was not recorded during sampling sessions.

I used backward-elimination multiple regression to identify which landscape variables (size, age, and isolation) were the best predictors of carnivore species richness in a study site. Independent variables with  $p < 0.15$  were included in all regression models to minimize exclusion of important predictors from the model, and tolerance values were set at 0.10 throughout to control for multicollinearity (Tabachnick & Fidell 1996). Comparison-wide error rates were examined in all statistical analyses (Mead 1988; Stuart-Oaten 1995) ( $p < 0.05$ , statistically significant;  $0.05 < p < 0.10$ , marginally significant). I first conducted the multiple-regression analyses including only the 29 urban habitat fragments and then including all 39 study sites.

I used logistic-regression analyses to evaluate the effect of landscape variables on the distribution of individual carnivore species. First, I constructed bivariate logistic-regression models to evaluate the separate effects of area and isolation (distance  $Z$ ) on the probability of occurrence for each species across all 39 study sites. Area and distance  $Z$  were chosen because preliminary analyses indicated that they were the two strongest predictors of carnivore distribution. For species with significant area and isolation effects, I plotted logistic-regression curves of the probability of occurrence of each species as a function of area, holding isolation constant by substituting its median value into a two-way (area  $\times$  isolation) logistic model. Likewise, I constructed isolation curves after holding area constant by substituting its median value into the two-way logistic model. From these curves, I calculated the area and isolation at which the probability of occurrence of the species equaled 50% and used these estimates to represent the relative area and isolation requirements for each species (following Crooks et al. 2001). Finally, I used multiple-logistic-regression models to graphically evaluate the combined effect of area and isolation on probability of occurrence for each species.

Logistic-regression estimates of probability of occurrences and relative area and isolation requirements are not intended, however, to represent the actual fragment size or isolation necessary to ensure the long-term persistence of a population (Hinsley et al. 1996). Rather, probability of occurrence measures the probability of an individual visiting the study area at least once during the course of the study, and the area and isolation estimates generated are intended to function only as relative indices of sensitivity to fragmentation. Area and isolation estimates are likely to be more accurate for those species with the most detections.

#### RELATIVE ABUNDANCE

I used backward-elimination regression models to identify which landscape variables were the best predictors

of the track indices of each species in each study area. The analyses were first conducted including only the 29 urban habitat fragments. Mountain lions, spotted skunks, badgers, and long-tailed weasels were omitted from these analyses because they were not detected in any urban habitat fragments. Bobcats, detected in only two fragments, were also omitted.

I repeated the multiple-regression analyses across all 39 fragments and control sites, including mountain lions and bobcats in the analyses. Spotted skunks, badgers, and long-tailed weasels were again omitted due to low detection rates. Because the track indices for mountain lions and bobcats were zero for many sites, the results of these regressions must be interpreted with caution. The final regression models were determined largely by the patterns of species' presence or absence across sites and not by variation in relative abundance among sites where they occurred. Nevertheless, I report regression models for mountain lions and bobcats to allow for further evaluation of the effects of landscape variables on these species and for further comparisons of their fragmentation sensitivities to those of other carnivore species.

#### Local Variables

Habitat heterogeneity within these urban habitat fragments is an important determinant of the persistence of native scrub-breeding birds (Soulé et al. 1988), rodents (Bolger et al. 1997), and invertebrates (Suarez et al. 1998; Bolger et al. 2000), all potential prey for carnivore species. I measured three variables to investigate the effect of habitat heterogeneity on carnivore populations: distance to the urban edge, percent cover of native shrubs, and percent cover of exotic vegetation. I estimated the distance of each track station to the nearest urban edge (the backyards of the houses bordering the fragment) and log-transformed these values to meet normality assumptions in the statistical analyses. I used a Braun-Blanquet categorical scale (Kent & Coker 1992) to estimate the percent cover of native shrubs and of total exotic cover within a 20-m radius around each track station. The cover scale was 0 (<1%), 1 (1–5%), 2 (6–25%), 3 (26–50%), 4 (51–75%), and 5 (76–100%). Distance to edge was positively related to shrub cover ( $r = 0.281$ ,  $p = 0.007$ ) and negatively related to exotic cover ( $r = -0.341$ ,  $p = 0.001$ ), and shrub cover was negatively related to exotic cover ( $r = -0.694$ ,  $p < 0.001$ ).

#### SPECIES RICHNESS AND RELATIVE ABUNDANCE

I calculated the total number of carnivore species and the number of native carnivore species detected at each track station in the 29 urban habitat fragments during the course of the study; two exotic species (opossum and domestic cat) and five native species (bobcat, coyote, gray fox, striped skunk, and raccoon) were detected

in the urban fragments and were hence included in the analyses. I then used backward-elimination multiple regression to identify which local variables were the best predictors of carnivore species richness at each station.

I calculated the mean track index for each species at each track station in the 29 urban habitat fragments to generate relative abundance indices. Again, mountain lions, spotted skunks, long-tailed weasels, badgers, and bobcats were omitted from these analyses due to low detection rates within fragments. I then used backward-elimination multiple regression to identify which local variables were the best predictors of the relative abundance of each species at a station. Some species were absent from some fragments, however, an absence driven in part by landscape variables such as area, age, and isolation. I therefore conducted the regressions for each species after excluding from the analyses all fragments where that species was never detected. By excluding these fragments I could account for the effects of landscape-level fragmentation on the presence or absence of a species and therefore more fully analyze the effects of local variables within fragments where that species occurred.

To further evaluate the effect of the urban edge on carnivores within fragments, for each species I graphed the mean track index at each station as a function of the distance of that station from the urban edge. Edge distances were classified into five categories: 0–24 m ( $n = 14$  stations), 25–49 m ( $n = 35$ ), 50–99 m ( $n = 16$ ), 100–199 m ( $n = 19$ ), and >200 m ( $n = 7$ ). Direct comparisons of track indices between species can be misleading, because the response of species to track stations may differ (Conner et al. 1983; Sargeant et al. 1998). To allow for more meaningful comparisons of track indices, I standardized the index for each species by dividing each value by the maximum track index recorded for that species. Therefore, these standardized track indices for each species ranged on a scale of 0 to 1.

### Body Size and Fragmentation Sensitivity

I evaluated the relationship between body mass and sensitivity to fragmentation among carnivore species through linear-regression analysis. As an index of sensitivity to fragmentation, I calculated the average area of study sites occupied by each species, multiplying the area of each study site by the standardized track index (scale 0 to 1) of that species at that site. With area weighted by relative abundance per sampling point, the indices accounted not just for occupancy but also for differences in the relative abundance of a species among study sites. For example, for a given species, some study sites supported resident populations, whereas other study sites were only visited temporarily during the course of the study. Average area weighted by relative abundance accounted for such differences. In addition, I

also compared body mass to typical home-range sizes and population densities reported in the literature for these species.

## Results

### Landscape Heterogeneity: Comparisons among Fragments

#### SPECIES RICHNESS AND DISTRIBUTION

The distribution of carnivore species varied across study sites (Table 1). Coyotes, opossums, gray foxes, domestic cats, striped skunks, and raccoons were detected in most urban fragments. Bobcats were detected in 9 of the 10 control sites but in only 2 urban habitat fragments, and mountain lions were detected in only 7 control sites and no urban fragments. I recorded few to no visits of mountain lions and bobcats in the habitat fragments, despite higher sampling intensity per unit area (station-nights/total area of site) in the 29 fragments (mean = 8.30 station-nights/ha, SE = 0.910) than in the 10 control sites (mean = 0.43 station-nights/ha, SE = 0.158) ( $t = 4.58$ ,  $p < 0.001$ ). Detections of spotted skunks, long-tailed weasels, and badgers were rare and occurred only in the larger habitat blocks.

Among the 29 urban habitat fragments, no landscape variables were retained as predictors of the total number of carnivore species in backward-elimination regression models (Table 2). When the opossum and domestic cat were excluded, however, the species richness of native carnivores exhibited a weak negative trend with fragment isolation (distance  $Z$ ) and a weak positive trend with fragment age. When control sites were included in the analyses, both total carnivore species richness and native carnivore species richness increased with the area of the study site.

Logistic-regression models for each species indicated that the probability of occurrence across all sites was positively related to fragment area for coyotes ( $\chi^2 = 5.57$ ,  $p = 0.018$ ), bobcats ( $\chi^2 = 29.85$ ,  $p < 0.001$ ), mountain lions ( $\chi^2 = 27.35$ ,  $p < 0.001$ ), spotted skunks ( $\chi^2 = 5.85$ ,  $p = 0.016$ ), long-tailed weasels ( $\chi^2 = 5.37$ ,  $p = 0.021$ ), and badgers ( $\chi^2 = 9.73$ ,  $p = 0.002$ ). In contrast to these native carnivores, the probability of occurrence of domestic cats was higher in smaller fragments ( $\chi^2 = 22.63$ ,  $p < 0.001$ ). Area was not a significant predictor of probability of occurrence for gray foxes ( $\chi^2 = 0.24$ ,  $p = 0.627$ ), striped skunks ( $\chi^2 = 1.81$ ,  $p = 0.178$ ), raccoons ( $\chi^2 = 2.02$ ,  $p = 0.155$ ), or opossums ( $\chi^2 = 0.357$ ,  $p = 0.550$ ).

Logistic-regression models indicated that probability of occurrence across all sites decreased with fragment isolation (distance  $Z$ ) for coyotes ( $\chi^2 = 6.92$ ,  $p = 0.008$ ), bobcats ( $\chi^2 = 11.57$ ,  $p < 0.001$ ), and mountain lions ( $\chi^2 = 11.88$ ,  $p < 0.001$ ). In contrast, probability of oc-

**Table 2.** Backward-elimination regression models of the effects of landscape variables on carnivore species richness and relative abundance among 29 urban habitat fragments and 10 control sites in coastal southern California.<sup>a</sup>

Variables	R <sup>2</sup>	Whole-model p	Coefficient	p
Urban habitat fragments				
total species richness				
n.s. <sup>b</sup>				
native species richness	0.146	0.129		
distance Z			-0.408	0.067
age			+0.374	0.091
coyote	0.133	0.052		
area			+0.365	0.052
gray fox	0.114	0.074		
area			-0.336	0.074
domestic cat	0.393	0.002		
area			-0.550	0.001
distance Z			+0.246	0.122
opossum	0.164	0.029		
area			-0.405	0.029
striped skunk				
n.s.				
raccoon				
n.s.				
All sites				
total species richness	0.194	<0.001		
area			+0.440	<0.001
native species richness	0.372	<0.001		
area			+0.610	<0.001
coyote	0.15	0.015		
area			+0.388	0.015
bobcat	0.595	<0.001		
age			-0.921	<0.001
distance Y			+0.607	0.004
distance Z			-0.376	0.030
mountain lion	0.277	<0.001		
age			-0.526	<0.001
gray fox	0.197	0.005		
area			-0.444	0.005
raccoon	0.081	0.081		
area			-0.284	0.081
domestic cat	0.335	<0.001		
area			-0.579	0.001
opossum	0.241	0.002		
area			-0.491	0.002
striped skunk				
n.s.				

<sup>a</sup>Independent variables are fragment area, age, and isolation (distance Y and distance Z). Independent variables with  $p < 0.15$  were included in the final regression models.

<sup>b</sup>No independent variables were retained in the regression model ( $p > 0.15$ ); n.s., not significant.

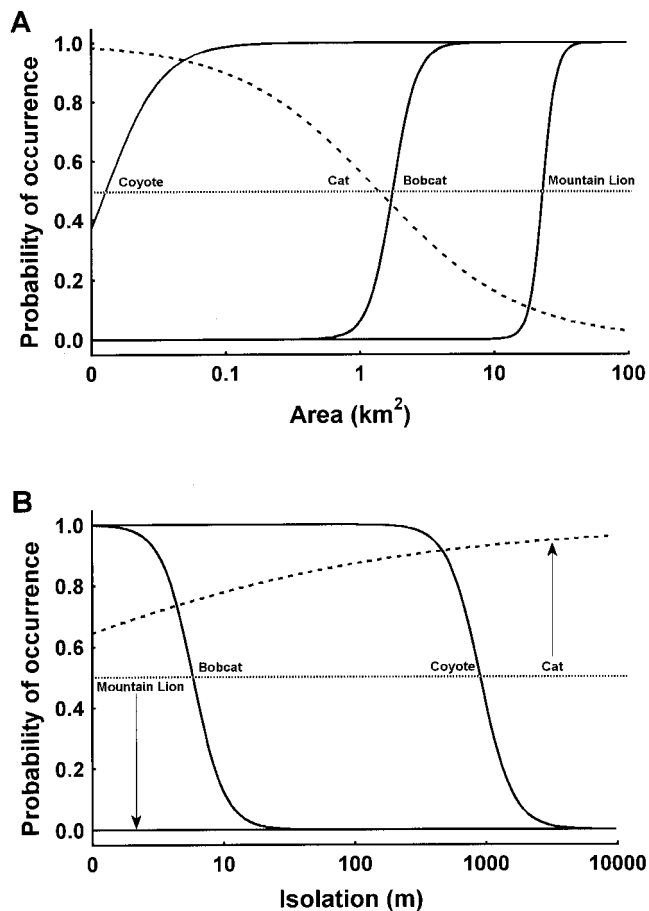
currence was higher in more isolated fragments for domestic cats ( $\chi^2 = 4.25$ ,  $p = 0.039$ ). Isolation was not a significant predictor of probability of occurrence for gray foxes ( $\chi^2 = 0.35$ ,  $p = 0.553$ ), opossums ( $\chi^2 = 1.88$ ,  $p = 0.171$ ), spotted skunks ( $\chi^2 = 0.18$ ,  $p = 0.671$ ), striped skunks ( $\chi^2 = 0.69$ ,  $p = 0.407$ ), raccoons ( $\chi^2 = 0.06$ ,  $p = 0.811$ ), long-tailed weasels ( $\chi^2 = 1.74$ ,  $p = 0.187$ ), or badgers ( $\chi^2 = 2.62$ ,  $p = 0.106$ ).

After I controlled for isolation effects, the estimated area at which probability of occurrence was 50% was 1 ha for coyotes, 1.8 km<sup>2</sup> for bobcats, and 23 km<sup>2</sup> for mountain lions (Fig. 1a). The probability of occurrence

for domestic cats dropped below 50% in fragments larger than 1.4 km<sup>2</sup>; cats were never detected in the interior of control sites, and few if any feral cats occurred in these sites.

After I controlled for area effects, the estimated fragment isolation (distance Z) at which probability of occurrence was 50% was 883 m for coyotes and 6 m for bobcats (Fig. 1b). The probability of occurrence for mountain lions was <50% across the entire isolation range of fragments. In contrast, the probability of occurrence for domestic cats was >50% across the entire range of fragment isolation.





**Figure 1.** Logistic-regression models of the probability of occurrence of native (solid lines) and exotic (dashed line) carnivores as a function of (a) fragment area and (b) isolation. Area and isolation curves were constructed after the other independent variable was held constant by substituting its median values into a two-way (area  $\times$  isolation) logistic-regression model. Only species with significant area and isolation effects are presented. Dotted line represents 50% probability of occurrence.

Multiple logistic-regression models of the combined effect of area and isolation on mountain lions, bobcats, and coyotes generated “extinction surfaces” that consisted of plateaus of occupancy at larger and less isolated sites that declined to basins of local extinctions at small and isolated fragments (Fig. 2). The effect of the area-isolation interaction, and hence the contour of the extinction surfaces, varied among species. The plateau for mountain lions was small and occurred only in the largest unfragmented sites, with large basins across all other study areas. The plateau for bobcats spanned a wider range of sites, but probability of occurrence dropped to zero in sites that were both small and isolated. Bobcats occurred in relatively small sites, but only those with little to no isolation. The plateau of coyotes was large, with

a low probability of occurrence in only the smallest, most isolated urban fragments. Domestic cats exhibited a surface that was the inverse of these native predators. Their probability of occurrence was high in small and isolated fragments but lower in larger, less fragmented sites.

It should be emphasized, however, that the probability of residency or long-term viability of populations is undoubtedly lower than these probabilities of occurrence, particularly in smaller and isolated sites. For example, coyotes visited some fragments only temporarily during the course of the study. In some quarterly sampling sessions they were detected and in others they were not. Although the plateau of occupancy for coyotes encompassed most combinations of area and isolation, residency declined with fragment area. The average area of the 13 fragments in which coyotes came and went (mean = 0.75 [5.6 ha back-transformed], SD = 0.20) was smaller ( $t = 3.01$ ,  $p = 0.006$ ) than the average area of the 13 fragments in which coyotes were detected in every quarterly sampling session (mean = 1.19 [15.6 ha back-transformed], SD = 0.95).

#### RELATIVE ABUNDANCE

When only the 29 urban habitat fragments were included in the analyses, the relative abundance of coyotes at each sampling point was higher in larger fragments, whereas track indices of gray foxes, domestic cats, and opossums were higher in smaller fragments (Table 2). No variables were retained in the final model for raccoons and striped skunks ( $p > 0.15$ ).

When control sites were also included in the regressions, coyote track indices at each sampling point again tended to be higher in larger sites. In contrast, the track indices of gray foxes, domestic cats, opossums, and raccoons were higher in smaller sites (Table 2). No landscape variables were retained in the models for the relative abundance of striped skunks.

When control sites were included in the regression models, fragment age was retained as the most significant predictor of the relative abundance of mountain lions and bobcats (Table 2); both species were less abundant in older sites. Mountain lions and bobcats were detected in relatively few sites, most of which were control areas not isolated by urban development (age = 0) and, for bobcats, a couple of recently isolated fragments (Table 1). This pattern generated the significant, negative slope between relative abundance and age for the two species.

The relative abundance of bobcats decreased with distance to the nearest movement linkage or natural area (distance  $Z$ ) but, paradoxically, increased with distance to the nearest habitat patch of equal or larger size (distance  $Y$ ). Bobcats were detected at sites that were relatively distant from larger natural areas (high values of

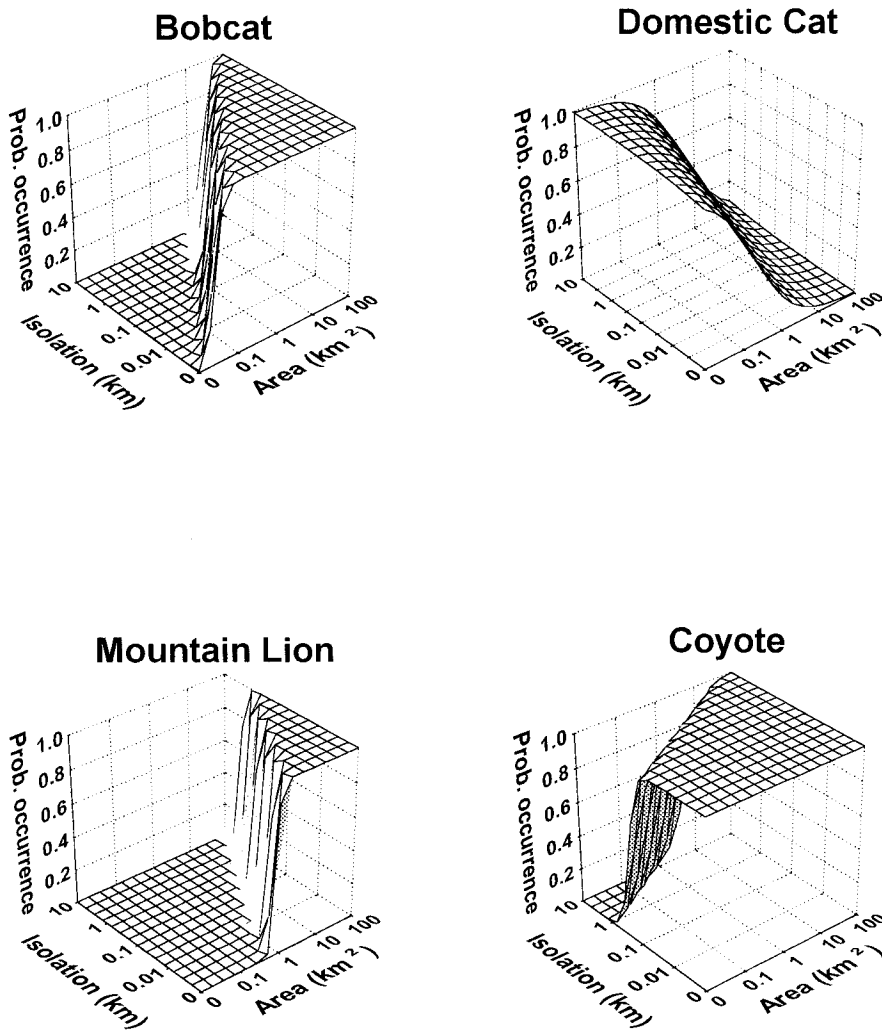


Figure 2. Multiple logistic-regression models of the probability of occurrence of mountain lions, bobcats, coyotes, and domestic cats as a function of fragment area and isolation. Only species with significant area and isolation effects are presented.

distance  $Y$ ), but only if they were large or were near movement linkages to larger habitat blocks (low value of distance  $Z$ ). For example, bobcats have persisted in the San Joaquin Hills, an isolated (distance  $Y = 5353$  m) but large (4219 ha) habitat block. Bobcats were also detected in Mil Cumbres, a small (6 ha) urban fragment that was isolated from larger natural areas (distance  $Y = 550$  m) but that was near a golf course (distance  $Z = 23$  m), which likely served as a movement linkage to natural areas to the east.

### Local Heterogeneity: Comparisons within Fragments

#### SPECIES RICHNESS AND RELATIVE ABUNDANCE

The number of carnivore species detected was greater at track stations closer to the urban edge (Table 3). This pattern was largely determined by non-native species. When exotic predators (domestic cats, opossums) were excluded from the analyses, the number of native species detected at each station did not vary significantly with any local variables.

The relative abundance of gray foxes and opossums was higher at track stations near the urban edge within fragments where each species occurred (Table 3). The abundance of domestic cat exhibited a weak negative trend with distance to urban edge. The relative abundance of striped skunks tended to be higher at greater distances from the urban edge. Domestic cats and raccoons tended to be more abundant at stations with more exotic cover. No local variables entered the model for the relative abundance of coyotes.

A graphical analysis revealed that the coyote rate of visitation to track stations was high both near the urban edge and into the interior of the urban habitat fragments (Fig. 3). The abundance of striped skunks also was relatively high in the interior of fragments. In contrast, the abundance of opossums, gray foxes, domestic cats, and raccoons was relatively high within 50 m from urban development, but then tended to decline into the interior of the habitat fragment.

### Body Size and Fragmentation Sensitivity

When all species were included in the regression, the relationship between body mass (Table 4) and the average

**Table 3. Backward-elimination regression models of the effects of local habitat variables on carnivore species richness and relative abundance at 92 track stations within 29 urban habitat fragments in southern California.<sup>a</sup>**

Variables	R <sup>2</sup>	Whole-model p	Coefficient	p
Total species richness	0.049	0.036		
edge			-0.222	0.036
Native species richness				
n.s. <sup>b</sup>				
Coyote (87 stations)				
n.s.				
Gray fox (85)	0.146	<0.001		
edge			-0.382	<0.001
Striped skunk (69)	0.042	0.095		
edge			0.205	0.095
Raccoon (62)	0.056	0.066		
exotic			0.237	0.066
Domestic cat (73)	0.143	0.005		
exotic			0.242	0.057
edge			-0.205	0.105
Opossum (79)	0.079	0.013		
edge			-0.281	0.013

<sup>a</sup>Independent variables are distance to urban edge, native shrub cover, and total exotic cover. Independent variables with  $p < 0.15$  were included in the final regression models. For each species, stations were included only in analyses for those fragments where the species was detected.

<sup>b</sup>No independent variables were retained in the regression model ( $p > 0.15$ ); n.s., not significant.

area of study sites occupied by each carnivore species, weighted by the standardized track index of each species at each site, was not significant ( $r = -0.392$ ,  $p = 0.233$ ) (Fig. 4a). Spotted skunks, long-tailed weasels, and badgers, however, appeared to be outliers to an otherwise positive relationship between body size and average area of sites occupied. When these three species were excluded from the regression, the positive relationship was significant ( $r = 0.725$ ,  $p = 0.042$ ). Body mass was also positively related to typical home-range sizes (Fig. 4b:  $r = 0.720$ ,  $p = 0.012$ ) and negatively related to typical population densities (Fig. 4c:  $r = -0.705$ ,  $p = 0.015$ ) recorded for these species (Table 4).

## Discussion

### Landscape Heterogeneity and Carnivore Populations

Fragment area and isolation were the two strongest landscape predictors of predator distribution and abundance. Badgers, long-tailed weasels, spotted skunks, mountain lions, bobcats, and coyotes appear to be the species most sensitive to fragmentation, with a lower probability of occurrence and relative abundance per unit area in smaller and more isolated habitat patches. In contrast, the probability of occurrence and relative abundance of domestic cats, gray foxes, and opossums tended to decrease with fragment area and increase with fragment isolation. Landscape descriptors had relatively little effect on the distribution and abundance of raccoons and striped skunks. Because some carnivores

were fragmentation-sensitive, some fragmentation-enhanced, and some fragmentation-tolerant, landscape variables appear to affect species composition more than species richness.

The probability of occurrence of mountain lions, bobcats, and coyotes declined in sequence as habitat patches became smaller and more isolated (Fig. 1). Because mountain lions, bobcats, and coyotes generally occurred in fragments above some threshold of size and isolation, local extinctions of their populations in a fragmenting landscape appear deterministic and predictable (Brown 1986). Such thresholds also suggest that, depending on the species and the degree of fragmentation, a single large reserve would have a higher probability of supporting populations of these predators than archipelagos of similar but smaller isolates (Soulé & Simberloff 1986). For example, our models predict that the probability of occurrence of bobcats will be low in 10 1-km<sup>2</sup> isolates but higher in a 10-km<sup>2</sup> reserve, and that the probability of occurrence of mountain lions will be low in 10 10-km<sup>2</sup> isolates but higher in a 100-km<sup>2</sup> reserve (Fig. 1).

Unlike true islands, habitat patches are part of a landscape mosaic, and the presence of a given species in a patch may be a function not only of patch size and isolation, but also of how the species perceives the intervening matrix (Andren 1994; Rosenblatt et al. 1999). In previous studies in this system, fragment age and area were the most important landscape predictors of the distribution and abundance of native plants (Alberts et al. 1993), scrub-breeding birds (Soulé et al. 1988; Crooks et al. 2001), rodents (Bolger et al. 1997), and invertebrates

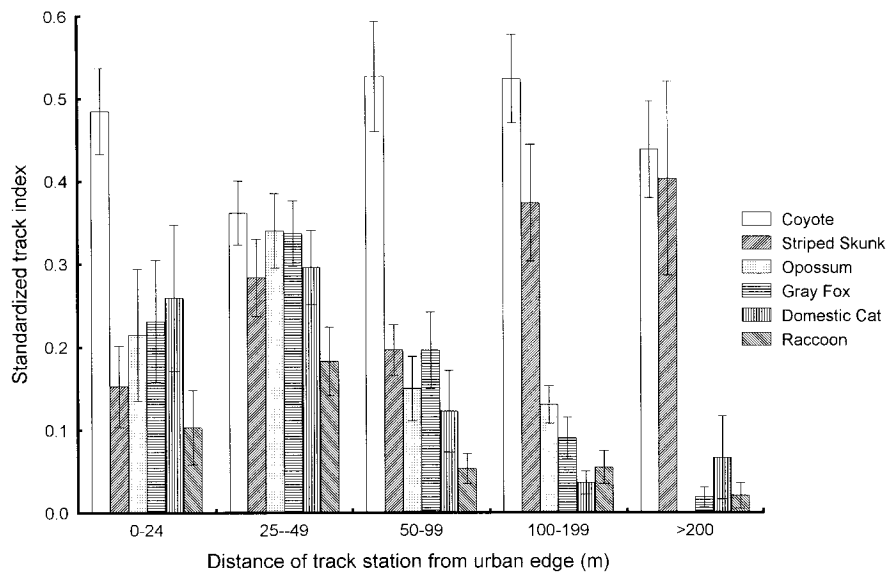


Figure 3. Track indices of carnivore species within urban habitat fragments as a function of the distance of the station from the urban edge. Track indices are standardized for each species.

(Suarez et al. 1998; Bolger et al. 2000). With limited exceptions, isolation effects were absent for these species, likely due to their strict habitat requirements and low dispersal capabilities (Soulé et al. 1992). For these taxa, little to no dispersal across developed areas resulted in complete isolation once fragmentation had occurred, with the fragments operating as true islands immersed within a relatively inhospitable matrix. My results also indicate that fragment isolation was not a strong predictor of the distribution and abundance of human-tolerant mesopredators, although the causal mechanisms differed. Unlike many native scrub-breeding birds, rodents, and invertebrates, mesopredator species such as raccoons, striped skunks, opossums, and domestic cats move through and reside within developed areas and thus perceive the urban matrix as somewhat permeable. High rates of movement through the matrix within

which fragments are embedded should also minimize the effects of fragment isolation.

#### Local Heterogeneity and Carnivore Populations

Within the urban fragments, exotic cover and distance to the urban edge were the strongest local predictors of carnivore distribution and abundance. These two variables were correlated, with more exotic cover and less native shrub cover closer to the urban edge. Previous studies have found that scrub-breeding birds (Soulé et al. 1988), rodents (Bolger et al. 1997), and invertebrates (Suarez et al. 1998; Bolger et al. 2000) require native vegetation to persist in these fragments. Unlike many of these species, however, the mammalian carnivores detected in the habitat fragments are resource generalists that likely benefit from the supplemental food resources

Table 4. Ecological characteristics of mammalian carnivores detected in coastal southern California.<sup>a</sup>

Species	Weight (kg)	Home range (km <sup>2</sup> )	Density (km <sup>2</sup> )	Reference
Mountain lion	69.5 (36.0–103.0)	492 (112–829)	0.027 (0.005–0.048)	Beier & Barrett 1993; Nowak 1999
Coyote	13.5 (7.0–20.0)	5.69 (0.66–11.96)	0.3 (0.2–0.4)	Nowak 1999; Sauvajot et al. 2000
Bobcat	9.7 (4.1–15.3)	2.94 (0.24–5.63)	1.34 (1.15–1.53)	Lembeck 1986; Nowak 1999
Badger	8.0 (4–12)	2.0 (1.6–2.4)	2.70 (0.39–5.0)	Messick 1987; Nowak 1999
Raccoon	7.0 (2.0–12.0)	0.52 (0.39–0.65)	11.2 (2.3–20.0)	Nowak 1999
Gray fox	4.4 (1.8–7.0)	0.69 (0.22–1.87)	5.2 (0.4–10.0)	Nowak 1999; Riley 1999
Domestic cat <sup>b</sup>	3.9 (3.3–4.5)	0.40 (0.001–3.80)	150 (2–500)	Barratt 1997; Nowak 1999
Opossum	3.8 (2.0–5.5)	0.20 (0.05–2.54)	26 (2–116)	Nowak 1999
Striped skunk	1.6 (0.7–2.5)	0.21 (0.11–0.37)	3.3 (1.8–4.8)	Nowak 1999
Spotted skunk	0.6 (0.2–1.0)	0.49 (0.34–0.65)	24.4 (8.8–40)	Crooks & Van Vuren 1995; Kinlaw 1995; Nowak 1999
Long-tailed weasel	0.2 (0.09–0.34)	0.62 (0.04–1.20)	19.4 (0.38–38)	Nowak 1999

<sup>a</sup>Estimates of body size, home range, and population density vary considerably (Nowak 1999). Values are typical averages and ranges (in parentheses). If no average estimate was provided, median values, calculated from the ranges, are presented. Body-mass estimates were taken from Nowak (1999). Where available, home ranges and population densities were taken from studies conducted in California.

<sup>b</sup>Estimates include studies from suburban, urban, rural, and island cat populations.

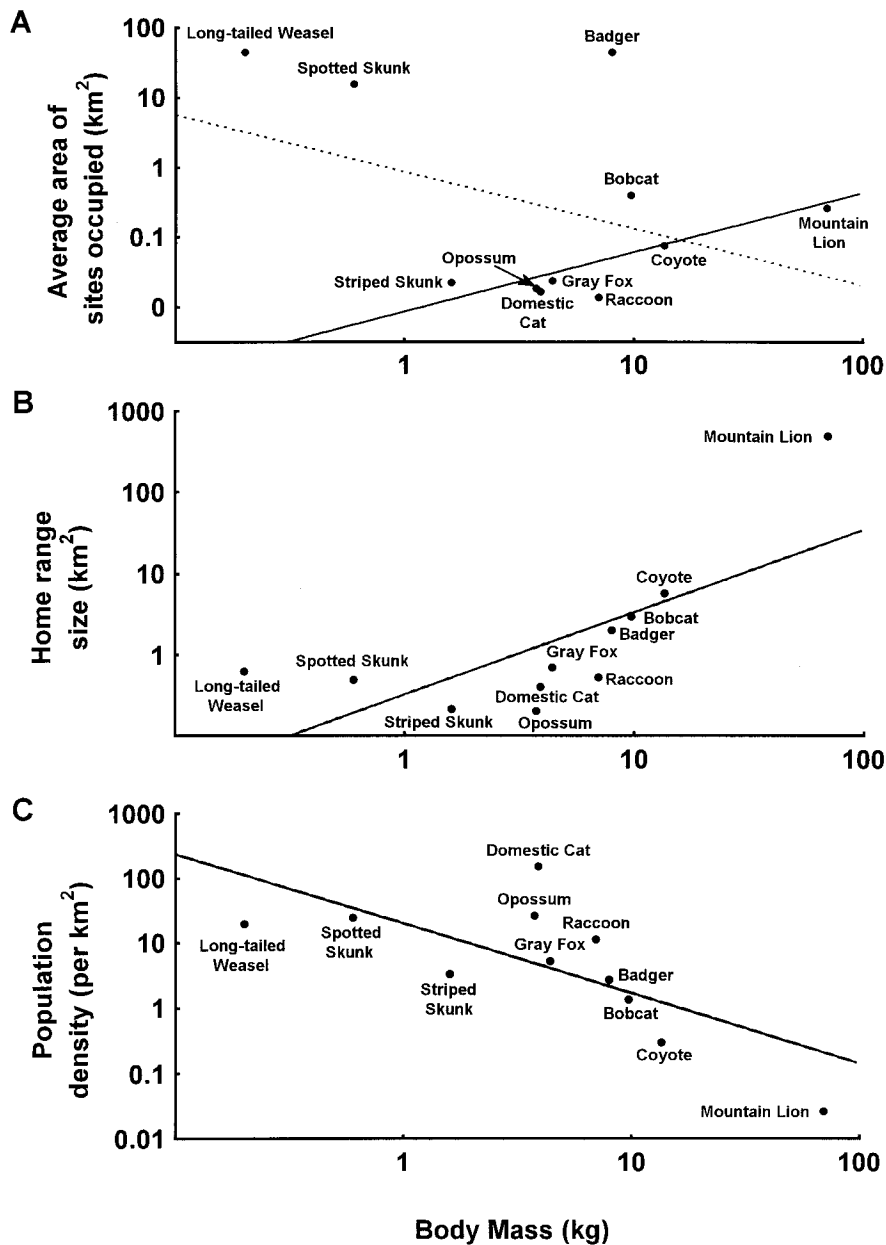


Figure 4. Relationship between log body mass and (a) log average area of sites occupied by mammalian carnivores, weighted by the relative abundance of each species at each site, (b) log home-range size ( $r = 0.720$ ,  $p = 0.012$ ; see Table 4 for values), and (c) log population density ( $r = -0.705$ ,  $p = 0.015$ ; see Table 4 for values). Dotted line in (a) is the least-squares regression fit including all species in the analysis ( $r = -0.392$ ,  $p = 0.233$ ), and the solid line in (a) is the regression excluding spotted skunks, long-tailed weasels, and badgers ( $r = 0.725$ ,  $p = 0.042$ ).

(e.g., garden fruits and vegetables, garbage, direct feeding by humans) associated with residential developments. As a result, the carnivore visitation rate actually increased at sites with more exotic cover and closer to the urban edge, a pattern determined largely by the increased abundance of fragmentation-enhanced mesopredators (gray foxes, opossums, and domestic cats) at edge sites within habitat fragments. Although some carnivores within the habitat fragments seem tolerant of disturbance, these fragments have already lost an entire suite of predator species, including mountain lions, bobcats, spotted skunks, long-tailed weasels, and badgers. Furthermore, the habitat fragments are relatively small (<100 ha), so the most “interior” sites within the fragments are still relatively near (<250 m) urban edges.

Unlike true islands, “edge effects” that emanate from the human-dominated matrix can increase the extinction probability of isolated populations (Murcia 1995; Woodroffe & Ginsberg 1998). Human-tolerant mesopredators in southern California represent such an edge effect. They occur within the developed matrix, and are effective predators on birds, bird nests, and other vertebrates in this system and elsewhere (Crooks & Soulé 1999). Several factors likely account for increased numbers and activity of mesopredators in disturbed landscapes. Residential developments represent suitable habitat for some mesopredator species whose distributions are closely associated with human-dominated landscapes (Donovan et al. 1997). In addition to



habitat suitability, however, dominance interactions between carnivores affect mesopredator populations. When large, dominant predators disappear in fragmented systems, smaller, subordinate predators can subsequently undergo an ecological release, a pattern termed mesopredator release (Soulé et al. 1988; Crooks & Soulé 1999). In the San Diego habitat fragments, Crooks and Soulé (1999) found that lower visitation rates of coyotes in small, isolated remnants resulted in elevated numbers and activity of urban mesopredators, even after statistically controlling for potential confounding variables such as fragment area, age, and isolation. Mesopredator species therefore appear to be ecologically released by fragmentation not only because they can adapt well to urban environments, but also because such sites may provide refugia from dominant predators.

### All Carnivores Are Not Created Equal

Although they are generally considered part of the same ecological guild, I found that carnivores were heterogeneous in their sensitivities to landscape and local fragmentation variables. As predicted, body-size differences partially accounted for this heterogeneity in response. Body mass was positively related to typical home-range sizes (Fig. 4b) and negatively related to typical population densities (Fig. 4c) recorded for these species, patterns consistent with those observed among mammals (Lindstedt et al. 1986). Due to their wide ranges and low densities, larger-bodied carnivores generally required larger areas (Fig. 4a), eventually disappearing in habitat fragments that were not connected by movement corridors. Obvious exceptions to the allometry of body size and fragmentation sensitivity, however, were spotted skunks, long-tailed weasels, and badgers, small- to medium-bodied species that exhibit relatively small home ranges and high population densities but that were detected only in the largest habitat blocks. Unlike the generalist urban mesopredators, these relatively specialized mustelids tend to be primarily carnivorous and somewhat restricted in their habitat preferences (Nowak 1999). Such specializations likely contribute to their patchy distribution in coastal southern California and increase their vulnerability to environmental disturbances. Clearly, in addition to body size, other ecological traits such as diet, resource specialization, social structure, and behavior contribute to species-specific responses to fragmentation effects.

Differential sensitivities to fragmentation can be useful criteria when focal species are chosen for ecological research and conservation planning. Mammalian carnivores can be excellent focal organisms with which to evaluate the degree of functional landscape-level connectivity, because they are area-dependent species that require movement corridors for persistence (Beier 1993;

Noss et al. 1996; Soulé & Terborgh 1999). The choice of appropriate carnivore focal species, however, depends on the scale or intensity of fragmentation in an area and the corresponding responses of carnivore populations to fragmentation effects at that scale. As Figs. 1 and 2 make evident, the scale of landscape-level connectivity in southern California varies widely, ranging from small, isolated urban remnants to large, intact habitat blocks.

At one extreme of the connectivity scale are the highly fragmented landscapes of urban coastal southern California (e.g., patch size  $<1 \text{ km}^2$ ; Fig. 1a). Coyotes and urban mesopredators can be useful focal species with which to understand the effects of fragmentation at this scale. Fragmentation-enhanced predators such as opossums and domestic cats can function as direct, positive indicators of environmental disturbances associated with urban development, edge effects, and the invasion of exotic predators and competitors into natural systems. Coyotes have also persisted in developed areas in southern California. The remarkable behavioral plasticity of coyotes and their ability to succeed in disturbed areas limits their utility as an indicator of connectivity across much of coastal southern California. Nevertheless, coyote occupancy, residency, and relative abundance declined with fragment area and isolation, to the point of local extinctions of coyote populations in the smallest, most isolated urban remnants. Coyotes can therefore serve as useful indicators of functional connectivity in highly fragmented areas, particularly those sites that have already lost more vulnerable predators such as bobcats and mountain lions (Figs. 1 & 2). Furthermore, the ecologically pivotal role of coyotes (Crooks & Soulé 1999) warrants their inclusion in research and conservation plans, particularly in regions with active predator-control programs.

Mountain lions are situated at the opposite end of the connectivity scale (e.g., patch size  $>100 \text{ km}^2$ ; Fig. 1a) and appear extremely sensitive to the loss and fragmentation of habitat. The large body size and solitary behavior of mountain lions translate to large home ranges and low population densities (Table 4). Therefore, many of the isolated habitat remnants in urban southern California are likely too small and too isolated to permanently support any resident lion populations (Figs. 1 & 2) (see also Beier 1993). Consequently, mountain lions or other large, apex predators may not be the most effective indicator species with which to evaluate the degree of functional landscape-level connectivity in moderately to highly fragmented landscapes. The mountain lion's requirement for a large home range and its sensitivity to environmental perturbations, however, can make it a valuable focal species in larger, more intact habitat blocks (Beier 1993).

Finally, bobcats were intermediate in their sensitivity to fragmentation, a degree of sensitivity commensurate to the scale of fragmentation across much of coastal

southern California (e.g.,  $1 \text{ km}^2 < \text{patch size} < 100 \text{ km}^2$ ; Fig. 1a). Bobcats were less sensitive to disturbance than mountain lions, which seldom occurred in fragmented areas, yet were more sensitive than coyotes and mesopredators, which were detected in even small urban habitat fragments. Bobcats are generally solitary and are strictly carnivorous (Nowak 1999), resulting in low densities and in resource specializations that likely increase their probability of local extinction. Landscape connectivity appears to be the key to the persistence of bobcat populations in developing landscapes. They can persist in fragmented habitats, but, as my results suggest, only in those landscapes with adequate movement linkages to larger natural areas. The status of bobcat populations is therefore a valuable indicator of the degree of functional, landscape-level connectivity across much of the fragmented landscapes of coastal southern California. In other systems, the choice of indicator species will require information on the level of fragmentation and connectivity in that region and how species respond to fragmentation effects at that scale.

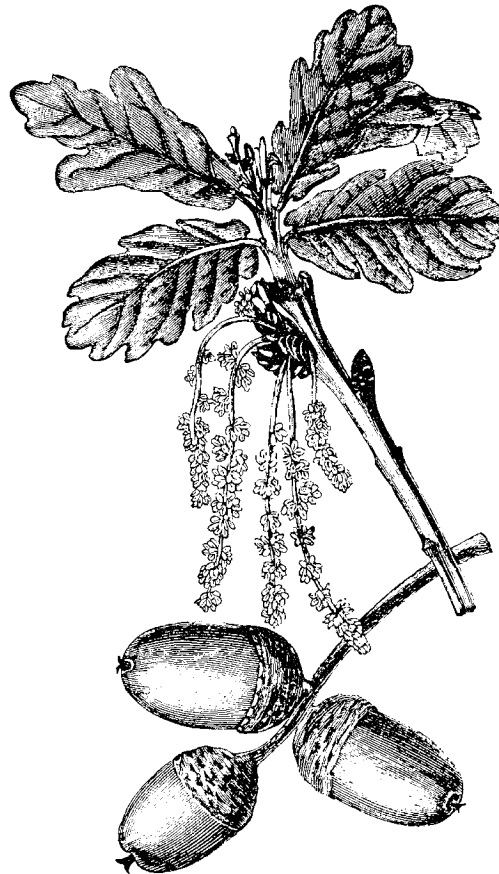
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# Effects of habitat loss and fragmentation on amphibians: A review and prospectus

Samuel A. Cushman\*

USDA Forest Service, Rocky Mountain Research Station, P.O. Box 8089, Missoula, MT 59801, USA

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## ABSTRACT

Habitat loss and fragmentation are among the largest threats to amphibian populations. However, most studies have not provided clear insights into their population-level implications. There is a critical need to investigate the mechanisms that underlie patterns of distribution and abundance. In order to understand the population- and species-level implications of habitat loss and fragmentation, it is necessary to move from site-specific inferences to assessments of how the influences of multiple factors interact across extensive landscapes to influence population size and population connectivity. The goal of this paper is to summarize the state of knowledge, identify information gaps and suggest research approaches to provide reliable knowledge and effective conservation of amphibians in landscapes experiencing habitat loss and fragmentation. Reliable inferences require attention to species-specific ecological characteristics and their interactions with environmental conditions at a range of spatial scales. Habitat connectivity appears to play a key role in regional viability of amphibian populations. In amphibians, population connectivity is predominantly effected through juvenile dispersal. The preponderance of evidence suggests that the short-term impact of habitat loss and fragmentation increases with dispersal ability. However, species with limited dispersal abilities are likely to be equally imperiled by habitat loss and fragmentation over longer time periods. Rigorous understanding of the effects of habitat loss and fragmentation on amphibians will require species-specific, multi-scale, mechanistic investigations, and will benefit from integrating large empirical field studies with molecular genetics and simulation modeling. Molecular genetic methods are particularly suited to quantifying the influences of habitat structure across large spatial extents on gene flow and population connectivity. Conservation strategies would benefit by moving from generalizations to species and process specific recommendations and by moving from site-specific actions to implementing conservation plans at multiple scales across broad landscapes.

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## 1. Introduction

### 1.1. The extinction crisis and amphibians

Earth is facing the largest mass extinction in 65 million years (Lawton and May, 1995; Vitousek et al., 1997; Wilson, 1999;

Myers and Knoll, 2001; Balmford et al., 2003). Current global extinction rates for animals and plants are estimated to be up to 1000 times higher than the background rate in the fossil record (Wilson, 1999; Baillie et al., 2004). Vertebrate animal taxa are disappearing at disproportionately high rates, and amphibians are the group with the highest proportion of

\* Tel.: +1 406 546 6379.

E-mail address: [scushman@fs.fed.us](mailto:scushman@fs.fed.us).

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species threatened with extinction (Stuart et al., 2004; Beebe and Griffiths, 2005). The 2004 IUCN red list of threatened and endangered species identifies one in three of the world's amphibian species as threatened with extinction (Baillie et al., 2004).

### 1.2. Vulnerability of amphibians

The apparent vulnerability of amphibians (Pechmann et al., 1991; Houlahan et al., 2000; Kiesecker et al., 2001; Baillie et al., 2004) may be due to a complex of factors, including: (1) relatively low vagilities, which amplifies the effects of habitat fragmentation (Sinsch, 1990; Gibbs, 1998; deMaynadier and Hunter, 2000; Bowne and Bowers, 2004), (2) high vulnerability to death when moving across roads and through inhospitable terrain, which depresses population growth rates (Fahrig et al., 1995; Carr and Fahrig, 2001; Carr et al., 2002), (3) often narrow habitat tolerances, which exacerbates the effects of habitat loss, degradation, and edge effects (Findlay and Houlahan, 1997; Semlitsch, 2000; Houlahan and Findlay, 2003), and (4) high vulnerability to pathogens, invasive species, climate change, increased ultraviolet-B exposure and environmental pollution (Pounds et al., 1999; Broomhall et al., 2000; Kiesecker et al., 2001; Blaustein et al., 2000; Hecnar, 1995; Bridges and Semlitsch, 2000; Davidson et al., 2001; Stuart et al., 2004).

### 1.3. Importance of habitat loss and fragmentation

Habitat loss and fragmentation contribute directly to most of these threats (Carr and Fahrig, 2001; Bowne and Bowers, 2004; Houlahan and Findlay, 2003). Recent research has provided information on the relationships between certain amphibians and certain attributes of habitat loss and fragmentation, and has clearly implicated the effects of habitat fragmentation on juvenile dispersal as one of the key issues in the conservation of pond breeding amphibians (Sjögren, 1991; Sinsch, 1992; Sjögren-Gulve, 1994; Vos and Chardon, 1998). However, most studies of the influences of habitat loss, fragmentation, or related mortality risks have not provided clear insights into the population-level implications of these impacts (Carr et al., 2002). There is a clear need for studies that focus on the mechanisms that drive patterns of distribution and abundance (Marsh and Trenham, 2001; Bowne and Bowers, 2004).

### 1.4. Moving from sites to landscapes; ponds to populations

In order to understand the population-level implications of habitat loss and fragmentation, it is necessary to move from site-specific inferences to assessments of how multiple factors interact across large spatial extents to influence population size and population connectivity (Ruggiero et al., 1994; McGarigal and Cushman, 2002; Bowne and Bowers, 2004). Non-spatial studies conducted at local scales do not provide a basis for inferences at the landscape or regional level (McGarigal and Cushman, 2002). There is often a gross mismatch between the scale of ecological research and population-level responses (Kareiva and Anderson, 1988; Ruggiero et al., 1994). For example, correlations between organism

abundance and the area of various landcover types within a certain distance of a breeding pond does not provide information necessary to infer how habitat patterns interact with the spatial distribution of breeding ponds to influence distribution and abundance. Landscape-level studies that represent the spatial patterns of the environment in a manner relevant to the organisms of question, and that address species-specific movement and abundance characteristics are essential to extend fine-scale species environment relationships to the population-level (McGarigal and Cushman, 2002).

### 1.5. Purpose and goals

The overall goal of this paper is to summarize the state of knowledge, identify information gaps and suggest approaches to provide reliable knowledge and effective conservation of amphibians in landscapes experiencing habitat loss and fragmentation. The paper is divided into four major components. The first is a review of current knowledge about relationships between habitat loss and fragmentation and pond-breeding amphibian populations at landscape and regional scales. Using this review as context, the second section identifies some important information gaps and research needs. Next, I propose several research approaches that may be effective at filling these information gaps. Then, I suggest several ideas to link research more effectively to conservation, and suggest interim conservation strategies.

## 2. The state of knowledge

### 2.1. Habitat area in uplands

Relatively few landscape-level studies of amphibian density and movement have been conducted (Houlahan et al., 2000; McGarigal and Cushman, 2002). Most existing studies have focused on relationships between forest cover and species occurrence. These have shown positive relationships between amphibian populations and area of forest in the surrounding landscape (Dupuis and Steventon, 1999; Knutson et al., 1999; Guerry and Hunter, 2002; Houlahan et al., 2000; Trenham and Shaffer, 2005), and negative relationships with urban development (Delis et al., 1996) and roads (Fahrig et al., 1995; Carr et al., 2002). Studies of landscape composition effects have found relationships between forest cover and amphibian presence at spatial scales ranging from 100 m to over 3000 m radii (Hecnar and M'Closkey, 1997; Knutson et al., 1999; Lehtinen et al., 1999; Guerry and Hunter, 2002; Houlahan et al., 2000; Trenham and Shaffer, 2005). Several studies also note a general pattern of increased species richness with increasing forest cover (Gibbs, 1998; Kolozsvary and Swihart, 1999; Houlahan et al., 2000).

Despite these generalizations, reliable inferences about habitat area effects require attention to species-specific ecological characteristics and their interactions with environmental conditions at a range of spatial scales. Species-specific characterization of habitat is essential if scientists are to evaluate the effects of habitat loss on populations. For example, the suggestion that forest cover in the landscape benefits amphibians may not apply to species that are fully aquatic or that depend on nonforested upland habitat. Also, some



populations of amphibians have been enhanced by human construction of ponds and wetlands in areas where breeding sites were previously limited, such as arid environments. In addition, the location and slope of critical thresholds in habitat amount are species specific, and related to reproductive potential, dispersal ability, home range size, habitat specificity, and other characteristics (Monkkonen and Reunanen, 1999; Fahrig, 2001). Thus, it is essential to explicitly link the habitat tolerances of a species to the extent and pattern of those habitats in the landscape if one is to produce reliable inferences about relationships between habitat area and species distributions.

## 2.2. Habitat isolation

Several studies have suggested that habitat area is often more important than habitat configuration (Fahrig, 1998, 2003; Cushman and McGarigal, 2004). The evidence for amphibians is equivocal on this question. Guerry and Hunter (2002) found positive associations between nine amphibian species, area of forested habitat and proximity of ponds to forest habitat. Seven of the nine species were associated with forest area. Three of the nine were associated with pond-forest adjacency. This indicates that habitat area and isolation are both important, and that the degree of importance is a species-specific property which likely reflects a combination of life-history and behavioral characteristics.

A growing body of work suggests that roads can have substantial negative effects on amphibian persistence (Vos and Chardon, 1998; Carr and Fahrig, 2001). Habitat fragmentation by roads and other barriers decreases dispersal (Gibbs, 1998; deMaynadier and Hunter, 2000), increases mortality (Fahrig et al., 1995; Carr and Fahrig, 2001) and reduces genetic diversity (Reh and Seitz, 1990). Habitat fragmentation leads to reduced patch size patches, increased patch isolation, and increased risk of demographic, stochastic and genetic events. This increases extinction risk by reducing demographic and genetic input from immigrants and reducing the chance of recolonization after extinction (Lande, 1988; Sjögren-Gulve, 1994).

## 2.3. Connectivity: a key to persistence

A number of researchers have proposed that habitat connectivity is a key to regional viability of amphibian populations (Hecnar and M'Closkey, 1996; Semlitsch et al., 1996; Semlitsch and Bodie, 1998; Skelly et al., 1999; Marsh and Trenham, 2001; Rothermel and Semlitsch, 2002). Amphibians generally have lower rates of movement per generation than invertebrates, mammals or reptiles (Bowne and Bowers, 2004). Low recruitment of dispersing individuals probably plays a major role in decline and extinction of amphibian populations in fragmented landscapes (Sjögren, 1991; Sinsch, 1992; Sjögren-Gulve, 1998; Vos and Chardon, 1998; Bulger et al., 2003). Breeding sites lacking connectivity to suitable terrestrial habitat may be population sinks due to high mortality of juveniles during emigration (Rothermel, 2004). A number of studies have indicated that populations may decline if immigration is prevented (Brown and Kodric-Brown, 1977; Harrison, 1991) and may not be recolonized following a local extinction (Sem-

litsch and Bodie, 1998). Connectivity seems to be of particular importance as even in unfragmented landscapes, amphibian populations experience relatively frequent local extinction and turnover (Edenhamn, 1996; Hecnar and M'Closkey, 1996; Alford and Richards, 1999; Trenham et al., 2003). Thus, dispersal is critical for recolonization of local populations and maintenance of regional populations (Hecnar and M'Closkey, 1996; Semlitsch et al., 1996; Skelly et al., 1999).

## 2.4. Role of juvenile dispersal in population connectivity

In amphibians, population connectivity is predominantly effected through juvenile dispersal (Madison, 1997; Preisser et al., 2001; Guerry and Hunter, 2002; Rothermel, 2004). Many studies have indicated that post-metamorphic dispersal contributes more to regional persistence than does adult dispersal (Sinsch, 1992, 1997; Sinsch and Seidel, 1995). For example, Preisser et al. (2001) found that adults of a variety of amphibian species move up to 125 m from breeding ponds, while juvenile *Ambystoma* sp. salamanders dispersed up to 670 m, and Wood frog (*Rana sylvatica*) over 1000 m. From this they concluded that juvenile dispersal is essential for landscape connectivity for these species. Other studies have reached similar conclusions based on the relatively small movement distances and philopatry of adults and relatively large dispersal distances of juveniles (Breden, 1987; Berven and Grudzien, 1990).

## 2.5. Effects of fragmentation on population connectivity

There are several important implications of habitat fragmentation on species persistence. First, a number of studies have shown that high levels of post-metamorphic survival are often required to maintain local populations. For example, one study found that survival to first reproduction had to exceed 18% in order to maintain local populations of the California tiger salamander (*Ambystoma californiense*) (Trenham et al., 2000). However, as they report survival to maturity of less than 5%, they conclude their study population is a sink that would be doomed to extinction in the absence of substantial immigration. In addition, a population model developed for marbled salamander (*Ambystoma opacum*) suggested that post-metamorphic survival had to exceed 70% to maintain local populations (Taylor and Scott, 1997). Second, a number of studies have shown substantial reductions in dispersal success and juvenile survival in fragmented landscapes. For example, Rothermel (2004) found an average of only 9% of juvenile spotted salamander (*Ambystoma maculatum*) released 50 m from a forest edge survived their initial migration to forest. Habitat loss and fragmentation can substantially reduce the abilities of juvenile amphibians to disperse across landscapes and the resulting reductions in post-metamorphic survival and population connectivity can threaten viability.

Recently, a number of studies have investigated the relationships between landscape structure and amphibian dispersal with experimental methods. Both spotted salamanders and wood frogs avoid crossing fields, pastures, clearcuts, lawns, and roads (Windmiller, 1996; Gibbs, 1998; deMaynadier and Hunter, 1999; Rothermel and Semlitsch, 2002; Regosin et al., 2003; Marsh et al., 2004). Wood frogs have also been

shown to orient toward forest (deMaynadier and Hunter, 1999). Rothermel and Semlitsch (2002) studied the orientation and movement of several amphibian species in open field and forest environments. They found that orientation of spotted salamander and wood frog is biased toward forest. Spotted salamanders moved three times as far into forest as into fields (Rothermel and Semlitsch, 2002). Lower recapture rates in fields reflected high mortality rates due to desiccation and predation. Also, avoidance of open-canopy habitats by juvenile American toads (*Bufo americanus*) indicates that predictions of dispersal behavior based on adult habitat use may be misleading (Rothermel and Semlitsch, 2002). Rothermel (2004) conducted an experimental study of movement of spotted salamanders and American toads in grass fields at distances of 5 or 50 m from a forest edge. Less than 15% of salamanders and toads released 50 m from the forest edge reached forest, suggesting that few juvenile amphibians would be able to migrate greater distances across pastures (Rothermel, 2004). The authors conclude that fields are substantially resistant, and thus forest fragmentation reduces dispersal rates for these species (Rothermel and Semlitsch, 2002; Marsh et al., 2004; Rothermel, 2004).

Recent research has also suggested that the short-term impacts of habitat fragmentation often increase both with population size and dispersal ability, but particularly strongly with increasing dispersal ability (Gibbs, 1998; Newcomb Homan et al., 2004). This pattern is opposite to what many researchers expect on theoretical grounds, namely that species with larger populations and larger dispersal abilities will be less impacted by fragmentation due to their relatively greater abilities to disperse between breeding sites in fragmented landscapes. For example, in a study of five amphibian species across a gradient of habitat loss, Gibbs (1998) found that organisms with low dispersal rates had better persistence in landscapes with low habitat area. This effect has also been seen in comparison of wood frog and spotted salamander habitat occupancy (Newcomb Homan et al., 2004). A possible explanation is that greater dispersal ability results in greater mortality risk in fragmented landscapes. Carr and Fahrig (2001) suggest that highly vagile organisms may be at a disadvantage in landscapes with roads because of increased likelihood of mortality. An example of this may be the response of red-spotted newt (*Notophthalmus viridescens*) in fragmented landscapes (Guerry and Hunter, 2002). Red-spotted newts appear to have high sensitivity to habitat loss and forest fragmentation. In one study, they were the first species to disappear from a fragmented landscape (Gibbs, 1998). The terrestrial stage of red-spotted newts may last seven years (Forrester and Lykens, 1991) in which they may travel long distances from the natal pond (Gill, 1978). Declines in fragmented landscapes are probably often related to elevated losses of juveniles in the terrestrial period (Gibbs, 1998). The preponderance of evidence suggests that the short-term impact of habitat loss and fragmentation increases with dispersal ability. In a fragmented landscape individuals of species with large dispersal abilities will generally encounter roads and other anthropogenic barriers at higher rates than less vagile species. This will tend to increase mortality rates for these species. The combined effects of roads and land-cover may result in high rates of death among dispersing

juveniles, which can imperil local and regional populations by decreasing recruitment (Sinsch, 1992, 1997; Sinsch and Seidel, 1995).

It appears that species with large dispersal abilities and those with relatively small dispersal abilities are both threatened by habitat loss and fragmentation, but in different ways. Those with large dispersal abilities are vulnerable to elevated dispersing mortality, which appears sufficient to lead to local extinctions (Hecnar and M'Closkey, 1996; Semlitsch et al., 1996; Skelly et al., 1999). However, species with limited dispersal abilities are likely to be equally imperiled by habitat loss and fragmentation over longer time periods. Once these local populations are isolated by fragmentation they may be ultimately doomed to extinction. Amphibian populations experience relatively frequent extinction and turnover (Edenhamn, 1996; Hecnar and M'Closkey, 1996; Alford and Richards, 1999; Trenham et al., 2003), thus population connectivity is ultimately important even for populations of species that are not directly impacted by habitat loss or elevated mortality risks in dispersing.

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## 3. Challenges to general knowledge

### 3.1. Lack of species-level information

Despite these generalizations, there are several obstacles that must be overcome before scientists will be able to reliably predict population-level responses of specific species to changes in habitat area or isolation. In most parts of world, there is very limited knowledge of the species–environment relationships of amphibians, their responses to habitat loss and fragmentation and the factors controlling population connectivity (Hazell, 2003). Knowledge is still quite rudimentary about the population-level implications of habitat area, edge, isolation, and road mortality relationships. The precision of knowledge about the habitat relationships, life-history, vagility and behavior of most amphibian species is insufficient. Few studies report population level effects of inter-patch movement and few document movement rates (Bowne and Bowers, 2004). In addition, those studies that do measure movements rarely produce results that can be generally applied, as dispersal data are highly sensitive to sampling scheme and landscape characterization (Carr and Fahrig, 2001). Amphibians exhibit a great range of habitat requirements and dispersal abilities (Stebbins and Cohen, 1995). Little is known about the factors influencing dispersal (Rothermel and Semlitsch, 2002; Rothermel, 2004). Information about the dispersal abilities and relative cost or risk of crossing various landcover types is insufficient for most species to reliably model responses to real landscape mosaics. Additional research is needed to determine appropriate threshold distances and cover-class resistance values for migrating amphibians (Rothermel, 2004). Furthermore, the high variability of population sizes through time confounds efforts to isolate mechanisms through correlative means (Alford and Richards, 1999). The combination of variable population sizes and imprecise knowledge of dispersal parameters and habitat tolerances presents a daunting challenge for researchers attempting to infer population-level impacts of habitat loss and fragmentation on amphibians.

Another obstacle to population-level predictions is that few landscape level studies of habitat fragmentation effects have been conducted. [McGarigal and Cushman \(2002\)](#) reviewed 134 papers on habitat fragmentation published between 1995 and 2000. They identified a paucity of experimental studies at the landscape-level. Most studies were patch-based, and poorly replicated or unreplicated, which greatly limits the inferences that can be reliably drawn. Importantly, they identified amphibians and reptiles as the animal taxa most poorly studied, accounting for only 4% of papers on the effects of habitat fragmentation.

## 4. Research needs

### 4.1. Importance of species-specific, multi-scale, mechanistic investigations

Survival of amphibian populations in fragmented landscapes depends on the interaction between the pattern of roads, landcover types, the distribution of breeding ponds, the population sizes in those ponds and the dispersal characteristics of the species ([Fahrig, 1998](#); [Carr and Fahrig, 2001](#)). For example, [Porej et al. \(2004\)](#) emphasize the importance of considering scaling differences among species and the structure of the landscape mosaic when investigating thresholds and minimum patch sizes. Furthermore [Marsh and Trenham \(2001\)](#) suggest that pond isolation is often better explained by details of the structure of terrestrial habitats than the distribution of breeding habitats in that landscape, and urge researchers to focus on mechanisms underlying patterns of dispersal and abundance. [Petranka et al. \(2004\)](#) found that there is often a lack of demographic independence within clusters of local breeding ponds, and that the degree of spatial synchrony in local populations varied between species and in response to localized disturbances. Predicting such effects would require information about species specific responses to disturbance, population sizes, movement rates and abilities. Both [Monkkoenen and Reunanen \(1999\)](#) and [Fahrig \(2001\)](#) predicted that the location and slope of critical thresholds in habitat amount should be species-specific, and based on a variety of traits including reproductive potential, emigration success, home range size, habitat specificity, dispersal ability and other behaviors.

Each species experiences and responds to ecological conditions in its environment uniquely. Thus, reliable understanding of interactions between species and their environments requires careful attention to both scale and the characterization of the environment. First, species-environment relationships may differ greatly among species across scales ([Cushman and McGarigal, 2004](#)). The environmental patterns that are important at one scale for a species may not be those that influence it at coarser or finer scales ([Grand and Cushman, 2003](#)). Thus, researchers must adopt multi-scale approaches that allow for assessment of the interaction of environmental patterns across scales ([Wiens, 1989](#); [Cushman and McGarigal, 2003](#)). Second, the environment is experienced differently among species. Thus, researchers should select and characterize the environmental attributes on a species-specific basis. For amphibians, this often means assessing interrelationships between multiple environmental

attributes, across a range of scales, for entire landscapes containing dozens or hundreds of local breeding populations. Only by analyzing species-relevant habitat patterns at scales relevant to the populations of those species will it be possible to obtain reliable inferences about the impacts of habitat loss and fragmentation on amphibian populations ([McGarigal and Cushman, 2002](#)).

## 5. Research approaches

### 5.1. Empirical approaches

There are at least four major ways that one could empirically test relationships between the presence or movement of a particular species and environmental structure at the landscape-level. First, one could conduct large-scale, correlative studies of distribution in relation to habitat composition and configuration at a range of scales ([Hecnar and M'Closkey, 1996](#); [Knutson et al., 1999](#); [Kolozsvary and Swihart, 1999](#); [Vallan, 2000](#); [Guerry and Hunter, 2002](#); [Weyrauch and Grubb, 2004](#)). Such studies, if replicated sufficiently at the landscape level, can provide reliable information about relationships between landscape structure and the distribution of specific amphibians. The major challenges to such studies are obtaining sufficient replication at the landscape-level to achieve reasonable statistical power, sampling sufficiently large landscapes to allow adequate consideration of environmental patterns at a range of spatial scales, and representing environmental conditions and landscape structures in manners that are relevant to each species in question ([McGarigal and Cushman, 2002](#)). These types of studies are also limited in inference because they do not directly measure biological responses such as mortality, movement and productivity. Presence does not always equate to quality. Patterns of distribution do not necessarily reflect patterns of fitness with respect to environmental gradients and landscape patterns.

Two alternative approaches are mark-recapture and telemetry studies ([deMaynadier and Hunter, 1999](#); [Rothermel and Semlitsch, 2002](#); [Rothermel, 2004](#)). By quantifying movement rates, distances and routes of dispersing juveniles through complex environments researchers can describe species-specific responses to environmental conditions. Importantly, these methods are well suited for incorporation in manipulative field experiments in which the area and configuration of habitat are controlled to isolate the effects of habitat loss and fragmentation on organism movement and survival rates. These kinds of studies provide the most reliable inferences about relationships between survival rates, movement and ecological conditions ([McGarigal and Cushman, 2002](#)). The challenge in these studies is one of cost and sample sizes. Large-scale manipulative field experiments and mark-recapture metapopulation studies are exceptionally expensive to implement, take a number of years to produce reliable results, and generally do not provide large landscape-level sample sizes due to financial and logistical constraints. Likewise, telemetry studies are often limited by spatial scope, sample size and pseudoreplication ([Litvaitis et al., 1994](#)).

A fourth alternative involves using molecular genetic methods to empirically derive rates of gene flow among ponds and effective population sizes ([Schwartz et al., 1998](#);

Manel et al., 2003; Curtis and Taylor, 2004; Funk et al., 2005). Molecular genetic methods offer a particularly attractive approach to quantifying gene flow across heterogeneous landscapes, as the logistical and financial costs of extensive mark-recapture study grids are obviated. The genetic characteristics of subpopulations at each sampled pond can provide both information on its effective population size and the degree to which it differs genetically from other ponds. Such methods allow one to quantify rates of gene flow between ponds, assuming time lags between landscape change and genetic response have been accounted for. This in turn allows researchers to test specific hypotheses about the role of specific landscape features and environmental conditions in affecting population connectivity (Manel et al., 2003).

## 5.2. Simulation models

Simulation models offer a flexible way to investigate the behavior of idealized ecological processes in idealized landscapes. It is important to understand that this idealization in simulation modeling is both a limitation and an asset. It is a limitation in that a simulation is never equivalent to the phenomena being simulated. Decisions are made on which processes to include, at which scales, their relative weights, the functional structure of each and how they interact. Similarly, decisions are made on how to represent the structure and composition of landscapes and how to represent the behavior and ecology of organisms. These decisions fundamentally determine the results, and error in them results inevitably in error in the predictions.

However, the fact that such decisions determine results can also be an advantage. By varying functional parameters, environmental characterization, and organism attributes, scientists can investigate hypotheses about the relative influence of different factors, their interactions, and ranges of organism characteristics, such as gradients of population size or dispersal ability. This provides a means for thorough evaluation of complexes of factors that would be impossible to investigate directly in the field.

## 5.3. Integrating simulation models and empirical field studies

Simulation results are not compelling unless verified by empirical data. Reliable model predictions depend on accurate algorithmic implementation of the process–pattern relationships that dominate the behavior of the phenomena being simulated. Models require extensive empirical understandings for their formulation, and require extensive empirical data for their verification. It can be said that models without data are not compelling, and data without models are not informative.

A powerful research paradigm is based on confronting models with rigorous empirical data to test the applicability and generality of relationships, and account for the influences of spatial patterns, temporal fluctuations and time lags (Kareiva and Anderson, 1988). It is an iterative process, with models proposing relationships, data refuting or supporting models, models being refined as a result and producing new predictions to be empirically tested. Field studies should be

designed specifically to provide information needed to parameterize and test simulation models. In this effort, manipulative experiments may provide the best information, given their ability to isolate particular factors. However, the most promising area for integrating models with field data is in the area of landscape genetics (Manel et al., 2003). Simulation models can produce explicit predictions of the level of connectivity among populations across landscapes. Molecular genetics can quantify actual rates and patterns of gene flow. The intersection of these two provides a means to optimize the fit of simulation models to actual patterns of gene flow in complex landscapes. This optimization of the fit of spatial models to patterns of gene flow in real populations provides an unprecedented means to explore and understand the interactions between environmental patterns across a range of spatial scales and the connectivity of populations, which is among the most important questions in conservation biology.

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## 6. Conservation strategies

### 6.1. From general to specific

A number of researchers have proposed generalized conclusions and conservation recommendations based on the observation that forest habitat area, habitat connectivity and road density are related to population persistence and population connectivity. These generalizations include that the effects of adjacent land use on amphibians can extend over large distances (Houlahan and Findlay, 2003), and that the proximity and area of upland/breeding habitat play a key role in determining occupancy (Laan and Verboom, 1990; Pope et al., 2000). It is clearly important to account for impact of uplands surrounding wetlands (Dodd and Cade, 1998; Semlitsch, 1998) as amphibian conservation often requires maintaining relatively large forest areas and relatively low road densities in the regional landscape (Houlahan et al., 2000). However, it is not clear how to translate these general understandings to specific management recommendations for individual species in any given landscape. There are large differences among amphibian species in terms of their habitat requirements and sensitivity to landscape change. Effective conservation requires specific predictions that can be applied to unique situations to produce conservation recommendations tailored to the system, species and situation.

### 6.2. Core area conservation

Several researchers have proposed conservation strategies based on protecting core areas based on limited adult migration and adult philopatry. For example, Bulger et al. (2003) suggested that specific protections for migrating California red-legged frogs (*Rana aurora draytoni*) were usually unwarranted and that protecting breeding sites is critical. Other researchers propose core zone widths based on adult migrations. For example, Semlitsch (1998) and Semlitsch and Bodie (2003) suggest core zones up to 218 meters for pond breeding amphibians and up to 290 meters for amphibians in general. Other researchers stress the importance of forest in core zones for persistence of spotted salamander, marbled



salamander, Jefferson's salamander (*Ambystoma jeffersonianum*), and wood frog, based on the fact that they are unlikely to persist and travel long distances in non-forest habitat (Whitford and Vinegar, 1966; Thompson et al., 1980; Douglas and Monroe, 1981; Kleeberger and Werner, 1983; deMaynadier and Hunter, 1998; Rothermel and Semlitsch, 2002). While these core zones have been advocated by some as a guide for setting biologically meaningful buffers for wetlands and riparian zones (Semlitsch and Bodie, 2003), they are insufficient as a basis for a conservation strategy for pond breeding amphibians. Any effective conservation strategy must consider more than critical core habitat for adults (Porej et al., 2004). Juvenile dispersal and habitat connectivity are at least as important (Carr and Fahrig, 2001).

### 6.3. Landscape-level, population-based conservation strategies

Just as it is necessary to move from site-specific to landscape-level analyses to understand the ecological relationships between amphibian populations and their environments, it is also necessary to base conservation planning on landscape-level and population-based approaches. Non-spatial conservation plans implemented at specific sites are unlikely to provide adequate conservation of populations that depend on dispersal across complex landscapes for persistence. Just as there is often a gross mismatch between the scale of ecological research and population-level responses, there is usually the same mismatch between the scale of conservation planning and the scale of population responses.

Effective conservation planning will require vast improvements in our understanding of the factors that influence vital rates, mortality and dispersal in complex landscapes. Given the urgency of the crisis facing amphibian populations (Baillie et al., 2004), it is imperative that conservation planners make the most effective use of the information currently available. This will entail extending information from empirical research on the relationships between population size, reproduction, dispersal, mortality and habitat factors across a range of scales to spatially explicit conservation proposals. These extensions can be made in a variety of ways, including through landscape genetic analysis and spatially explicit simulation models.

## 7. Summary

- Habitat loss and fragmentation are among the largest threats to amphibian populations.
- The extent, pattern and quality of terrestrial habitat in landscape mosaics are as important for many species as the quality of breeding sites.
- Many species of amphibians appear vulnerable to both the loss and fragmentation of nonbreeding upland habitat.
- Population connectivity appears to be a key to regional viability, and is primarily effected through juvenile dispersal.
- In fragmented landscapes, dispersal survival is often lower than required for population viability.
- The preponderance of evidence suggests that the short term impacts of habitat loss and fragmentation increase with dispersal ability.
- Species with limited dispersal abilities are equally imperiled by habitat loss and fragmentation over longer time periods.
- Combining molecular genetics and spatial modeling of organism movement provides a means to improve understanding of how habitat amounts and configurations influence dispersal, survival and population dynamics.
- Effective conservation of amphibian populations is limited by the lack of species-specific ecological knowledge, and lack of landscape-level studies of the effects of habitat loss and fragmentation on movement, survival rates, and population dynamics.
- Conservation strategies could benefit from taking multi-scale, landscape-level approaches that integrate knowledge of species biology with broad-scale evaluations of the area and accessibility of both breeding and nonbreeding habitat.

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# Biological corridors and connectivity

Samuel A. Cushman<sup>1</sup>, Brad McRae<sup>2</sup>, Frank Adriaensen<sup>3</sup>,  
Paul Beier<sup>4</sup>, Mark Shirley<sup>5</sup> and Kathy Zeller<sup>6</sup>

<sup>1</sup>USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ, USA

<sup>2</sup>The Nature Conservancy, North America Region 1917, Seattle, USA

<sup>3</sup>Department of Biology, University of Antwerp,  
Antwerp, Belgium

<sup>4</sup>School of Forestry, Northern Arizona University, Flagstaff, AZ, USA

<sup>5</sup>School of Biology, Newcastle University, Newcastle upon Tyne, UK

<sup>6</sup>Panthera, 8 West 40th Street, 18th Floor, NY, USA

*hring utan ymbbearh, þæt heo þone fyrdhom ðurhfon ne mihte, locene leoðosyrcaŋ laþan fingrum.*

*On his shoulder lay braided breast-mail, barring death, withstanding entrance of edge or blade.*

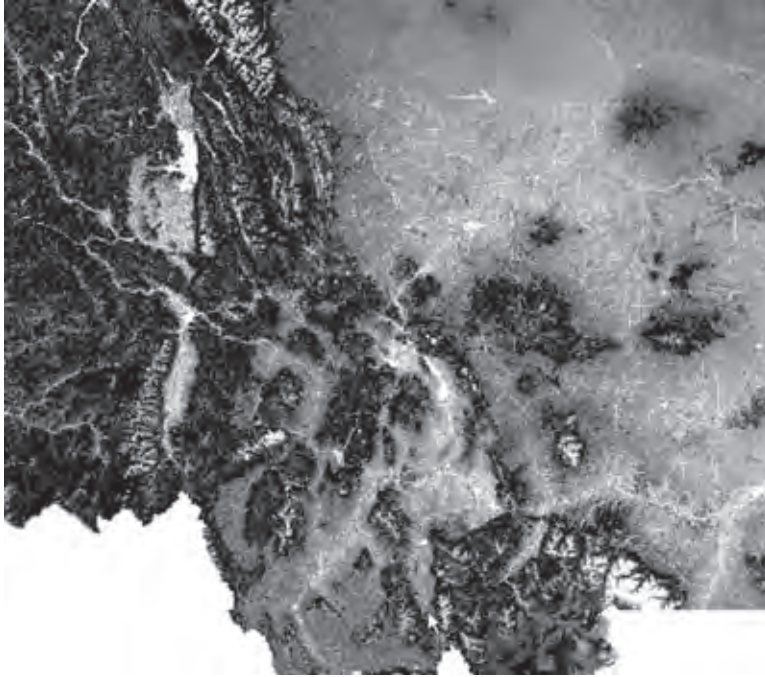
**Beowulf (Old English epic poem, c. 10th Century)**

## Introduction

The ability of individual animals to move across complex landscapes is critical for maintaining regional populations in the short term (Fahrig 2003; Cushman 2006), and for species to shift their geographic range in response to climate change (Heller & Zavaleta 2009). As organisms move through spatially complex landscapes, they respond to multiple biotic and abiotic factors to maximize access to resources and mates while minimizing fitness costs such as mortality risks. Habitat fragmentation decreases dispersal

success (Gibbs 1998), increases mortality (Fahrig et al. 1995) and reduces genetic diversity (Reh & Seitz 1990; Wilson & Provan 2003). Local populations may decline if immigration is prevented (Brown & Kodric-Brown 1977; Harrison 1991) and may prevent recolonization following local extinction (Semlitsch & Bodie 1998).

The goal of this chapter is to describe the state of the art in quantitative corridor and connectivity modelling. We will review several critical issues in modelling, and provide expert guidance and examples to help practitioners implement effective programmes to preserve, enhance or create connectivity among wildlife populations. We first



**Figure 21.1** Example landscape resistance map for American black bear in an area of the US northern Rocky Mountains encompassing Montana and northern Idaho. Dark areas are low resistance for movement, while light areas are high resistance for movement. The resistance map was developed by Cushman et al. (2006) and validated with independent data by Cushman & Lewis (2010) and in multiple independent study areas by Short Bull et al. (2011).

review the fundamental task of estimating landscape resistance, comparing expert opinion and empirical methods. Next, we describe current methods of predicting connectivity from resistance surfaces. Then we discuss how to develop linkage designs that can maintain connectivity for multiple species, and under changing climate. We conclude with discussion of how effectively to validate connectivity model predictions.

### **Estimating landscape resistance**

Most current methods of predicting population connectivity and mapping areas significant in facilitating animal movements begin with landscape resistance maps (Figure 21.1). Landscape resistance maps depict the cost of movement through any location in the landscape (pixel cell in a raster map) as a function of

landscape features of that cell (e.g. high resistance might be assigned to a road or a body of water). In its most basic sense, landscape resistance reflects the local movement cost incurred by an animal. More formally, the resistance reflects the step-wise cost of moving through each cell for least-cost analyses (Singleton et al. 2002) or the relative probability of moving into the cell for circuit theory-based analyses (McRae et al. 2008).

### **Expert versus empirical estimation**

Most published studies using landscape resistance maps have estimated resistance of landscape features to movement based on expert opinion alone (e.g. Compton et al. 2007). However, non-human species perceive landscapes in ways that may not correspond to human assumptions concerning connectivity and habitat quality (With et al. 1997). Using



unvalidated expert opinion to develop resistance maps has been a major weakness of most past landscape resistance modelling efforts (Seoane et al. 2005).

## **Methods for empirically estimating resistance**

### ***Habitat quality as surrogate for landscape resistance***

Habitat quality can be predicted based on patterns of occupancy in relation to ecological conditions, such as through resource selection functions (e.g. Guerry & Hunter 2002; Weyrauch & Grubb 2004). The simplest way to estimate relationships empirically between population connectivity and environmental conditions is to assume that habitat quality directly equates to population connectivity. Predictions of habitat quality based on patterns of occurrence studies are limited because they do not directly measure biological responses such as mortality, movement and productivity (Cushman 2006). Patterns of species occurrence do not necessarily reflect patterns of fitness with respect to environmental gradients and landscape patterns (Van Horne 1983). More importantly, in the context of connectivity modelling, suitability for occupancy and suitability for dispersal may not be driven by the same factors at the same scales (e.g. Shirk et al. 2010; Wasserman et al. 2010). Habitat selection reflects the behaviour of individual organisms to maximize fitness within home ranges, while population connectivity is driven by dispersal, migration and mating events. These are functionally and biologically different processes. Few studies have formally evaluated the performance of habitat suitability models as surrogates for landscape resistance, but those that have generally have found them to perform poorly (e.g. Shirk et al. 2010; Wasserman et al. 2010). This highlights the importance of not assuming that habitat relationships optimally reflect the landscape features governing population connectivity.

### ***Mark-recapture and experimental movement studies***

By quantifying movement rates, distances travelled and routes of animals through complex environments, researchers can quantitatively describe species-specific responses to environmental conditions and landscape structure. For example, a study by Gamble et al. (2007) quantified dispersal in relation to topography and vegetation for several pond-breeding amphibians, demonstrating the value of mark-recapture approaches to evaluating population connectivity. In addition, these methods are well suited for incorporation in manipulative field experiments in which the area and configuration of habitat are controlled to isolate the effects of habitat loss and fragmentation on organism movement and survival rates. For example, Haddad & Baum (1999) used a large-scale experiment to find that three habitat-restricted butterfly species reached higher densities in patches connected by corridors than in similar, isolated patches.

These kinds of studies provide the most reliable inferences about relationships between survival rates, movement and ecological conditions (McGarigal & Cushman 2002). Unfortunately, large-scale manipulative field experiments and mark-recapture meta-population studies are expensive, take several years, and generally suffer from small sample sizes. Another potential limitation is that these studies focus on short-term, fine-scale movement path selection of individual animals, which may not scale up to population-level effects on migration and gene flow.

### ***Telemetry***

Advances in wildlife telemetry technology have enabled collection of very accurate and frequent location data for individual animals. Landscape resistance modelling based on telemetry is a powerful technique to address the factors that affect organism movement directly on scales of space and time greater than are possible with mark-recapture and experimental movement studies (e.g. Osborn & Parker 2003; Cushman et al. 2005,

2010a). GPS telemetry data enable direct assessment of the influences of landscape features on movement path selection. For example, Cushman et al. (2010a) modelled the influence of landscape features on elephant movement path selection using telemetry data, showing that elephants (*Loxodonta africana*) select movement paths near water, avoid human settlements and do not cross wildlife cordon fences. Similarly, Cushman & Lewis (2010) used satellite telemetry data to show that American black bears (*Ursus americanus*) choose movement paths that avoid roads and human residences and concentrate activity in forested areas at middle elevations. Directly associating movement paths with landscape features enables the development of species-specific landscape resistance models that are more reliable than those produced by expert opinion.

### ***Landscape genetics***

Gene flow among populations is necessary to support the long-term viability of populations, as it maintains local genetic variation and spreads potentially advantageous genes. Thus it is important to infer the functional connectivity among populations and across landscapes (van Dyck & Bagnette 2005). The ultimate validation of any method of estimating functional connectivity lies in how well it explains gene flow (Cushman et al. 2006; Shirk et al. 2010; Wasserman et al. 2010; Short Bull et al. 2011). Genetic methods can directly measure dispersal and immigration (Waples 1998; Landguth et al. 2010). Logistical and financial costs associated with tracking individual animals are obviated and because genetic data integrate time and space, slow rates of dispersal through complex landscapes are measurable. Landscape genetic analyses enable direct association of movement cost across resistance surfaces with genetic differentiation, which enables empirical derivation and validation of connectivity maps. For example, Wasserman et al. (2010) used non-invasive monitoring to collect genetic data from several hundred individual American marten (*Martes americana*) across a 4000 square kilometer study area, and were able to use multivariate

landscape genetic modelling to identify the landscape features that affect gene flow.

### **Combining multiple methods to produce robust estimates of resistance**

Every method of estimation has its own limitations, so it is valuable to use multiple methods and independent data sets to estimate resistance. The strongest inferences are derived from multiple analyses of different kinds of data that produce a consistent result (Cushman & Lewis 2010). For example, landscape genetics and GPS telemetry are two complementary analyses that can be combined to produce robust estimates of landscape resistance. Using movement data to predict landscape resistance, and comparing that to landscape resistance predicted from landscape genetic analyses of the same species in the same study area, is a useful way to verify the robustness of landscape connectivity hypotheses (e.g. Cushman & Lewis 2010). In addition, such analyses would illuminate the multi-scale drivers of population connectivity, since mating and dispersal movement behaviours are the mechanisms through which gene flow operates in animal populations. At the present time, only a few research programmes have estimated resistance from a combination of approaches (Coulon et al. 2008; Cushman & Lewis 2010; Shanahan et al. 2011; see Box 21.1).

### **From landscape resistance to population connectivity**

While resistance is point specific, connectivity is route specific (Cushman et al. 2008). Therefore, while resistance models can provide the foundation for applied analyses of population connectivity, they do not, in themselves, provide sufficient information to evaluate the existence, strength and location of barriers and movement corridors. Connectivity must be evaluated with respect to the paths, costs and success of moving across a landscape. The resistance model is the

**Box 21.1** Combining landscape genetics and telemetry to estimate landscape resistance for American black bear

Cushman et al. (2006) used causal modelling with landscape genetics data to evaluate support for 110 alternative hypotheses describing the effects of landscape variables on population connectivity in an American black bear (*Ursus americanus*) population in northern Idaho, USA. Their analysis rejected hypotheses of isolation by distance and isolation by a geographical barrier, and affirmed a landscape resistance model which predicts that rates of gene flow are related to elevation, forest cover, roads and human development. Cushman & Lewis (2010) used conditional logistic regression to predict landscape resistance based on black bear GPS telemetry data in the same landscape. They used a path-level spatial randomization method to assess the effects of multiple landscape features on movement path selection (e.g. Cushman et al 2010a). The path-level randomization approach provides a robust means to compare the landscape features an animal encounters in its actual path with those that would be encountered in a large sample of available paths of identical length and topology. They found that consistent landscape factors influence genetic differentiation and movement path selection, with strong similarities between the predicted landscape resistance surfaces. Genetic differentiation among individual American black bears is driven by spring movement (mating and dispersal) in relation to residential development, roads, elevation and forest cover. The real value of this study is that it used two independent data sets and different kinds of analyses to validate the results, and it quantified the scale and strength of bear behavioural response to several landscape features. For example, it showed that gene flow is maximum at middle elevations due to impassable snow pack at high elevations in the dispersal season, and concentrated human populations in low-elevation valleys, and that bears strongly avoid roads and human resistances (e.g. near-total avoidance within a 200m radius buffer around human structures).

foundation for these analyses, but it is explicit consideration of movement paths across the resistance surface that provides the key information for conservation and management.

### Identifying corridors using least-cost modelling

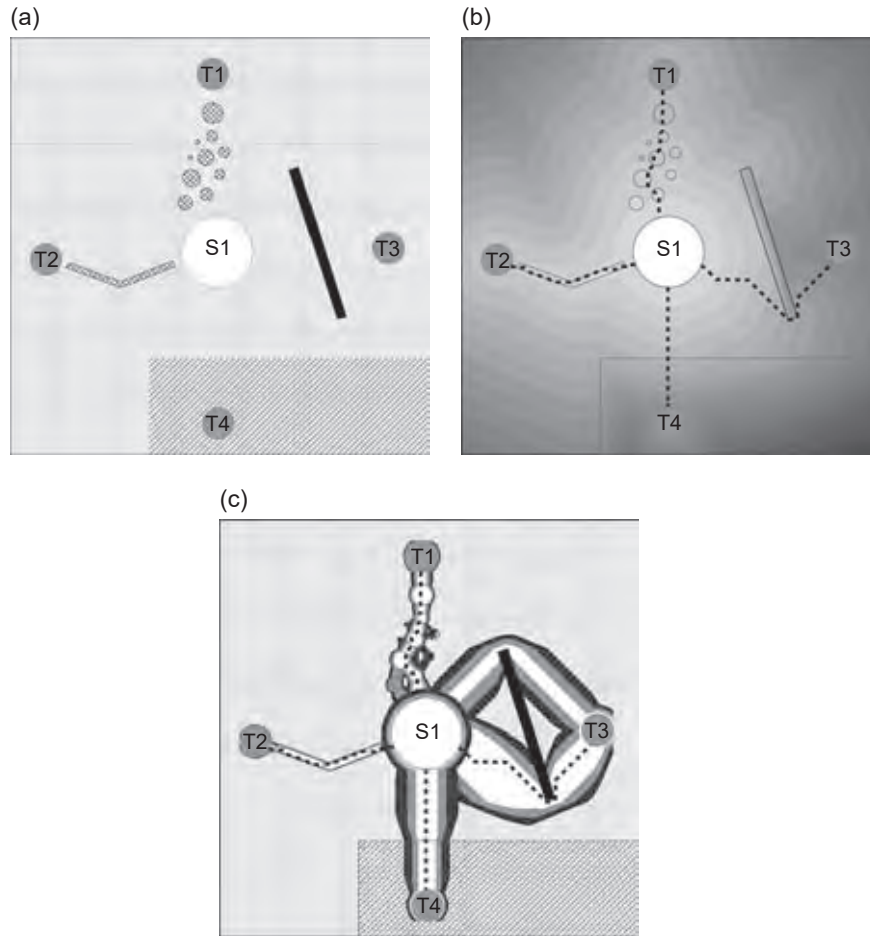
In recent years least-cost (LC) modelling (part of graph theory, see below) has become the dominant modelling tool to evaluate functional landscape connectivity, especially in applied studies. This is mainly because:

- it produces an unambiguous corridor or path as an output, whereas most other approaches do not
- it is available in most commercial GIS packages as well as open source software
- LC models generate visually attractive and easy to communicate representations of connectivity (maps) and quantitative metrics of effective distance (cost values) in the same units (meters) as Euclidean distance (Adriaensen et al. 2003; Fagan & Calabrese 2006).

These attributes make LC modelling very well suited for quantitative landscape analyses and for evaluating effects of future scenarios on connectivity.

In LC models the only inputs are the map of sources and targets and the map of resistance values (R; Figure 21.2a). The cost layer is the first and central level of output of a LC analysis (see Figure 21.2a), and provides the functional cost distance values from the designated source to all locations in the geographical extent of the analysis. The least-cost path (Figure 21.2b) is the series of cells in the landscape which results in the minimum cumulative cost value (LC path value) to move from a source cell/cells to the target cell/cells under investigation. The LC path indicates the location of the cheapest route, but gives no information on how cost values are distributed over the landscape. For example, it does not indicate other zones in the landscape resulting in comparable costs (Figure 21.2c) or how wide the LC path zone is (Adriaensen et al. 2003; Pinto & Keitt 2009).

There are several methods available to produce biologically informative measures of landscape connectivity from such cost surfaces. One of these is the combination of several cost



**Figure 21.2** Input (a) to output (b-c) in LC modelling using a simple virtual landscape to show the basics of this modelling approach. (a) Landcover map showing a hypothetical landscape (source area S1: forest; target areas T1–4: woodlots; grassland (dotted); intensive cropland (hatched); hedgerow and bushes (cross-hatched); open water (solid black). (b) Cost layer from source area S1 and LC path to 4 target areas (dashed lines). (c) Corridor map showing 1–10% corridor buffers derived from bidirectional cost layers from source area S1. Result of 4 corridor analyses superimposed (targets=T1–4): white, increase in minimum cumulative cost less than 1% of LCP; light grey 1–5%; dark grey 5–10%.

layers into one ‘corridor’ layer (other names: bidirectional cost layer, conditional minimum transit cost [CMTC, Pinto & Keitt 2009]; see Figure 21.2c), in which the value of each cell is the overall cost to reach the target cell T from source cell S, but with the constraint to go through the cell under investigation. The LC path is a special case of this (with all cells having a value equal to the LC path value and thus the minimum present in the corridor layer). The LC path will always be the path of minimal

corridor values but elsewhere in the landscape, there could be other zones with nearly equal cost values (see Figure 21.2c). Corridor maps give a more realistic view of the functionally cheapest routes in the landscape from the designated source to the destination (Adriaenssen et al. 2003) (Box 21.2). For example, the width of corridors can be determined by taking percent slices of the landscape representing the lowest cumulative resistance (e.g. Singleton et al. 2002; Spencer et al. 2010) or by limiting



**Box 21.2** Landscape connectivity in the Taita Hills

The Restoration and Increase of Connectivity among Fragmented Forest Patches in the Taita Hills, South-east Kenya project (CEPF project 1095347968; Adriaensen et al. 2007) included a detailed analysis of functional landscape connectivity in the area. In this project, evidence of the distribution and population status of bird species in the remaining small cloud forest patches on the hill tops (black patches) was successfully combined with output of LC models to support and prioritize habitat restoration actions in plantations with exotic trees (white patches). Forest restoration is now being implemented in a set of five pilot projects.

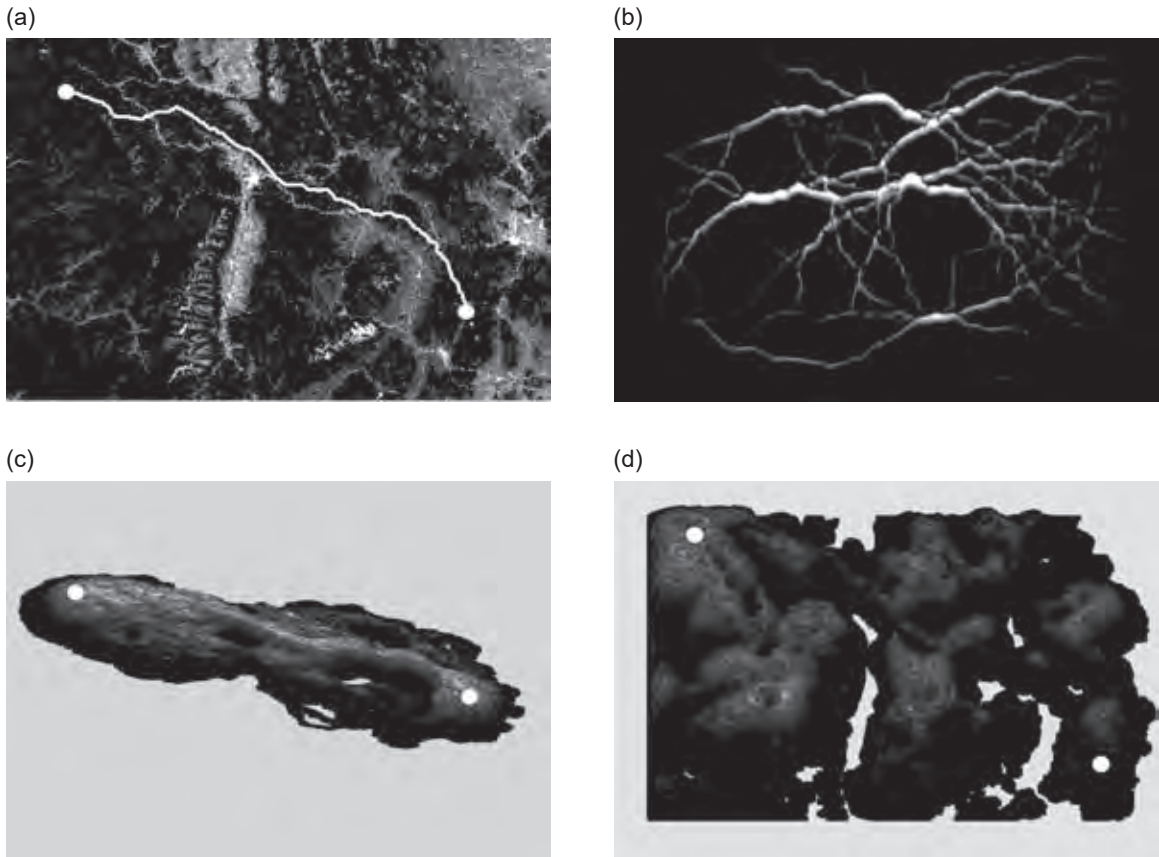
Least-cost models were used to model the location of exotic tree plantations in relation to modelled connectivity corridors for forest interior birds (dark grey zones), in order to evaluate their potential roles as stepping stones to promote recolonization after rehabilitation of the plantations. In the map shown, corridors between all pairs of remaining forest plots were superimposed (resistance set R1S5 for eco-type 'sensitive interior forest bird', including the critically endangered Taita thrush *Turdus helleri*).



corridors to a maximum cost-weighted cut-off distance above that of the LC path (WHCWG 2010). Regional connectivity assessments can require mapping corridors between hundreds

to thousands of core area pairs (e.g. Spencer et al. 2010; WHCWG 2010). The development of GIS tools to automate corridor mapping, including decisions of which pairs





**Figure 21.3** Comparison of four connectivity modelling methods applied to a single study area and resistance map. The study area is northern Idaho, USA. The resistance map is shown in panel (a) as a colour scale from blue (low resistance) to red (high resistance), and reflects landscape resistance to black bear gene flow (Cushman et al. 2006). Panel (a) shows a single least-cost path (white line) between two point locations (white dots). Panel (b) shows a factorial least-cost path analysis between several hundred source points. Panel (c) shows the least-cost corridor between the same two source points as in (a). Panel (d) shows the cumulative resistant kernel model of synoptic landscape connectivity.

of core areas to connect (e.g. McRae & Kavanagh 2011), makes this easy.

### Factorial least-cost paths

One limitation of traditional LC path and LC corridor analyses is that they are limited to prediction of connectivity between single sources and single destinations (Figure 21.3a). While this may be ideal in the case where one is interested in the lowest cost routes between

two focal conservation areas, there are many situations where a more synoptic analysis of connectivity is valuable. For example, it may be that there is a need to calculate corridor connectivity between thousands of sources and a single destination (e.g. Cushman et al. 2010a) or between hundreds of sources and hundreds of destinations distributed across a complex landscape (e.g. Cushman et al. 2008, Cushman et al. 2011; Figure 21.3b). For example, Cushman et al. (2008) used factorial least cost path analysis to predict the most important movement

routes for bears between Yellowstone National Park and the Canadian border in the United States Northern Rocky Mountains, showing that there are few major connections and locating several dozen potential barriers. This, in turn, focuses attention on where restoration and mitigation efforts would be most effective. A factorial implementation of least cost paths (e.g. UNICOR; Landguth et al. 2011) permits integration of a vast number of least cost paths to show synoptic connectivity across large and complex landscapes (Figure 21.3b). For example (Cushman et al. 2011) mapped regional corridor networks for several species of conservation concern across a vast area of the United States great plains using UNICOR (Landguth et al. 2011). The analysis identified which species have the most fragmented populations and mapped the most important corridor linkages among population core areas, focusing conservation efforts on the most important locations.

### Other ways to analyse connectivity

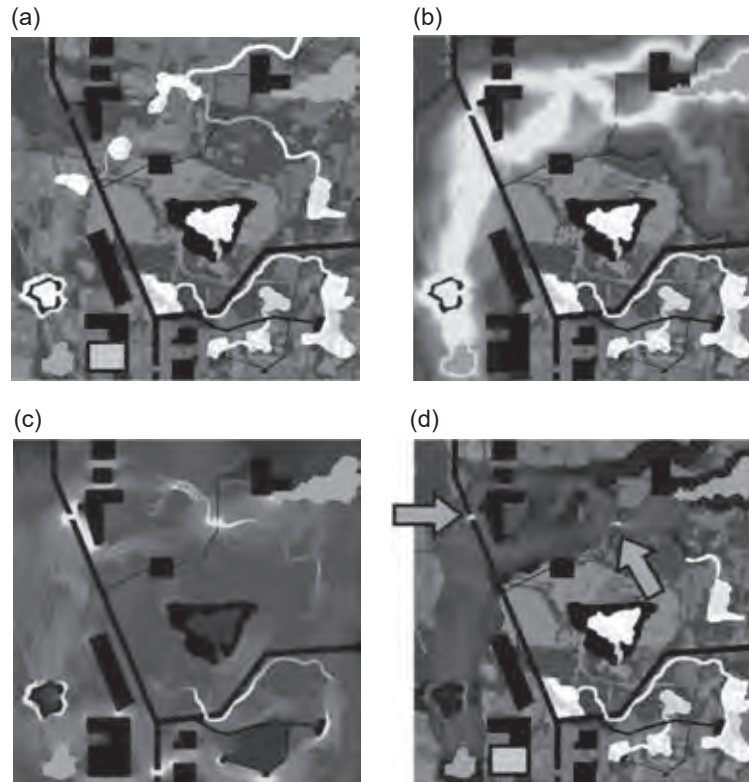
Ecologists often use the term *graph theory* to refer to a family of analyses in which patches are reduced to nodes at patch centroids, with centroids connected by lines or 'edges' (e.g. Bunn et al. 2000; Urban & Keitt 2001; Minor & Urban 2007). Such graphs underlie many methods in connectivity analysis, including LC corridor modelling. Advances in computing and algorithms borrowed from other disciplines have allowed applications of graph algorithms to continuous landscapes instead of simple networks. Rayfield et al. (2011) review graph-based connectivity measures and provide a framework for classifying them as applications to connectivity conservation.

### Circuit theory

Connectivity analyses based on electrical circuit theory use networks of electrical nodes connected by resistors as models for networks

of populations, habitat patches or locations on a landscape connected by movement. Because connectivity increases with multiple pathways in electrical networks, distance metrics based on electrical connectivity are applicable to processes (e.g. gene flow; McRae 2006) that respond positively to increasing numbers of pathways. Additionally, previous work has shown that current, voltage and resistance in electrical circuits all have mathematical relationships with random walks (Doyle & Snell 1984; Chandra et al. 1997). Random walks can predict the expected routes that an animal with a preference for low-resistance habitat will take as it moves through a landscape. The precise relationships between circuit theory and random walks mean that circuits can be related to movement ecology and population genetics via random walk and coalescent theories, providing concrete interpretations of connectivity measures (McRae 2006; McRae et al. 2008).

Circuit and LC models represent two extremes in assumptions about movement and connectivity. Least-cost corridors calculate the routes expected to be taken by animals with perfect or near-perfect knowledge of the landscape, whereas current maps generated from circuit models predict movement routes taken by random walkers, with all possible paths contributing to connectivity. Neither will entirely correctly predict movement behaviour of real animals (Spear et al. 2010, and see below) but there are benefits to both models, as we show in the example in Figure 21.4. Least-cost analyses can show what routes/zones would permit the most efficient movement, which can be important for conservation planning; if a large portion of a landscape is likely to be developed, identifying those areas which, if conserved, provide the easiest movement routes will be important. Circuit theory has the advantage of identifying and quantifying 'pinch points' (see Figure 21.4), i.e. constrictions in corridors that, if lost, could sever connectivity entirely. Such areas can be prioritized for early conservation action because options are limited. Circuit algorithms also integrate across all movement pathways to



**Figure 21.4** Example of how circuit theory can be used to identify and prioritize important areas for connectivity conservation. (a) Simple landscape, with two patches to be connected (green) separated by a matrix with varying resistance to dispersal (low resistance in white, higher resistance in darker shades, and complete barriers in black). (b) Least-cost corridor between the patches (lowest resistance routes in yellow, highest in blue). (c) Current flow between the same two habitat patches derived using Circuitscape (McRae & Shah 2009), with highest current densities shown in yellow (from McRae et al. 2008). Circuit analyses complement least-cost path results by identifying important alternative pathways and ‘pinch points’, where loss of a small area could disproportionately compromise connectivity. (d) A promising application is restricting circuit analyses to least-cost corridor slices to take advantage of the strengths of both approaches (from McRae & Kavanagh 2011). This hybrid approach shows both the most efficient movement pathways and critical ‘pinch points’ within them, which glow yellow. These could be prioritized over areas that contribute little to connectivity, such as the corridor at the top right of the map that has been coloured dark blue because it does not provide connectivity between the patches.

provide measures of redundancy, i.e. availability of alternative pathways for movement (see Figure 21.4). New applications allow identification of barriers that have a strong effect on connectivity, which can be useful for highlighting opportunities to restore connectivity, e.g. through re-establishment of natural vegetation or installation of highway crossing structures (McRae, unpublished data).

### Centrality analyses

A promising graph-theoretic approach to connectivity modelling is centrality analysis, which ranks the importance of habitat patches or corridors in providing movement across an entire network, i.e. as ‘gatekeepers’ of flow across a landscape (Carroll et al. 2011). Centrality analyses can be based in LC path,

circuit theory or other connectivity analysis methods. The difference is that, instead of mapping corridors or current flow between single pairs of core areas, they add up results from connectivity analyses between all pairs of nodes (sites or cells) on a landscape. Centrality analyses can be applied to raster GIS data or networks to identify core areas, linkages or grid cells that are particularly important for overall connectivity. Because centrality metrics can incorporate connectivity between all pairs of nodes on a landscape, they can eliminate the need to identify specific pairs of habitat patches to connect. For example, betweenness centrality (Freeman et al. 1991) identifies the shortest paths connecting all pairs of nodes in a network, and sums the number of such shortest paths involving each intervening node. This procedure identifies areas lying on a large proportion of the shortest paths in a network, the loss of which can disproportionately disrupt connectivity across the network as a whole. The Connectivity Analysis Toolkit (Carroll 2010) specializes in centrality analysis, and supports metrics based on betweenness, current flow (Newman 2005), maximum flow (Freeman et al. 1991) and minimum-cost flow (Ahuja et al. 1993). It also allows time-series analyses of connectivity across landscapes where habitats shift through time (Phillips et al. 2008).

### Resistant kernels

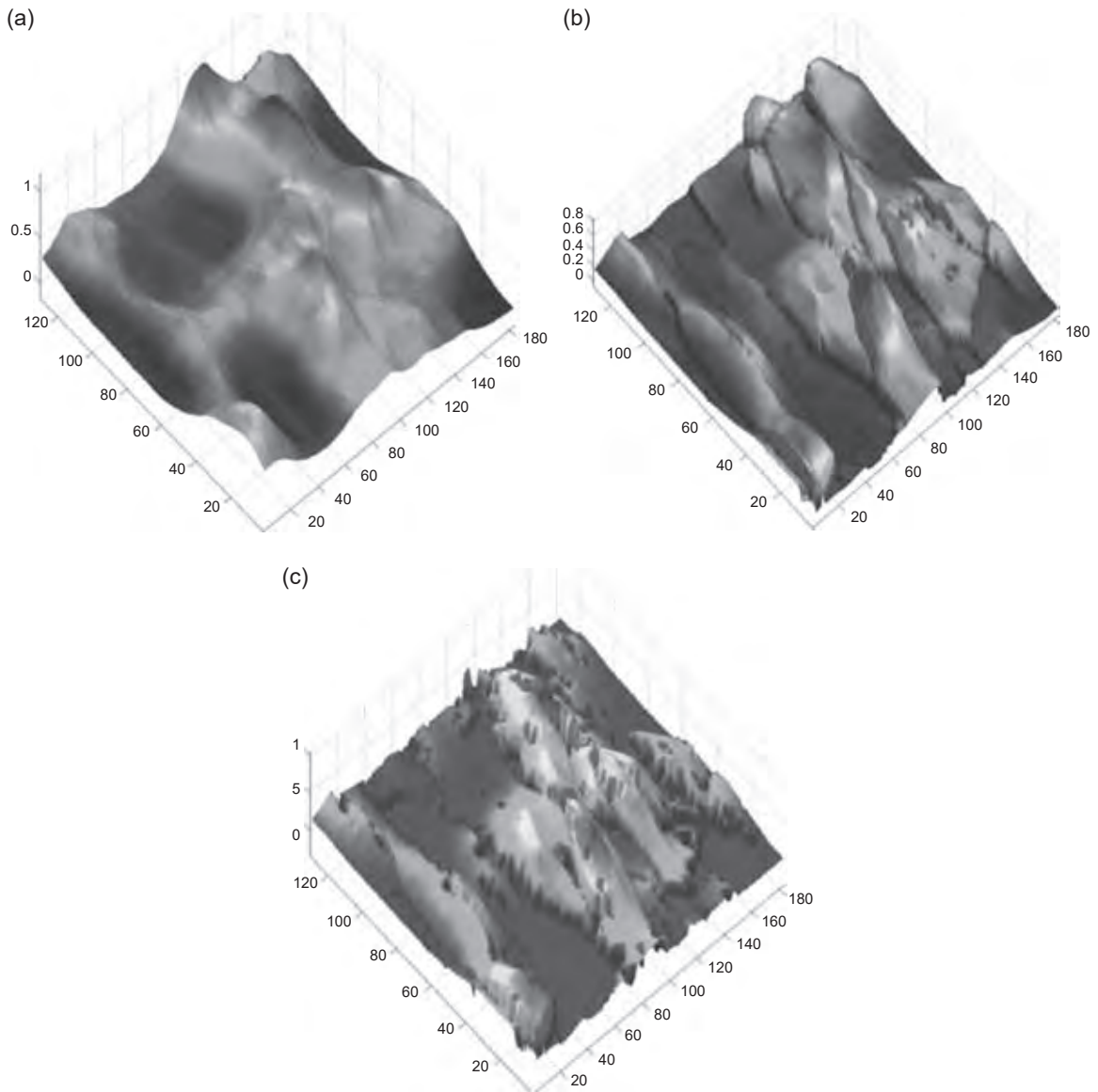
The resistant kernel approach to connectivity modelling is based on least-cost dispersal from some defined set of sources. The model calculates the expected density of dispersing individuals in each pixel around the source, given the dispersal ability of the species, the nature of the dispersal function and the resistance of the landscape (Compton et al. 2007; Cushman et al. 2010b). Once the expected density around each source cell is calculated, the kernels surrounding all sources are summed to give the total expected density at each pixel (see Figure 21.3d). The results of the model are surfaces of expected density of dispersing

organisms at any location in the landscape. For example, Cushman et al. (2010b) used resistant kernel modelling to evaluate the interactive effects of roads and human land use change on population connectivity for a large number of pond-breeding species in Massachusetts (USA). The resistant kernel approach quantified expected density of dispersers in the upland environment as functions of breeding population size, dispersal ability and quantified the relative impacts of roads and land use on population connectivity (Figure 21.5).

The resistant kernel approach to modelling landscape connectivity has a number of advantages as a robust approach to assessing current population connectivity (Compton et al. 2007; Cushman et al. 2010b, 2011). First, unlike most approaches to mapping corridors, it is spatially synoptic and provides prediction and mapping of expected migration rates for every pixel in the whole study area, rather than only for a few selected 'linkage zones' (e.g. Compton et al. 2007). Second, scale dependency of dispersal ability can be directly included to assess how species of different vagilities will be affected by landscape change and fragmentation under a range of scenarios (e.g. Cushman et al. 2010b). Third, it is computationally efficient, enabling simulation and mapping at a fine spatial scale across large geographical extents (e.g. Cushman et al. 2010b, 2011).

### Individual-based movement models

Individual-based (IB) models explicitly simulate the processes acting on the individual to predict movement. IB models predict movement paths of simulated dispersers based on parameters such as energetic cost of movement in different patch types, turning angles within patches and at patch transitions, movement speeds, duration of movement events, mortality risks in different patch types, and likelihoods of movements between patch types. Thus, IB models usually incorporate much more detail and thus greater realism than other



**Figure 21.5** Example of resistant kernel results from Cushman et al. (2010b) showing predicted density of dispersing individuals in upland habitat under three hypotheses: (a) connectivity is unaffected by land use and roads and only a function of distance, (b) connectivity is reduced by roads but not by differences in land cover and land use, (c) connectivity is affected by roads and land use/land cover.

connectivity models, such as demographic and dispersal data, in addition to landscape characteristics.

There are three broad categories of models that simulate individual movement (raster based, vector based and network based), which

differ according to whether the landscape is represented as fields, features or graphs. Conceived as fields, a landscape is a continuous surface defined by one or more variables (layers) that can be measured at any point within the field. Fields usually model continuous data such



as elevation, or temperature gradients, but can also represent categorical data such as habitat classification. If movement through the landscape is dependent on the variables of the field, then raster-based movement rules are most appropriate. Features are discrete entities that occupy positions in space, such as lines (rivers, roads, hedgerows) and polygons (lakes, woodland). The interiors of polygons are considered to be homogeneous. Movement between features is usually simulated using vector-based models. Finally, graphs represent the positional relationship between discrete elements in a landscape; a graph consists of a set of nodes that may represent continuous or categorical data, and a set of edges, which are dimensionless but describe how the nodes are connected to one another. Edges may be temporally referenced, indicating changes in graph connectivity over time. Network-based models are used to simulate IB movement in graphs. Examples of all three of these categories are discussed below.

### ***Movement rules and models***

Regardless of whether movement models are raster, vector or network based, they encode a series of rules that predict how the dispersal behaviour of individual animals is expected to interact with the spatial pattern of landscape structure (King & With 2002). Variations in patch quality, boundaries between patches, the nature of the mosaic, and overall landscape connectivity all affect the permeability of the landscape to dispersing individuals (Wiens 1997). The limited empirical information on the behavioural responses of animals to landscape structure (Turner et al. 1995; Lima & Zollner 1996) means that model parameters are usually based on observed habitat preference, dispersal rates in different patches, and how the energetic costs of crossing a landscape affect distance moved as well as direction taken. For example, the rules employed by Boone & Hunter (1996) simulated IB searching behaviour in grizzly bears by encoding permeability into the cells of habitat patches.

Highly permeable habitat patches produced straight paths and long distance movements whereas patches of low permeability caused convoluted paths and short displacement.

### ***Raster-based models***

Raster- or grid-based representations of the landscape permit the greatest flexibility with which movement interacts with the landscape, and are appropriate where the dispersal matrix is heterogeneous (Wiegand et al. 1999). The landscape is represented as a series of tessellated shapes, usually square grid cells, and the model animal moves through each cell based on movement rules.

An advantage of this approach to modelling is the inclusion of a clear relationship between a cell and its neighbours, facilitating the description of local interactions by state transition rules. Each cell stores its own state variables that influence the decisions made by individuals through the landscape it represents. However, there are three principal disadvantages to raster-based models.

- The resolution of the grid is limited by memory capacity and simulation speed, and raster-based models have a tendency to be computationally demanding.
- The fixed spatial structure implies a fixed relationship between the spatial scale in the simulation and the scale of individual movements of the organism investigated.
- The geometry chosen to represent landscape in raster-based models (i.e. square grid, hexagonal grid, Dirichlet tessellation, etc.) can substantially affect the simulated behaviour of the individual dispersers even if the rules for movement and settlement are the same between different geometries (Holland et al. 2007).

### ***Vector-based models***

Vector-based models simulate organisms dispersing through continuous or homogeneous landscapes. If the motivations for these movements

are random or quasi-random search patterns, they can be simulated using correlated random walk algorithms (Kareiva & Shigesada 1983). Alternatively, if individual movements are targeted searches for resources with a particular spatial or temporal distribution, movement decisions will be informed by the underlying landscape structure. Finally, if motivation for movement is prompted by the desire to avoid or join conspecifics, it will result in density-dependent movement rules. Where motivations for movement are known and appropriate, IB models benefit from vector-based dispersal simulations, which are less computationally demanding than the raster-based alternative.

### **Network-based models**

Network-based models differ from the other types in that they do not include a continuous representation of the landscape. Rather, connectivity between locations is represented by an edge between nodes. Network-based models usually specify an *a priori* representation of patch size, patch adjacency and other criteria (e.g. Lookingbill et al. 2010). Edges are formed when movement is possible between nodes. Dispersal corridors can be represented as nodes as well as edges in network visualizations of a landscape used as analytic connectivity models (McRae et al. 2008). They calculate walks through the network that minimize total weight, suggesting optimal pathways for dispersal. In IB models, network-based landscapes are utilized probabilistically (Lookingbill et al. 2010; Morzillo et al. 2011), and may result in biologically plausible but analytically suboptimal solutions. Graph-theoretic approaches to network analysis can be applied to the utilized networks of IB models to identify the nodes and edges that maintain cohesion of the network. For example, Gurnell et al. (2006) identified routes of entry for invasive grey squirrels into potential conservation areas for the endangered red squirrel in northern England through network analysis.

### **Corridors based on shifting climate envelopes**

This approach produces 'temporal corridors' that track how a species' climatic envelope (suitable temperature and moisture regimes) might move across a landscape under climate change scenarios. Like some types of individual-based models, this approach avoids the concept of resistance that is central to most previous approaches. The heart of this approach is either a dispersal chain model (Williams et al. 2005) or a network flow model (Phillips et al. 2008), either of which identifies cells with suitable climate envelopes that are spatially contiguous for long enough to allow the species to establish new populations in cells as they become suitable. Although dispersal chain and network flow models are conceptually sound, they depend completely on the outputs of three other models, namely models of future emissions of greenhouse gasses, models of future climate resulting from how the atmosphere and oceans respond to these emissions, and climate envelope models for the focal species. Unfortunately, each of these latter three models is plagued with massive uncertainty (summarized in Beier & Brost 2010). In the future, ensemble modelling (building many alternative corridors based on various combinations of emission scenarios, circulation models and climate envelope models) might identify corridors robust across the range of assumptions in the ensemble.

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### **Beyond single species**

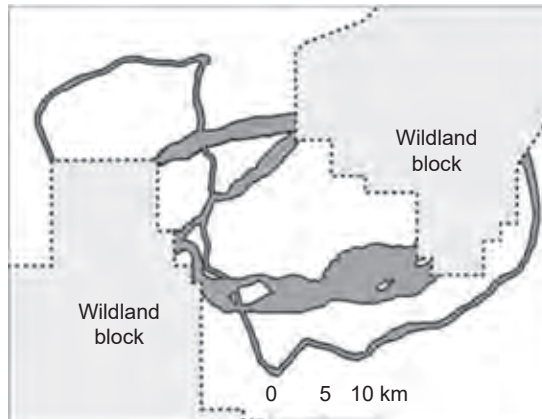
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#### **From optimal corridors for single species to linkage designs for multiple species**

Up to this point, we have described methods of mapping an optimal corridor, or areas important for connectivity, for a single species. Beier et al. (2008) proposed the term *linkages* to denote lands intended to support movement of

**Box 21.3** Example of optimizing multispecies linkage

A hypothetical linkage design including optimal corridors for eight focal species, expanded to include patches of modelled breeding habitat for an additional five focal species for which corridor models were not appropriate, and a narrow riparian strand for fishes. Each strand needs to be >1 km wide in order to create large interior spaces free of edge effects, support meta-populations of species needing multiple generations to achieve gene flow through the corridor, and support ecological processes more complex than animal movement.



multiple focal species and ecosystem processes. To design linkages, conservation planners can select a suite of representative focal species suitable to serve as a collective umbrella for the entire biota. For instance, each of 27 linkage plans in California and Arizona (Beier et al. 2006, 2007) was designed to meet the needs of 10–30 focal mammals, reptiles, fishes, amphibians, plants and invertebrates. Focal species included species requiring dispersal for meta-population persistence, species with short or habitat-restricted dispersal movements, species tied to an important ecological process (e.g. predation, pollination, fire regime), and species reluctant to traverse barriers in the planning area. Although large carnivores are appropriate focal species and flagships (Servheen et al. 2001; Singleton et al. 2002), most of them are highly mobile habitat generalists and thus inadequate umbrellas for other species (Beier et al. 2009; Minor & Lookingbill 2010).

A simple unweighted union of single-species corridors is an obvious way to produce a linkage design to promote the goal of 'no species left

behind' (Beier et al. 2006, 2007; Adriaensen et al. 2007; Cushman et al. 2011) (Box 21.3). But corridor models are not appropriate for some focal species, such as many flying animals, that do not move across the landscape in pixel-to-pixel fashion. To support movement of these species, Beier et al. (2008) recommend draping maps of known or modelled breeding habitat over the union of corridors, and enlarging the union to include patches that would decrease the inter-patch distances that dispersers would need to cross. The linkage design should be further expanded to include major riverine connections, which provide natural corridors for aquatic and some upland organisms, and promote other ecological processes and flows such as movement of sediment, water and nutrients.

### **Coarse-filter linkage designs for climate change**

Climate change poses a challenge to all types of conservation planning, including linkage

design. As climate changes, existing land covers in some planning areas will not merely shift but will disappear as plant associations reassemble (Hunter et al. 1988; Lovejoy & Hannah 2005). Linkage designs should be robust to such changes, and should allow species to shift their ranges into and out of the planning area. To address this, one could attempt to model corridors for the shifting climate envelopes of all species (above). A simpler alternative is to design linkages with a coarse-filter approach based on the abiotic drivers of land cover and species distributions (Hunter et al. 1988; Anderson & Ferree 2010). This idea is grounded in the foundational ecological concept (Jenny 1941; Amundson & Jenny 1997) that biodiversity at any point in time is determined by the interaction of the recent species pool with climate, soils and topography.

Beier & Brost (2010) and Brost & Beier (2012) developed multivariate procedures to identify *land facets*, defined as recurring landscape units with uniform topographic and soil attributes, from readily available digital maps of elevation and soils. They used multivariate dissimilarity as a measure of pixel resistance for each land facet type. Finally, they used least-cost modelling to design land facet corridors, and joined these corridors into a linkage design. Other coarse-filter approaches are feasible. For instance, Rouget et al. (2006) suggest that species will shift their ranges by sequentially colonizing areas that lie along the most gentle and monotonic temperature gradients. Assuming these gradients in temperature are conserved in a changing climate, it may be possible to identify corridors along today's most gentle and monotonic temperature gradients, without the need for uncertain models of future climate.

Linkage designs should be produced by a combination of coarse-filter and focal species approaches. In each of three landscapes, Beier & Brost (in preparation) developed two linkage designs – one based on land facets and the other on focal species. The land facet linkage designs included optimal corridors for 25 of 28 focal species, whereas the focal species designs encompassed optimal corridors for 21 of 32

land facets. Neither approach on its own was likely to meet all conservation goals.

### **Validation of predicted corridors**

Corridors resulting from models have sometimes been criticized because they lack supporting movement data (Simberloff et al. 1992; Rosenberg et al. 1997) and because they may contain errors in model parameters or incorrect assumptions (Spear et al. 2010). Therefore, additional vetting of modelled corridors in the field is strongly recommended.

Many field studies have evaluated the efficacy of existing corridors, such as corridors that follow linear features like fencerows or rivers (Hill 1995; Castellón & Sieving 2006), or that were constructed as part of experimental landscapes (Berggren et al. 2002; Haddad et al. 2003). There have also been tests of species' response to conservation action in established corridors (Duke et al. 2001; Shepherd & Whittington 2006). But field testing of modelled corridors, like the ones described in this chapter, have been scarce.

Modelled corridors may cover large spatial extents and span multiple land ownerships and management types, or even national borders, making the collection of field data logistically complex and resource intensive. If corridors are modelled for dispersal movement, capturing infrequent dispersal events is akin to finding a needle in a haystack, so collecting sufficient data to reliably test predicted corridors can be difficult. Finally, modelled corridors can only be truly validated if movement through the corridor is documented along with the outcome for which the corridor was intended, whether that be by successful migration to summer or winter ranges, successful recolonization of habitat patches, safe passage across a road, demographic rescue, or successful breeding and gene flow.

Even if all aspects of linkage cannot be validated, a partial field study will add confidence and transparency to a corridor project. For

example, Clevenger et al. (2002) developed two habitat models for black bears, one based on expert opinion and the other based on data from the literature. They identified road crossing zones from these models, and using data on crossings by real bears, they tested if the predicted linkages were used more than would be expected by chance. They found that the linkage models based on data from the literature outperformed the expert opinion models. The authors indicated that the expert opinion models may not have performed as well due to an overestimation of the importance of riparian habitat.

As an additional example of empirical field validation of corridors, Quinby (2006) used existing data from the annual breeding bird survey to test the utility of a proposed corridor. More bird species were found inside the corridor than outside it, confirming its validity. Chardon et al. (2003) used presence/absence data on the speckled wood butterfly from two different landscapes to compare the explanatory power of Euclidean distance and effective-distance connectivity models. They found that cost-distance was better able to predict connectivity than Euclidean distance. Zeller et al. (2011) used interviews with local residents to collect detection/non-detection data on jaguars and seven prey species in a grid-based design. The data were analysed by a site-occupancy model to determine probability of habitat use inside and outside the modelled corridor. It was found that probabilities of habitat use were mostly higher outside the modelled corridor, a conclusion which prompted a redesign of the final corridor.

The fact that there have been few studies to validate corridor models calls for more attention to this topic. Corridor validation techniques not only need to be improved upon, they need to be accessible to researchers and land managers working at different scales and on various species. Bridging the gap between corridor identification and corridor implementation will increasingly depend upon these validation studies, since land managers do not want to be left to implement a corridor of questionable efficacy, or be blamed for creating a sub-par corridor

while more appropriate lands are unprotected from development and fragmentation (Hess & Fischer 2001; Morrison & Boyce 2008).

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## Conclusions

Population connectivity is critical for maintaining viable regional populations in the short term and to enable species to shift their geographic range in response to future climate change and other pressures such as land use change. In this chapter, we described the state of the art in quantitative corridor and connectivity modelling approaches. The first step in most quantitative connectivity analyses is to estimate and map landscape resistance. Traditional expert opinion is less useful for developing landscape resistance maps now that new and effective approaches using empirical data provide a much more reliable and robust means to map landscape resistance. There are a number of ways to predict or describe connectivity from resistance surfaces. Least-cost paths, least-cost corridors, circuit theory, centrality analyses, and resistant kernels are all powerful approaches suitable for different objectives. The efficient application of corridor analyses to future applied conservation problems must develop corridor designs to maintain connectivity for multiple species, and under changing climate. Finally, empirical validation of predicted corridors and linkages is essential to demonstrate their functionality and guide improvement of future corridor designs.

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## PLANT ECOLOGY

# Ongoing accumulation of plant diversity through habitat connectivity in an 18-year experiment

Ellen I. Damschen<sup>1\*</sup>, Lars A. Brudvig<sup>2</sup>, Melissa A. Burt<sup>3†</sup>, Robert J. Fletcher Jr.<sup>4</sup>, Nick M. Haddad<sup>5</sup>, Douglas J. Levey<sup>5</sup>, John L. Orrock<sup>1</sup>, Julian Resasco<sup>6</sup>, Joshua J. Tewksbury<sup>7,8,9</sup>

Deleterious effects of habitat fragmentation and benefits of connecting fragments could be significantly underestimated because changes in colonization and extinction rates that drive changes in biodiversity can take decades to accrue. In a large and well-replicated habitat fragmentation experiment, we find that annual colonization rates for 239 plant species in connected fragments are 5% higher and annual extinction rates 2% lower than in unconnected fragments. This has resulted in a steady, nonasymptotic increase in diversity, with nearly 14% more species in connected fragments after almost two decades. Our results show that the full biodiversity value of connectivity is much greater than previously estimated, cannot be effectively evaluated at short time scales, and can be maximized by connecting habitat sooner rather than later.

Habitat loss and fragmentation are leading threats to biodiversity in ecosystems across the globe (1–4). In a world replete with small, isolated fragments, where 70% of the world's forest area is within just 1 km of an edge, biodiversity loss is mounting (1). Increasing habitat connectivity is a key conservation strategy to minimize biodiversity losses by facilitating dispersal and rescuing declining populations from extinction (5). However, it is not known if restoring connectivity among habitat fragments will increase biodiversity by promoting the colonization of new species.

A well-established body of ecological theory predicts the importance of connectivity for biodiversity. Metapopulation theory (6, 7) illustrates how increasing connectivity is predicted to lead to greater regional population persistence by promoting colonization of new habitats, increasing recolonization of habitats where extinction has occurred (recolonization rescue), and buffering existing populations against extinction via increased immigration (demographic rescue).

Metacommunity theory (8, 9) and island biogeography theory (10) integrate these population-level effects of connectivity to yield predictions regarding biodiversity. These developments provide strong theoretical reasons to expect that modifying connectivity can increase biodiversity by increasing colonization and decreasing extinction, but they also caution that nonintuitive effects (e.g., synchronization of population dynamics or modification of interactions) are possible (8, 11).

Despite the presumed importance of connectivity for community diversity in both basic and applied ecology (12, 13), empirical evidence for predictions from theory has been mixed (14–16). A primary challenge in evaluating these predictions in empirical systems is that ecological processes vary greatly in space and time: The dynamic nature of colonization and extinction processes necessitates well-replicated, large-scale, and long-term studies to draw meaningful inference about the ultimate role of connectivity in affecting diversity. For example, changes in biodiversity due to either lost or restored connectivity do not occur instantaneously. In fragmented habitats, species can continue to persist for years before eventually going extinct (17), resulting in an “extinction debt” paid over decades or even centuries (18, 19). Similarly, “colonization credits” can accrue when habitat connectivity is restored among species-impooverished habitats, catalyzing the potential for biodiversity gains (20–23). Species may not colonize immediately because of low dispersal rates, which are difficult to measure, making the extent of colonization credits unknown (20, 23). This lack of information is important because colonization credits could forestall or even reverse extinction debt.

We tested the long-term effects of habitat connectivity on plant colonization and extinction dynamics and their resulting impacts on species richness over nearly two decades in a habitat fragmentation experiment at the Savannah

River Site in South Carolina, USA. This experiment manipulates connectivity through the creation of habitat corridors—thin strips of habitat that connect otherwise isolated habitat fragments (24). Ten experimental landscapes each contain four 1.375-ha fragments of equal area that are either unconnected or connected to a central 1-ha fragment by a 150 m-by-25 m corridor (Fig. 1). Fragments and corridors are being restored to longleaf pine savanna, a threatened ecosystem within a global biodiversity hotspot (25), and are surrounded by dense pine plantations that limit herbaceous plant growth. For 18 years, we censused occupancy of all plant species as communities assembled after each restored fragment's creation. Connected and unconnected fragments were randomly assigned and did not differ in species richness at the start of the experiment [fig. S1; see also supplementary materials and methods (26)].

Habitat connectivity has increased rates of colonization and decreased rates of extinction. As communities assembled, connectivity increased the average annual species colonization rate by 5% and decreased the average annual extinction rate by 2% beyond expected successional dynamics (Fig. 2A and fig. S2). These apparently small differences in annual rates are persistent and have compounded over time, generating large increases in species richness in fragments connected by corridors, magnifying colonization credits (Fig. 2B and fig. S3). These impacts occur across 239 plant species with diverse life histories, including species of conservation and restoration concern from the longleaf pine ecosystem (fig. S6) and species that vary in their dispersal ability (fig. S7).

Higher colonization rates and lower extinction rates have shortened the average time for a species to colonize a fragment (Fig. 3) and have driven a large increase in plant species richness (Fig. 2B and figs. S3 and S5). Corridor-connected fragments now support, on average, 24 additional plant species compared with unconnected fragments (200 versus 176 in connected versus unconnected fragments, respectively; fig. S3), an increase of 14%. Notably, connectivity's effects on species richness continue to accumulate; our best-fit models of species richness differences over time show no asymptote. Moreover, connectivity's impacts on colonization and extinction rates remain consistent across the 18 years of this study (Fig. 2 and figs. S4 and S5) (26).

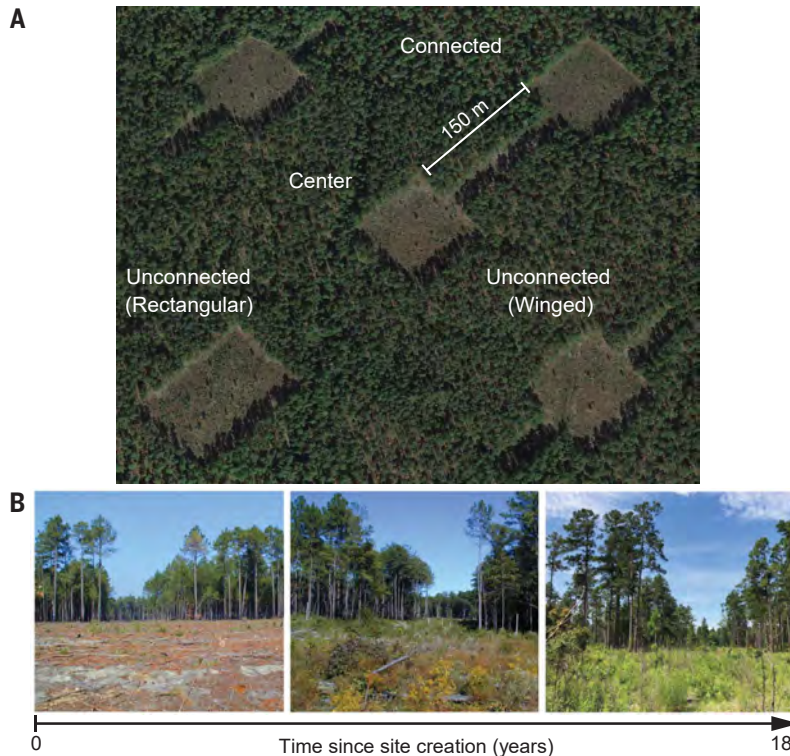
Our results underscore that typical experiments of 1 to 5 years in duration (1, 27) likely underestimate the impact of long-term connectivity restoration on community diversity. Connectivity's impacts are not fully realized until the ongoing, lagged assembly processes and responses equilibrate. Theory from spatial ecology and community assembly predicts that connectivity's effect on diversity will eventually reach an asymptote because of local ecological processes constraining species richness (e.g., competition) and because local communities draw from a finite number of species in the region (10, 28). Long-term empirical investigations of how landscape configuration alters colonization

<sup>1</sup>Department of Integrative Biology, University of Wisconsin–Madison, Madison, WI 53706, USA. <sup>2</sup>Department of Plant Biology and Program in Ecology, Evolutionary Biology, and Behavior, Michigan State University, East Lansing, MI 48824, USA. <sup>3</sup>Kellogg Biological Station and Department of Integrative Biology, Michigan State University, Hickory Corners, MI 49060, USA. <sup>4</sup>Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611, USA. <sup>5</sup>Division of Environmental Biology, National Science Foundation, Alexandria, VA 22314, USA. <sup>6</sup>Department of Ecology and Evolutionary Biology, University of Colorado, Boulder, CO 80309, USA. <sup>7</sup>Future Earth, Sustainability Innovation Lab at Colorado and Department of Environmental Studies, University of Colorado, Boulder, CO 80309, USA. <sup>8</sup>Future Earth, School of Global Environmental Sustainability, Colorado State University, Fort Collins, CO 80523, USA. <sup>9</sup>Department of Environmental Science and Policy, George Mason University, Fairfax, VA 22030, USA.

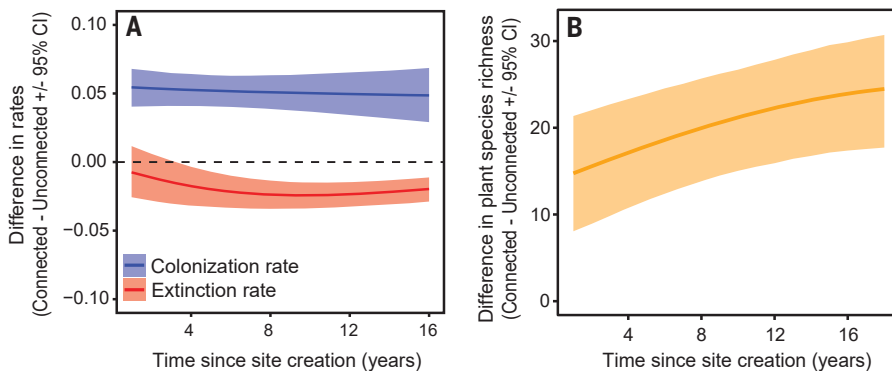
\*Corresponding author. Email: damschen@wisc.edu

†Present address: Department of Biological Sciences, Virginia Tech University, Blacksburg, VA 24061, USA.





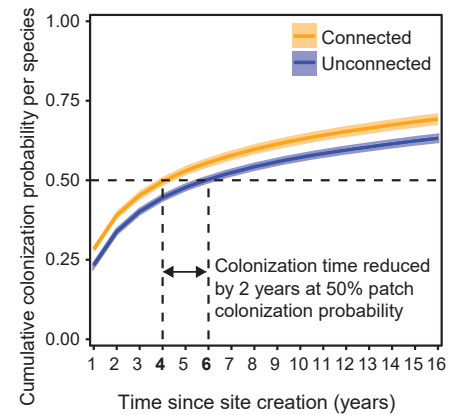
**Fig. 1. A long-term habitat connectivity experiment.** (A) One of 10 experimental landscapes ( $N = 10$ ), each containing a center fragment that is connected or unconnected (winged and rectangular) to peripheral fragments of open longleaf pine savanna surrounded by dense pine plantations [additional details in (26)]. [Credit: Google Earth 2019] (B) Plant communities within fragments have assembled over nearly two decades and are being restored to native longleaf pine savanna using frequent, low-intensity fires that mimic the historic fire regime. See (26) for further information on the study design. [Credits (left to right): M. A. Burt, N. M. Haddad, and E. I. Damschen]



**Fig. 2. Connectivity reduces extinction and increases colonization rates over two decades, resulting in accruals of species in connected fragments.** (A) Average colonization rates are 5% greater and extinction rates are 2% lower for species in connected fragments than rates for those in unconnected fragments. These rates are constant over time. The net accrual of colonization credits increases biodiversity in connected fragments. (B) Plant species richness in connected fragments has increased at a greater rate than in unconnected fragments. Shown is the difference in estimated species richness over time, illustrating greater increases in richness in connected versus unconnected fragments. This rate increase has been consistent for nearly two decades and has resulted in connected fragments having 24 more plant species than unconnected fragments (fig. S3). A linear model (on the logit scale) is the best fit for the difference in species richness between connected and unconnected fragments over time (26). Shaded regions represent 95% confidence intervals.

and extinction rates are critical for determining and predicting human-induced changes to the environment; communities will almost never exhibit instantaneous responses or equilibrium dynamics (29).

We show that connectivity directly alters colonization and extinction dynamics among fragments, providing mechanisms for observed landscape-level biodiversity patterns (30). Our



**Fig. 3. Connectivity reduces colonization timing, resulting in colonization credits.** The average cumulative probability of each individual species colonizing connected fragments is 1 to 6 years earlier than in unconnected fragments, resulting in reduced colonization lags and increased colonization credits. For example, the point at which a single species has a 50% likelihood of colonizing a habitat fragment (dotted lines) occurs a full 2 years earlier in connected versus unconnected fragments. Shaded regions represent 95% confidence intervals.

results contrast with hypotheses that attribute biodiversity change to habitat area alone and those that do not attempt to isolate underlying mechanisms (14). In our study system, connectivity leads to wholesale temporal shifts in community assembly, driven by lags in colonization that generate colonization credits, regardless of whether an equilibrium is achieved. Connecting fragments with corridors results in a 1- to 6-year reduction in the time it takes an individual species to colonize new habitat fragments, relative to the time needed for colonization of unconnected fragments (Fig. 3). For example, the 50% likelihood of a single species colonizing a fragment (dotted lines in Fig. 3) occurs a full 2 years earlier in connected fragments than for that same species in unconnected fragments (Fig. 3). These temporal shifts in the speed of colonization (Fig. 3 and fig. S8) have unexplored and potentially important ramifications for time-dependent ecological processes (e.g., priority effects). Although less explored, our results also suggest that corridor-mediated changes in the movement of individuals and alleles may affect evolutionary processes by altering effective population size and gene flow (31). Our results raise the need for theory to better integrate temporal duration in conservation and management.

Conservation strategies to mitigate biodiversity losses due to habitat fragmentation and loss are urgently needed, and habitat corridors feature prominently in global conservation plans (4). Our study shows that efforts to increase connectivity will pay off over the long term. Conservation plans that ignore connectivity, such as plans that focus solely on habitat area, will

leave unrealized the substantial, complementary, and persistent gains in biodiversity attributable specifically to landscape connectivity (30, 32).

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#### SUPPLEMENTARY MATERIALS

[science.sciencemag.org/content/365/6460/1478/suppl/DC1](https://science.sciencemag.org/content/365/6460/1478/suppl/DC1)  
Materials and Methods  
Supplementary Results  
Figs. S1 to S8  
Table S1  
References (34–61)  
Supplementary Code

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## Ongoing accumulation of plant diversity through habitat connectivity in an 18-year experiment

Ellen I. Damschen, Lars A. Brudvig, Melissa A. Burt, Robert J. Fletcher Jr., Nick M. Haddad, Douglas J. Levey, John L. Orrock, Julian Resasco and Joshua J. Tewksbury

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### Habitat connectivity enhances diversity

Fragmentation of ecosystems leads to loss of biodiversity in the remaining habitat patches, but retaining connecting corridors can reduce these losses. Using long-term data from a large, replicated experiment, Damschen *et al.* show quantitatively how these losses are reduced. In their pine savanna system, corridors reduced the likelihood of plant extinction in patches by about 2% per year and increased the likelihood of patch colonization by about 5% per year. These benefits continued to accrue over the course of the 18-year experiment. By the end of monitoring, connected patches had 14% more species than unconnected patches. Restoring habitat connectivity may thus be a powerful technique for conserving biodiversity, and investment in connections can be expected to magnify conservation benefit.

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## Supplementary Materials for

### **Ongoing accumulation of plant diversity through habitat connectivity in an 18-year experiment**

Ellen I. Damschen\*, Lars A. Brudvig, Melissa A. Burt, Robert J. Fletcher Jr., Nick M. Haddad, Douglas J. Levey, John L. Orrock, Julian Resasco, Joshua J. Tewksbury

\*Corresponding author. Email: [damschen@wisc.edu](mailto:damschen@wisc.edu)

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#### **This PDF file includes:**

Materials and Methods  
Supplementary Results  
Figs. S1 to S8  
Table S1  
Caption for Supplementary Code  
References

**Other Supplementary Material for this manuscript includes the following:**  
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Supplementary Code (.pdf)

## Materials and Methods

### Landscape experiment

In 2000, we initiated a landscape experiment to test whether habitat corridors promote connectivity and impact community diversity. The experiment is at the Savannah River Site, a National Environmental Research Park in Aiken and Barnwell Counties, South Carolina, USA. Established by the U.S. Department of Energy, the site is managed by the US Forest Service under agreement with the Department of Energy.

The experiment consists of 10 replicate landscapes (experimental blocks), each comprised of five open-habitat fragments created by clearing mature pine plantation forest and restoring fragments to native longleaf pine savanna. There is a strong contrast between the open fragments and the surrounding closed-canopy pine plantation matrix. Eight landscapes were created prior to the 2000 growing season (i.e., before April) and two additional landscapes were created prior to the 2007 growing season. Two of the original eight landscapes were discontinued following the 2007 growing season due to management constraints and one was destroyed by a wind event following the 2015 growing season. The remaining five landscapes initiated in 2000 and the two landscapes initiated in 2007 continue through the end of this study. When examining patterns over time, landscapes are evaluated based on the number of years since that landscape was created. All available replicate landscapes (blocks) are used for each time point in this study. This staggered initiation of replicate landscapes also provides a benefit by separating connectivity effects due to time since replicate initiation from annual effects attributable to specific years.

Each landscape contains a center fragment ( $100 \times 100$  m, 1 ha) surrounded by four peripheral fragments that are each 150 m from the center fragment (Fig. 1). The center fragment is connected to one peripheral fragment by a  $150 \times 25$  m corridor and the other three peripheral fragments are isolated from the center fragment by dense, mature loblolly (*Pinus taeda*) or longleaf pine (*Pinus palustris*) plantation forest. Unconnected fragments are equal in area to the connected peripheral fragment plus its corridor (1.375 ha) and are either rectangular ( $100 \times 137.5$  m) or winged. Winged fragments have two  $75 \times 25$  m projections, each with the dimensions of half of a corridor, extending from each side of a  $100 \times 100$  m fragment (Fig. 1). The identity of peripheral fragments (connected, rectangle, winged) was randomly assigned within each landscape, with one duplicate winged or rectangle fragment in each landscape. This study design allows us to separate influences of corridors mediated through connectivity from those mediated through differences in edge-to-area ratio. Specifically, impacts of connectivity are assessed by comparing response variables in winged and connected fragments (comparable edge-to-area ratio, different connectivity). Impacts of edge-to-area ratio are assessed by comparing the same variables in winged and rectangle fragments (comparable connectivity, different edge-to-area ratio). Because analyses used in this study showed no differences among unconnected fragment types (Table S1), response variables were averaged for those fragment types. The center fragment is not included in analyses comparing fragment types, therefore comparisons are always made for fragments of equal area. This approach is directly comparable to an earlier analysis of species richness in these fragments (27).

Through periodic prescribed fire and removal of establishing hardwood trees, we have restored fragments to their historical ecosystem type: open-canopy longleaf pine savanna. We used standard management practices in this ecosystem (34) and applied them consistently across experimental treatments (i.e., we managed all fragment types in the same way). Prescribed fires



are implemented and controlled by our partners at the USDA Forest Service-Savannah River consistent with the historic fire regime and with fire management in longleaf pine savanna conservation today (35). Low-intensity surface fires are ignited every two to three years during the dormant season (November - April) and are allowed to burn across large burn areas that include all experimental fragments for a given experimental landscape (block). Longleaf pine savanna species are fire-adapted and many species readily re-sprout after fire. Thus, ecological communities in our experimental landscapes recover quickly following fire, yet fire results in both mortality of resident species and recruitment opportunities for new species (36). Consistent with restoration practices in this ecosystem (34), we have also reduced woody encroachment in our fragments by cutting hardwood tree species with brush saws every three-to-four years and applying targeted herbicide to cut stumps and/or the base of individual stems. These management practices allow the fragments to undergo succession toward mature longleaf pine savanna, characterized by low density overstory longleaf pine trees and an understory dominated by highly diverse perennial herbs and grasses (36), while maintaining the contrast between our experimental fragments and surrounding matrix over the duration of the study.

### Data collection

To quantify plant species richness and rates of extinction and colonization within our fragments, we annually survey each fragment for all plant species occurrences. We conduct surveys between May 15 and July 15, when most species in our system are visually identifiable. Here, we include data from 2001 through 2018 (except 2004 when active management prevented sampling). The goal of each survey is to census all species in each fragment by systematically walking the area of each fragment in a set pattern around permanent 3m-tall poles placed in a 12.5m grid. This grid consists of 88 small (12.5 × 12.5 m) sampling units in each fragment. For each census, we record all species in the first sampling unit and then record only new species in subsequent sampling units. This method allows us to consistently cover the entire area of each fragment and compile a list of all vascular plant species observed in each fragment as well as the order in which they were detected across the 88 sampling units. Over the entire 18-year time series, we have kept the number of observers to a minimum – three (Damschen, Brudvig, and Burt). These observers standardize sampling effort and taxonomic identification rules prior to each annual survey. Resulting estimates of species richness for each fragment are from equal areas (1.375 ha). Taxonomy follows (38) and (39). In rare cases where identification is not possible at the species level (2% of taxa), we combine species to the genus level.

We assigned each plant species one of three primary dispersal modes: wind, animal, or gravity. We chose these modes because they capture distinctive classes of seed movement. We determined dispersal modes by first searching the Kew Garden Seed Information Database (40). If species were not in that database, we searched the primary literature with ISI Web of Science for papers that described dispersal for the species and/or genus. In some cases, we also searched reliable plant natural history websites to cross-reference obtained information. All designations were independently reviewed by two plant ecologists within our plant ecology research team (E. Damschen, L. Brudvig, M. Burt, C. Warneke, Q. Sorenson). Any conflicting or missing designations were discussed and decided by this entire team and decided on based on morphological and field observations (11% of species). Wind dispersal included both wind and tumbling dispersal mechanisms. Animal dispersal included endozoochory and epizoochory by birds and mammals and myrmecochory by ants. Gravity dispersal included ballistic dispersal mechanisms and species lacking apparent morphology to assist dispersal.

We also determined whether each species was associated with longleaf pine savannas (i.e., “longleaf pine species”). We were interested in assessing the responses of these species because they are of particular conservation and restoration concern and could respond more strongly to the contrasting habitat differences between the fragments and matrix in our experimental landscapes. We classified species as longleaf pine indicator species if they met one or both of the following criteria: 1) designation as longleaf pine upland species in published species lists for the Savannah River Site (41, 42), or 2) designation as “indicator species” in previous analyses of longleaf pine savanna plant communities at the Savannah River Site (43).

Because soil moisture is an important determinant of plant diversity in longleaf pine savannas (44, 45), we quantified soil water holding capacity. We used the same methods as Damschen et al. (27) by collecting 96-136, 10-cm deep  $\times$  2.5-cm diameter soil cores, evenly distributed across each fragment. We then determined soil water holding capacity as (wet mass - dry mass)/dry mass for each sample (46) and used the average of all samples from a fragment in our analyses.

All data are available from the Environmental Data Initiative and Data One (33).

### Analyses

We modeled changes in plant communities using multi-species occupancy models and their extensions to capture both changes in species richness and colonization-extinction dynamics (47, 48). Occupancy modeling provides two major benefits. First, it can account for species-specific imperfect detection (observation errors). Second, it estimates species directly rather than modeling summary statistics of communities (e.g., species richness), such that species identity is honored and tracked in the modeling process. The latter benefit also allows for understanding how species-specific characteristics (e.g., dispersal mode) may impact communities while also providing a means to derive community-level parameters (e.g., species richness). This general approach uses a hierarchical framework. To ensure that results were robust to the modeling framework we used, we used a negative binomial regression to contrast results to those from modeling species richness without accounting for imperfect detection.

As part of our occupancy modeling, we estimated imperfect detection using detection histories for each species in each fragment for each year. We used spatial replicates based on the long-term sampling design to create those detection histories. For each fragment, we pooled 88 samples that covered the entire fragment into  $J = 8$  replicates. This sampling strategy is best viewed as a ‘removal’ design (49), where once a species is detected, it is no longer tracked in fragment  $i$ . For example, a detection history for species  $k$  at fragment  $i$  in year  $t$  could be [0 0 0 0 1 NA NA NA], where NA refers to no data, given the ‘removal’ design. For most analyses, we focus on comparing communities in connected (corridor) versus unconnected (rectangular and winged) fragments and did not include the center fragment in modeling (but see below for interpreting if colonization of corridor fragments arose from center fragments).

We first modeled the entire plant community ( $K = 309$  species) to estimate potential effects of corridors over time on species richness. To model species richness over time, we used an ‘implicit dynamics’ formulation of the multi-species occupancy model (50). In this context, we modeled the probability of occurrence  $\psi$  for species  $k$  in time  $t$  at fragment  $i$  as:

$$z_{k,i,t} \sim \text{Bernoulli}(\psi_{k,i,t}) \quad (1)$$

where  $z$  is the latent occupancy state (0,1). We modeled  $\psi$  as:

$$\text{logit}(\psi_{k,i,t}) = \alpha_{trt,k} + \beta_{trt,k} \text{time}_t \quad (2)$$

such that each species  $k$  had a different, treatment-specific intercept and slope over time (i.e., an interaction of treatment\*species\*time). Note that in this model, we initially considered site as a random effect to account for within-site repeated measures over time, which provided similar results. We removed this effect in the final model to simplify model structure given the large number of latent parameters (e.g., species-specific effects).

Our observation model was described as:

$$y_{k,i,t,j} \sim \text{Bernoulli}(z_{k,i,t}p_k) \quad (3)$$

Where  $y_{k,i,t,j}$  is the detection of species  $k$  in fragment  $i$  at year  $t$  for replicate observation  $j$  and  $p_k$  is the probability of detection of species  $k$ , conditional on presence. We allowed detection to vary by species.

This model formulation assumes a linear effect of time since corridor creation (on the logit scale) on species-specific occurrence; however, this effect can appear non-linear on the probability (and species richness) scale, as in logistic regression. We also considered two types of non-linear functions (considering the log of time or adding a quadratic term of time), neither of which were supported by the data based on the Deviance Information Criterion, DIC (lower values indicate better fit; linear time: 93634; log time: 93840; quadratic time: 94352). We also initially considered the potential effects of soil moisture in this model, but found no support for its effect based on DIC (soils ignored: 93634; soils included: 99562). Thus, we did not include soil moisture in final models. We contrasted these results to modeling raw species richness with non-linear effects over time using a negative binomial regression, finding similar support for a linear effect of time and qualitatively similar patterns of changes in species richness as found in the multi-species occupancy model (Figs. S4, S5).

For a subset of the community (i.e., those species with  $> 10$  detections over time;  $K = 239$  species of the possible 309 species), we explicitly modeled colonization-extinction dynamics. While the entire community could be modeled to interpret colonization-extinction dynamics, little information is available for rare species to interpret treatment effects and how they change over time. Thus, such an approach would make the implicit assumption that rare species, which contribute a comparatively small amount of data on extinction and colonization, respond similarly to treatments as more common species, such that rare species dynamics do not have a large impact on conclusions (48). Because of this effect, we use the 239 species subset of more common species to make conclusions on colonization-extinction dynamics. We note, however, that modeling colonization-extinction dynamics of all species showed similar patterns.

We followed methods of Dorazio et al. (48), who extended the multi-species occupancy framework for capturing colonization-extinction dynamics. The dynamics of species occurrence can be described and estimated with time-series data by assuming a first-order Markov process, where  $z_{k,i}$  at time  $t$  is contingent on  $z_{k,i}$  at time  $t - 1$ , as well as local colonization,  $\gamma$ , and local extinction,  $\varepsilon$ , processes. If we define  $\phi = 1 - \varepsilon$ , then:

$$z_{k,i,t} = \text{Bernoulli}(z_{k,i,t-1}\phi_{k,i,t-1} + (1 - z_{k,i,t-1})\gamma_{k,i,t-1}). \quad (4)$$

This framework requires estimating occupancy at time 1, and then colonization-extinction dynamics in subsequent time steps. We also considered an alternative parameterization that accounts for potential rescue effects ("pseudo-rescue effects" sensu Hanski 1999) replacing  $\phi_{k,i,t-1}$  in equation 4 as (51):

$$\phi_{k,i,t-1}^* = (1 - (1 - \phi_{k,i,t-1})) (1 - \gamma_{k,i,t-1}). \quad (5)$$

To further interpret support of rescue effects, we contrasted similar models as described in equations 4-5 but fit to single species (i.e., 'dynamic occupancy models'; 52). We also note that

rescue effects are also often interpreted as occurring when connectivity (e.g., corridors) decrease local extinction rates, although it can be unclear if such patterns are driven by rescue effect mechanisms (53).

We allowed for  $\psi$  to vary by species (we also initially considered that  $\psi$  could vary by treatment; however, there was no support for this added complexity so we do not consider it further, See Fig. S1). We also allowed for  $\gamma$  and  $\varepsilon$  to vary by treatment over time for each species as:

$$\text{logit}(\gamma_{k,i,t}) = \alpha_{trt,k} + \beta_{trt,k} \text{time}_t \quad (6)$$

$$\text{logit}(\phi_{k,i,t}) = \alpha_{trt,k} + \beta_{trt,k} \text{time}_t \quad (7)$$

From this model, we then summarized the average  $\varepsilon$  and  $\gamma$  across species and associated 95% credible intervals for each treatment over time based on the species-specific posterior distributions of model parameters. We averaged unconnected treatments (winged, rectangular) because the rates of change for these treatments were similar (Table S1).

To determine if the results are consistent for species of conservation and restoration concern and to determine whether movement ability of species influences our results, we also summarize colonization-extinction dynamics on two types of species traits: 1) longleaf indicator status; and 2) dispersal mode (see Data Collection for descriptions of these characteristics).

To better interpret if colonization was driven by corridors, we re-ran the colonization-extinction model (using equation 4) and included the center fragment (Fig. 1) into the model. Based on this model, we determined if connected fragments tended to be colonized sooner than unconnected fragments for species that occurred (i.e.,  $z_{k,i,t}=1$ ) in center fragments prior to other fragments within each landscape.

We assumed vague priors for all parameters ( $N \sim (0, 100)$ ), and used uniform hyperpriors for standard deviation parameters ( $U \sim (0, 10)$ ). We ran all models in jags using the jagsUI package to call jags from R. We ran four chains for 37,500 Markov chain Monte Carlo (MCMC) iterations and thinned chains by 50 after a burn-in of 15000 and an adaptation phase of 15000, ultimately saving 3000 samples from the posteriors. We assessed model convergence using the Gelman-Rubin statistic R-hat, assuming that an R-hat  $> 1.05$  indicated convergence problems (50, 54).

## Supplementary Text

### Supplementary Results

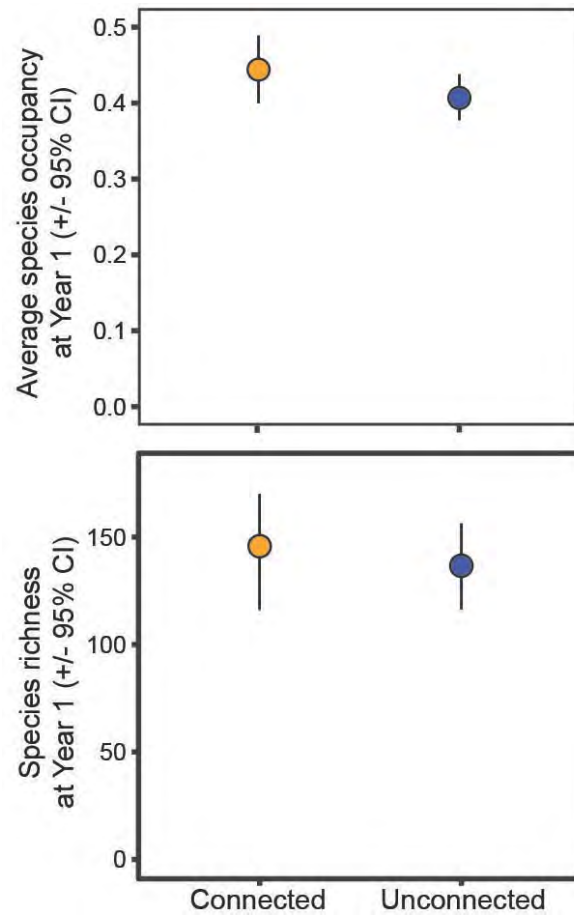
Plant species in may have arrived in fragments through three different pathways. First, seeds could have arrived in the area where we created our experimental fragments before our experiment was created and remained in the soil seed bank. In our study system, the soil seed bank is dominated by annual herbs and graminoids, a small subset of the total species in our study system, and whose composition did not differ by fragment type at the start of our study (27). Second, plants were present in the pine plantation understory before our experiment was created, and some regrew after forest harvest. Our assignment of treatments to fragments was randomized and we have previously confirmed that species richness and composition did not differ by fragment type at the start of our study (27) (Figure S1). Third, species may arrive from the regional species pool into one of the fragments within an experimental landscape. The increased colonization rates and decreased extinction rates in connected fragments suggests that

species are more likely to move to a connected fragment than unconnected fragments. Based on temporal changes in  $z_{k,i,t}$  from the colonization-extinction model that include all five fragments in each experimental landscape, we found species that first arrived in the center fragment of an experimental landscape (block) were more likely to next colonize a connected fragment than an unconnected fragment (Fig. S8). Our analysis of the order of colonization events showed that connected fragments were colonized sooner than unconnected fragments in 60% of the species (out of 120 species for which this situation occurred), but the distribution was highly skewed (Fig. S8), providing evidence of corridors facilitating colonization of species from center fragments. This evidence is bolstered by studies of individual species' movement in our experiment that overwhelmingly show increased rates of movement between connected fragments when compared to unconnected fragments (55).

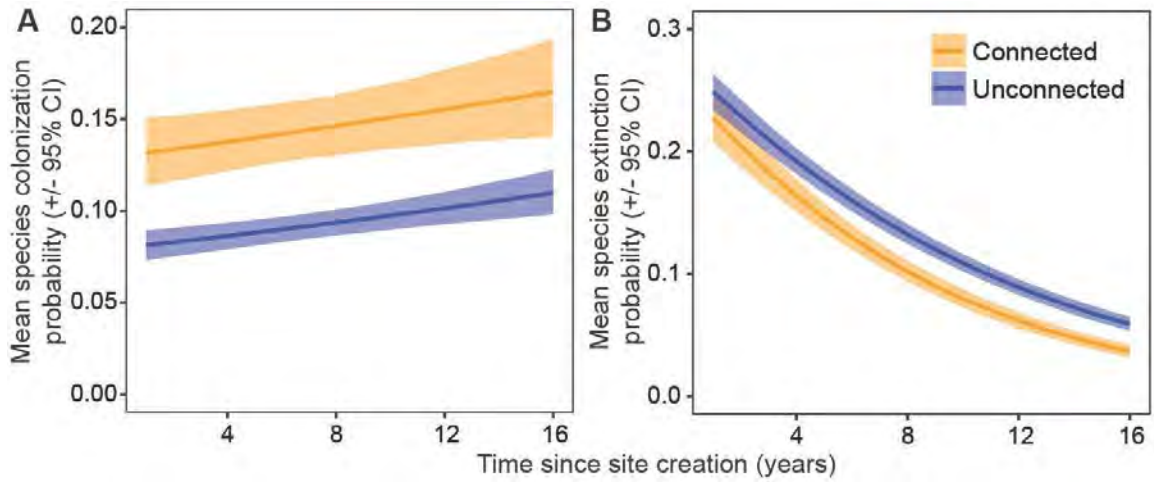
It is also possible that rescue effects – instances where immigration prevents extinction (5) – are responsible for the lower extinction rates in connected fragments. When we evaluated the potential for rescue effects for the entire community, the model parameterization that included rescue effects (Eq. 5) did not fit the data as well as when no rescue effects were assumed (based on DIC: assuming rescue effect, DIC = 194,151.7, assuming no rescue effect, DIC = 192,533.7). Thus, there was no strong support for rescue effects at the community level. When evaluating whether models that included rescue effects were important for individual species, there was support for rescue effects for 54% of the 239 species based on DIC (i.e., lower DIC for the rescue effects parameterization than assuming no rescue effects). This support did not explain variation in species responses to corridors (i.e., variation in DIC did not correlate with corridor effect sizes based on treatment parameters in Eq. 6-7;  $r < |0.07|$ ). Thus, we focused on the non-rescue effect model parameterization above for all general results in the main text. However, it is important to note that while rescue effects do not generally explain the community-level patterns we report, they can and do occur for some species.

Finally, once species arrive within fragments, connectivity may alter species interactions in ways that minimize species extinctions or promote colonization. For example, we have documented higher pollination rates in connected than unconnected fragments (56, 57), which may increase seed set and population size, thereby lowering the likelihood of extinction. Additionally, changes in seed predation caused by connectivity may create competition-free microsites that facilitate colonization (58). Corridors also increase the temperature at which prescribed fires burn, opening microsites for plant colonization and reducing dominance by woody species, which can increase persistence of subordinate herbs (59). Populations may also benefit from corridors by increasing gene flow and reducing impacts of inbreeding depression (60). Gene flow takes place through seed dispersal and pollination, both of which are facilitated by corridors in our study system (56, 57, 61).

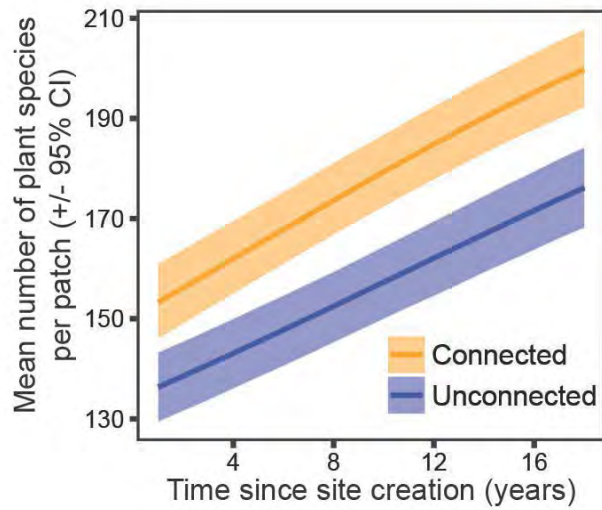




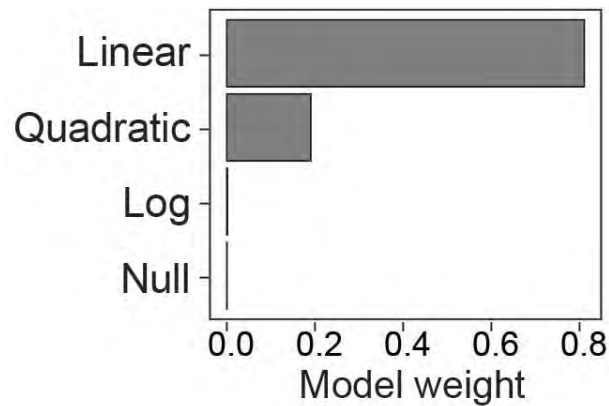
**Fig. S1. Starting conditions did not vary by treatment.** Initial probability of **(A)** species occurrence and **(B)** species richness did not differ by fragment type.



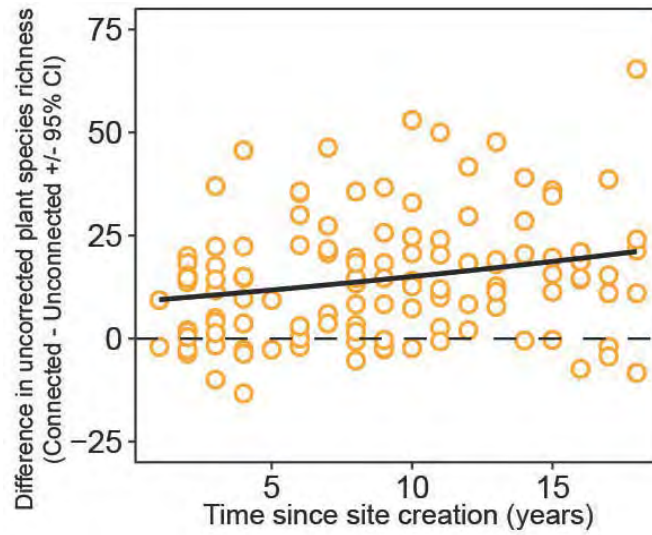
**Fig. S2. (A) Colonization and (B) extinction rates over time for connected and unconnected fragments.** The difference in these rates were used to produce Fig. 2A.



**Fig. S3. Estimated species richness over time in connected and unconnected fragments.** In the last time point (Year 18), on average there are 24 more species in connected than unconnected fragments (200 vs 176 species, respectively). The difference in these rates were used to produce Fig. 2B.

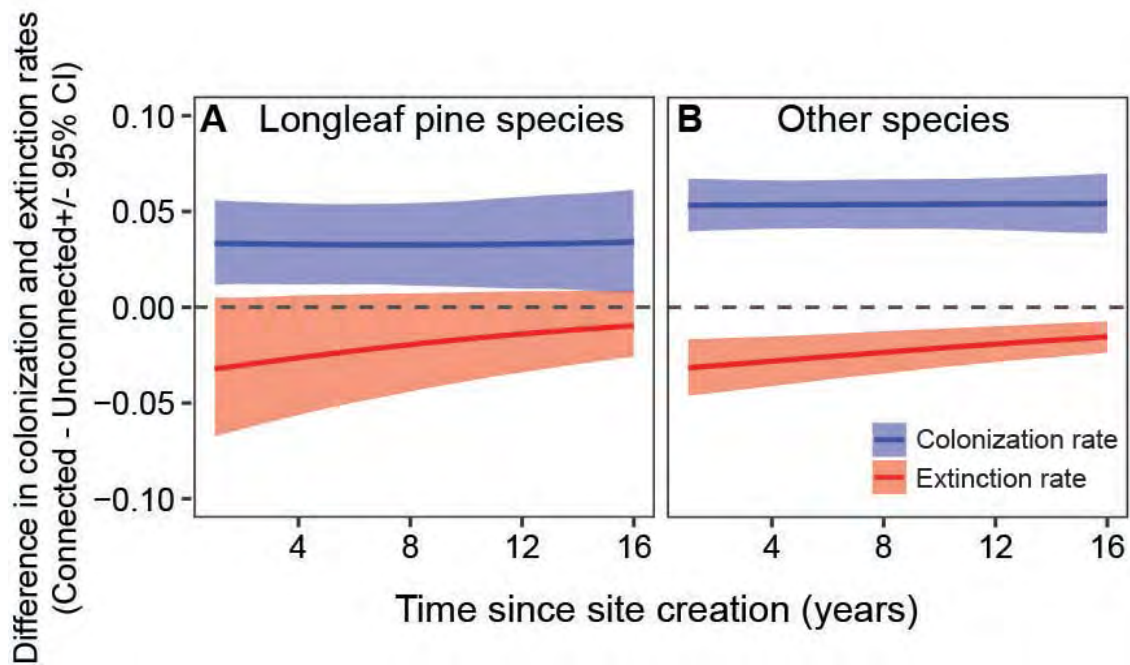


**Fig. S4. A linear model is the best fit for the difference in species richness between connected and unconnected fragments over time.** Model weights represent AIC model weights taken from negative binomial regressions that included the main and interactive effects of treatment and time since site creation (treated as either a linear, log-linear, or quadratic effect of time, in contrast to no effect of time represented as ‘Null’). Higher model weight signifies greater support for a model relative to the other models considered, with a value of 1 indicating full support. Consequently, these weights suggest overwhelming support of a linear effect of treatments over time relative to potential non-linear (log time, quadratic time) effects of time.

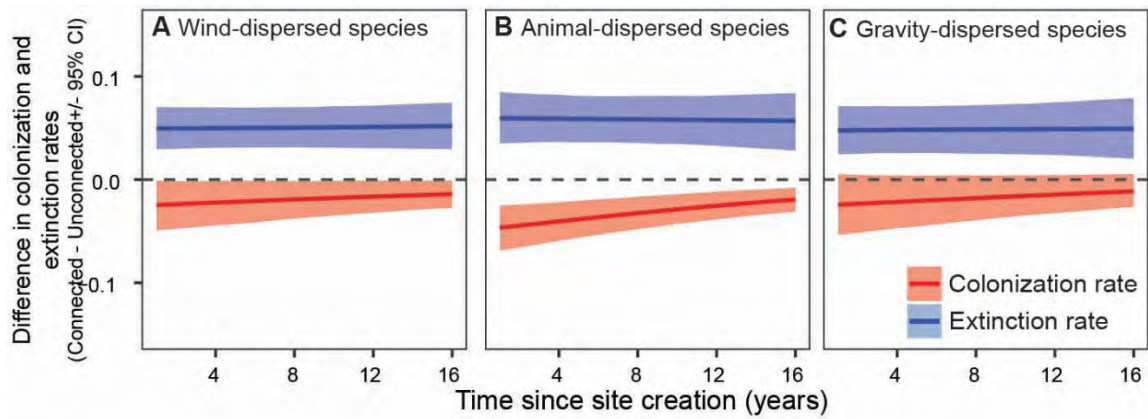


**Fig. S5. The linear increase over time is evident in the difference in uncorrected, raw plant species richness over time between connected and unconnected fragments. Predicted line comes from the linear model (Fig. S4).**

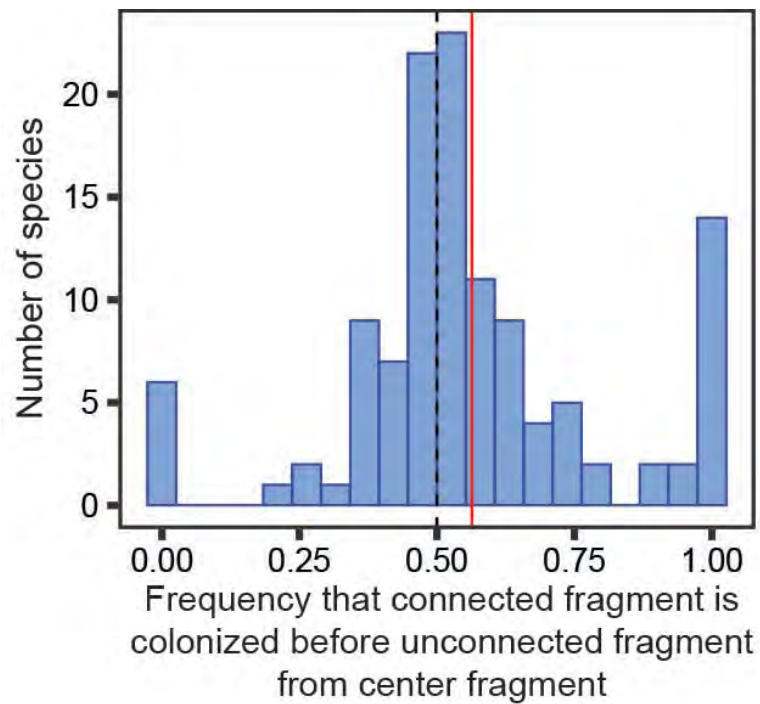




**Fig. S6. Plant species (A) associated with longleaf pine habitat and (B) other species respond similarly to connectivity over time**, although uncertainty is greater for species associated with longleaf pine habitat due to a smaller number of species. The difference between connected and unconnected fragments for colonization and extinction probabilities is shown for both groups.



**Fig. S7. Plant species respond similarly to connectivity over time across seed dispersal modes.** The difference between connected and unconnected fragments for colonization and extinction probabilities of (A) wind-dispersed, (B) animal-dispersed, and (C) gravity-dispersed plant species over time.



**Fig. S8. Colonization events from the center fragment reach connected fragments sooner than unconnected fragments.** When species arrived for the first time in an experimental block in the center fragment, connected fragments were colonized sooner than unconnected fragments for 60% of the species (out of 120 species for which this situation occurred; mean frequency = 0.56). The distribution was highly skewed providing some evidence of corridors facilitating colonization of species from center fragments.

**Table S1. Summary of parameter estimates (on the logit scale) from multi-species occupancy model used to derive species richness over time.** We show average estimates across species because this model estimates a parameter for each species ( $K = 309$ ) regarding species detectability, treatment intercepts and rates of change over time. Estimates are provided for connected, unconnected rectangular, and unconnected winged fragments. LCL and UCL are lower and upper confidence limits, respectively.

Parameter	Estimate	95% LCL	95% UCL
Species mean detectability	-2.123	-2.466	-1.773
Species mean occupancy			
Connected intercept	0.447	0.294	0.607
Rectangular intercept	-0.220	-0.379	-0.065
Winged intercept	0.251	0.098	0.407
Connected time effect	0.672	0.574	0.768
Rectangular time effect	0.491	0.404	0.578
Winged time effect	0.553	0.467	0.672

**Supplementary Code.** The code used to estimate occupancy, species richness, and colonization-extinction dynamics over time is provided as a separate supplementary file.



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# A Rapid, Strong, and Convergent Genetic Response to Urban Habitat Fragmentation in Four Divergent and Widespread Vertebrates

Kathleen Semple Delaney<sup>1\*</sup>‡, Seth P. D. Riley<sup>2</sup>, Robert N. Fisher<sup>3</sup>

**1** Department of Ecology and Evolutionary Biology, University of California Los Angeles, Los Angeles, California, United States of America, **2** Santa Monica Mountains National Recreation Area, National Park Service, Thousand Oaks, California, United States of America, **3** San Diego Field Station, U.S. Geological Survey, San Diego, California, United States of America

## Abstract

**Background:** Urbanization is a major cause of habitat fragmentation worldwide. Ecological and conservation theory predicts many potential impacts of habitat fragmentation on natural populations, including genetic impacts. Habitat fragmentation by urbanization causes populations of animals and plants to be isolated in patches of suitable habitat that are surrounded by non-native vegetation or severely altered vegetation, asphalt, concrete, and human structures. This can lead to genetic divergence between patches and in turn to decreased genetic diversity within patches through genetic drift and inbreeding.

**Methodology/Principal Findings:** We examined population genetic patterns using microsatellites in four common vertebrate species, three lizards and one bird, in highly fragmented urban southern California. Despite significant phylogenetic, ecological, and mobility differences between these species, all four showed similar and significant reductions in gene flow over relatively short geographic and temporal scales. For all four species, the greatest genetic divergence was found where development was oldest and most intensive. All four animals also showed significant reduction in gene flow associated with intervening roads and freeways, the degree of patch isolation, and the time since isolation.

**Conclusions/Significance:** Despite wide acceptance of the idea in principle, evidence of significant population genetic changes associated with fragmentation at small spatial and temporal scales has been rare, even in smaller terrestrial vertebrates, and especially for birds. Given the striking pattern of similar and rapid effects across four common and widespread species, including a volant bird, intense urbanization may represent the most severe form of fragmentation, with minimal effective movement through the urban matrix.

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\* E-mail: Katy\_Delaney@nps.gov

‡ Current address: Santa Monica Mountains National Recreation Area, National Park Service, Thousand Oaks, California, United States of America

## Introduction

Habitat loss and the resulting fragmentation can have many impacts on wildlife populations. However, the effects of fragmentation may vary based on many factors including the size, configuration, and age of habitat patches, the vagility of the species in question, and the characteristics of the matrix between patches. Urban development may represent a particularly intense form of fragmentation for many animals. Species that are particularly sensitive to urban development may be quickly lost from urban areas [1,2,3]. For species that remain widely distributed across fragmented landscapes, connectivity and gene flow between populations may be reduced, leading to longer-term problems such as inbreeding, loss of genetic diversity, and even local extinction [4,5,6,7]. If local extinction occurs, then more isolated

patches will be harder to re-colonize [4]. In addition, the loss of genetic diversity within isolated patches can lead to a decrease in a species' ability to adapt to environmental change [8,9].

An increasing number of studies of the genetic effects of fragmentation have occurred in the past decade or so, although 30–40% of these have not shown significant effects and many are in non-urban landscapes such as fragmented forests [10]. Urbanization is a common cause of fragmentation, and conservation efforts point to the extreme land use changes associated with urbanization as one of the largest threats to biodiversity [11]. However, to date, fine-scale (within 5–10 km) genetic effects of urban fragmentation have been documented for few species [12,13,14,15,16,17], and many studies find little effect [18,19,20]. Moreover, studies of the genetic effects of fragmentation are overwhelmingly on a single species, and we know of no studies

where genetic patterns were compared in the same urban landscape for species from different broad taxa, such as reptiles (Class *Reptilia*) and birds (Class *Aves*), and with radically different means of locomotion, such as flying and crawling.

We investigated the genetic effects of urban fragmentation on three lizards, the side-blotched lizard (*Uta stansburiana*), western skink (*Plestiodon skiltonianus*) and western fence lizard (*Sceloporus occidentalis*), and one bird, the wrenit (*Chamaea fasciata*) in Santa Monica Mountains National Recreation Area (SMMNRA), a national park near Los Angeles. The three lizard species have widespread distributions in California [21], are small in size, are still relatively common and widespread in natural habitat throughout the area [22], and have low dispersal capabilities [23,24,25,26,27]. Side-blotched lizards and fence lizards are both in the family *Iguanidae*, but side-blotched lizards are considerably smaller and prefer more open habitat. Western skinks are in a distantly-related different family (*Scincidae*) and locally prefer grassland habitat, although all three species are broadly sympatric in the region.

Wrenits are small birds (approximately 15 g) with a distribution that is limited to the west coast of North America and follows the scrub and chaparral habitat that they prefer [28]. Wrenits are monogamous, hold small (1–2.5 acres), year-round multi-purpose territories [28], and have short dispersal distances [29]. Wrenits are obviously very different phylogenetically and ecologically from the lizards and also have the ability to fly, which could potentially increase their movement across the landscape. A bird isolated in a habitat fragment could presumably simply fly over urban areas to disperse to other suitable habitats, thereby preventing genetic divergence between patches. However, because wrenits have short dispersal distances, small territories, and relatively specific habitat requirements, it is possible that wrenits could be affected by habitat fragmentation.

The landscape of southern California continues to be rapidly altered by urbanization and the resulting habitat loss and fragmentation, even though it is part of the California Floristic Province and is one of Conservation International's world biodiversity hotspots ([30,31], [www.biodiversityhotspots.org](http://www.biodiversityhotspots.org)). Because it is in the Los Angeles area, SMMNRA is under intense development pressure and urbanization might increase to as much as 47% of the area by 2050, whereas only 11% was urbanized in 2000 [32]. Given the low vagility of these four focal species, it is possible that movement out of suitable habitat across a highly urbanized landscape is rare. This isolation could increase the genetic divergence between populations living in fragments and also decrease genetic variability within fragments. If urbanization is not an impenetrable barrier to movement, migration between patches by individuals could mitigate negative genetic effects [4,33,34]. Understanding plant and animal responses to habitat destruction and fragmentation will be important for maintenance of this important biodiversity hotspot, especially in the face of unknown consequences of global climate change.

## Results

We attempted to genotype approximately 20 individuals from each species for each sample site (Fig. 1a, Table 1), although for some locations fewer than 20 were captured. Microsatellite loci in lizards did not significantly deviate from HWE, however three loci in wrenits did (Ase48, Ase64, Ase50). We didn't find an excess of homozygotes, which could indicate the presence of null alleles, at any of the three loci; so analyses were done using all loci. All microsatellite loci were in linkage equilibrium for all 4 species,

except that in western skinks 2 pairs of loci were significantly linked ( $p = 0.05$ ; Eufa1 × Elo34, Elo34 × Eufa27).

## Genetic Divergence

Pairwise  $F_{ST}$  values indicated many significant genetic differences between patches for all four species (84% of comparisons were significant for side-blotched lizards, 89% for fence lizards, 87% for skinks, and 71% for wrenits; Table S1). Average pairwise  $F_{ST}$  between patches was highest in the wrenit at 0.095 (range 0.012–0.299). Among lizards, the level of differentiation was highest for side-blotched lizards, with an average pairwise  $F_{ST}$  of 0.073 (range  $-0.006$ –0.200), and very similar for western skinks (mean  $F_{ST} = 0.040$ , range 0.003–0.104) and western fence lizards (mean  $F_{ST} = 0.040$ , range 0.003–0.095). As a baseline comparison from continuous habitat, when we computed genetic distances between the sampling arrays within large and core patches and between several other sites outside of our urban study area (but within the park, see Methods), we found lower average  $F_{ST}$  for all three lizard species (side-blotched lizards, 0.02; western fence lizard, 0.016; western skinks, 0.013), and fewer significant pairwise  $F_{ST}$  (side-blotched lizards, 12.5%; western fence lizards, 16.7%; western skinks, 30%; Table S2). For wrenits, genetic samples were also collected from two coastal canyons outside of our study area, and the  $F_{ST}$  between these two sites was non-significant ( $F_{ST} = 0.026$ ). Significant genetic distances between patches could also be caused by isolation by geographic distance. We found no significant correlations between genetic distance ( $F_{ST}$ ) and geographic distance in any of the four species, suggesting no pattern of isolation by distance (Table 2). However, partial Mantel tests showed that genetic distances for all four species were significantly correlated with highway presence, roads presence, and time since isolation (patch age) when geographic distance was held constant (Table 2).

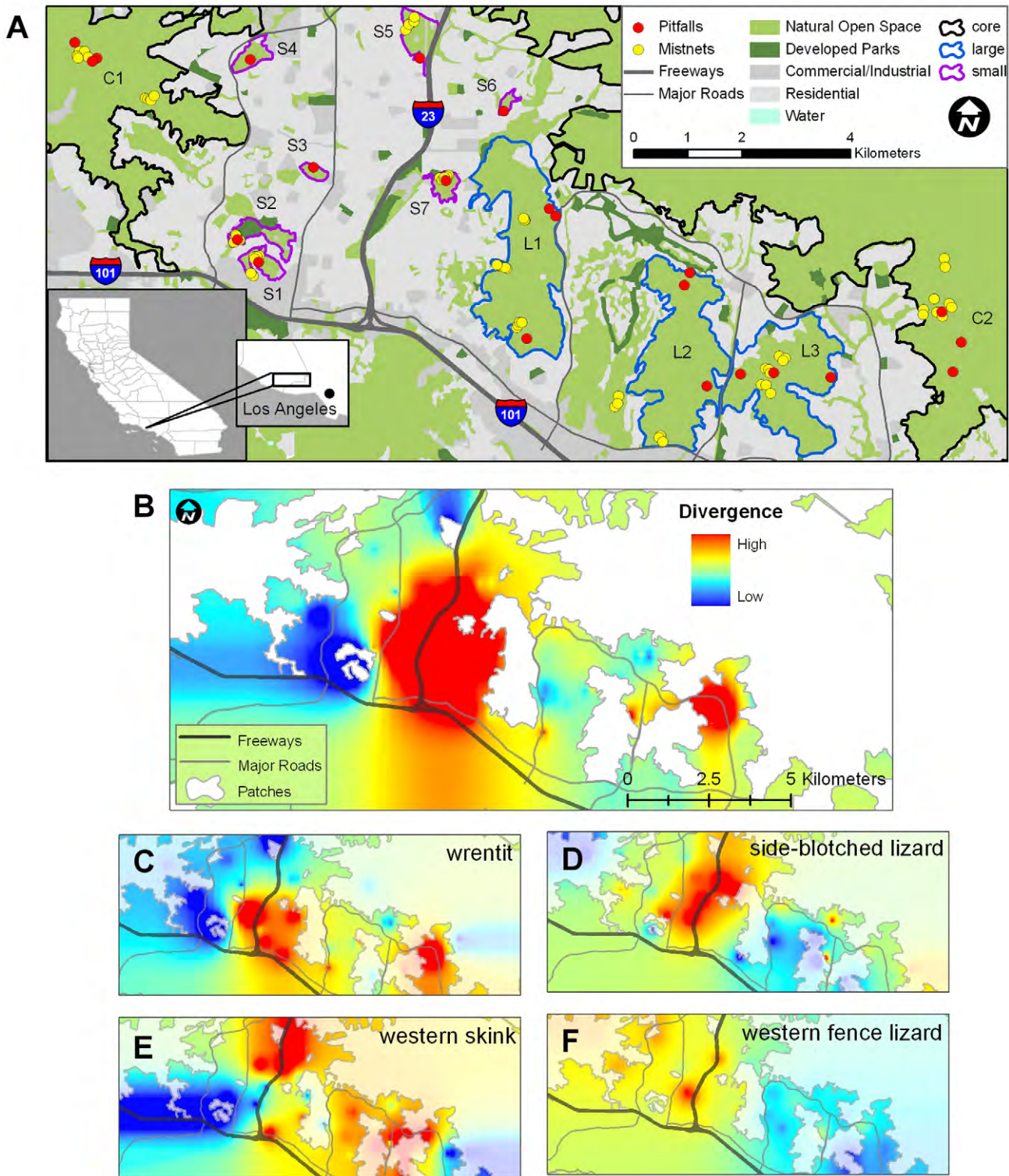
Alleles in Space allows for visualization of genetic divergence over geographic space. We found that the largest area of genetic divergence for all four species was located in the area surrounding and including Highway 23 (Fig. 1b). There was also an area of higher divergence in the eastern part of the study area for two of the four species (wrenits, Fig. 1c; and western skinks, Fig. 1e).

Genetic clustering analysis revealed that the most likely number of genetic groups for all four species was between three and five (Table S3, Fig. 2). For wrenits (Fig. 2a) there were three most likely clusters, with the main genetic break again located across the developed areas surrounding and including Highway 23. For side-blotched lizards (Fig. 2b) and skinks (Fig. 2d) the most likely number of clusters was five, and for western fence lizards (Fig. 2c) it was four.

## Genetic Diversity

Mean heterozygosity ( $H_e$ ) and the mean number of effective alleles ( $N_A$ ) were not significantly lower in smaller patches for any of the four species (Table S4). However, relatedness was higher in small patches for all three lizard species (side-blotched lizard difference = 0.03,  $t = 4.1$ ,  $p = 0.003$ , d.f. = 6; fence lizard difference = 0.02,  $t = 4.5$ ,  $p = 0.001$ , d.f. = 7; skink difference = 0.02,  $t = 2.25$ ,  $p = 0.03$ , d.f. = 6). Rarefaction analysis indicated that the number of loci used produced consistent average relatedness results for all species and that the addition of the last locus added a 0.5% (fence lizards), 0.8% (side-blotched lizards), 1.4% (western skinks), and 0.1% (wrenits) change in relatedness estimates.

We tested the relationship between genetic diversity and the degree of isolation of each habitat patch and found that for wrenits,  $H_e$  was lower in more isolated patches ( $R^2 = 0.498$ ,  $p = 0.051$ ,



**Figure 1. Study area and genetic divergence.** A. Sampling sites (mist-net and pitfall locations), roads, and habitat patches (S = small, L = large, C = core) within the study area (Sample sizes are shown in Table 1). B. Mean genetic divergence mapped on the Simi Hills landscape for all four species, and separately for C. wrenitis, D. side-blotched lizards, E. western skinks, and F. western fence lizards.  
doi:10.1371/journal.pone.0012767.g001

d.f. = 7), as was  $N_A$  ( $R^2 = 0.55$ ,  $p = 0.035$ , d.f. = 7; Fig. 3a). Relatedness was higher in more isolated patches for all three lizard species (side-blotched lizard  $R^2 = 0.4$ ,  $p = 0.03$ , d.f. = 10; fence

lizards  $R^2 = 0.52$ ,  $p = 0.002$ , d.f. = 8; western skink  $R^2 = 0.33$ ,  $p = 0.05$ , d.f. = 9; Fig. 3b). There were no correlations between genetic diversity and patch age for any of the four species (Table S5).

**Table 1.** Patch metrics (area, isolation, and age) and the number of samples genotyped by species.

Patch metrics					Number of samples genotyped			
Patch type	Sample site/patch	Area (ha)	Isolation (PROX) <sup>a</sup>	Age (years) <sup>b</sup>	Wrentit	Side-blotched lizard	Western fence lizard	Western skink
Small	S1	267.2	119.3	13	0	14	14	16
	S2	376.6	115.4	13	3	15	18	17
	S3	104.8	52.8	33	0	18	0	18
	S4	254.8	6404.8	23	0	17	0	0
	S5	450.2	195.9	33	5	14	18	5
	S6	78.2	747.4	13	0	17	0	20
	S7	206.5	133.1	43	8	15	16	10
Large	L1	4445.4	18428.1	28	7	0	18	28
	L2	3905.7	1598.1	23	8	22	17	29
	L3	3276.1	30121.0	18	12	18	17	18
Core	C1	25453.6	6368.9	23	11	7	15	0
	C2	121014.2	10718.8	13	15	24	14	18

<sup>a</sup>Patch isolation values (PROX) decrease with increasing isolation of patches.

<sup>b</sup>Patch age was calculated as the number of years since the patch was 100% isolated from other open natural space.

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## Discussion

### Loss of genetic connectivity

Using three different methods, traditional pair-wise genetic distance analysis ( $F_{ST}$ ; Table S1), landscape genetic analysis (Fig. 1b), and Bayesian genetic clustering (Fig. 2), we found significant genetic differences between sample locations in all four species. Moreover, the three methods showed strikingly similar and strong genetic effects of fragmentation. All four species exhibited the largest genetic divergence over the oldest (based on building dates, see Methods) and widest expanse of urban areas surrounding and including Highway 23 (Fig. 1b).

Pairwise  $F_{ST}$  between habitat patches showed that the genetic divergence was significant, especially given the short amount of time that the habitat fragments have been isolated from each other and from core areas. For all four species, average  $F_{ST}$  values within continuous habitat were 2.5 to 3.6 times lower than in fragmented habitat, and the majority of comparisons were non-significant (Table S2). This suggests that microsatellite allele frequencies within and between habitat patches are changing on a very short time scale. Several other reptile and amphibian studies have found similar genetic divergences on similar time scales. For example,

genetic divergence between fragmented populations of two gecko species in Australia was higher than divergence between samples in un-fragmented landscapes [35]. In that study, forested habitat patches were fragmented beginning around 1900 by wheat fields, which can be dry and barren during the non-growing season. In our study, however, the intervening landscape is concrete, asphalt, buildings, or urban yard landscaping, and although fragmentation began in the 1940s, many patches were only 50–75% isolated until 1980, making the isolation more recent. The long-lived tuatara (*Sphenodon punctatus*) was shown to have small yet significant genetic structuring (overall  $R_{ST} = 0.012$ ) over less than 500 meters on a recently fragmented island [18]. Overall divergence was driven by one remnant forest fragment which was most isolated by island topography. Therefore, it was unclear that human activity, in this case pasture cleared for livestock grazing, was the cause of the genetic divergence. The eastern red-backed salamander (*Plethodon cinereus*), an even smaller and less mobile animal than the lizards we investigated, had pairwise  $F_{ST}$  between patches similar in value to the lizards in our study [14]. In that study, habitat fragmentation was also caused by 20<sup>th</sup> Century urbanization.

For birds, few studies have shown large pairwise  $F_{ST}$  between patches on such a small scale. For example, a study of the

**Table 2.** Mantel and partial Mantel tests with genetic distance and landscape features.

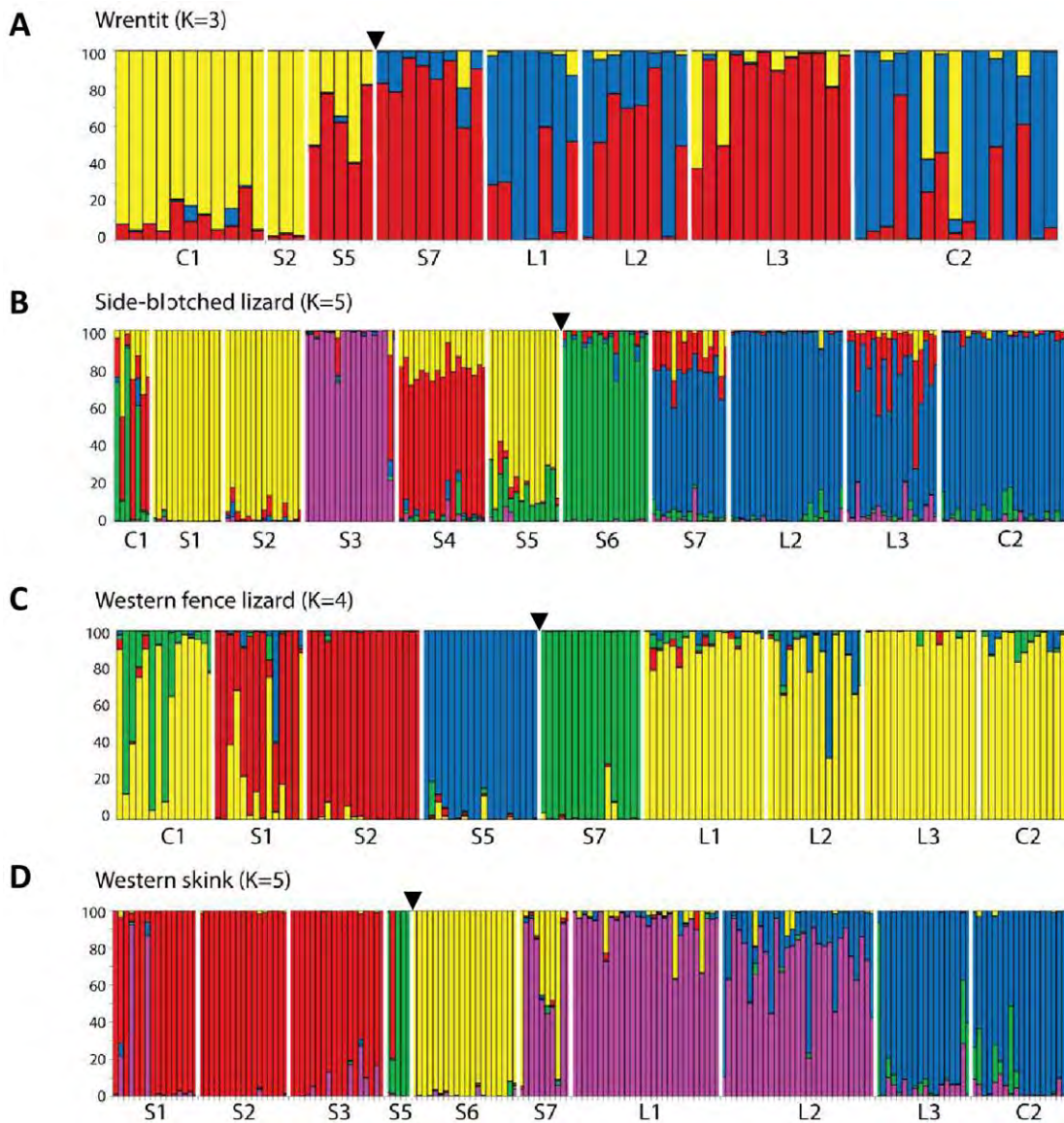
Mantel Tests	Wrentit		Side-blotched lizard		Western skink		Western fence lizard	
	r	p	r	p	r	p	r	p
$F_{ST}$ and GD <sup>a</sup>	−0.015	0.500	−0.011	0.509	0.178	0.162	0.042	0.408
Partial test, HWY <sup>b</sup>	0.430	0.001	0.259	0.027	0.442	0.007	0.255	0.049
Partial test, RDS <sup>b</sup>	0.425	0.031	0.314	0.015	0.495	0.012	0.399	0.016
Partial test, AGE <sup>b</sup>	0.458	0.009	0.393	0.033	0.466	0.045	0.760	0.002

<sup>a</sup>Mantel test correlations between genetic distance ( $F_{ST}$ ) and geographic distance (GD).

<sup>b</sup>Partial Mantel tests for partial correlations between the presence of Highway 23 only (HWY), the presence of major roads including Highway 23 (RDS), and the age of isolation between patches (patch age; AGE) while controlling for geographic distance.

doi:10.1371/journal.pone.0012767.t002





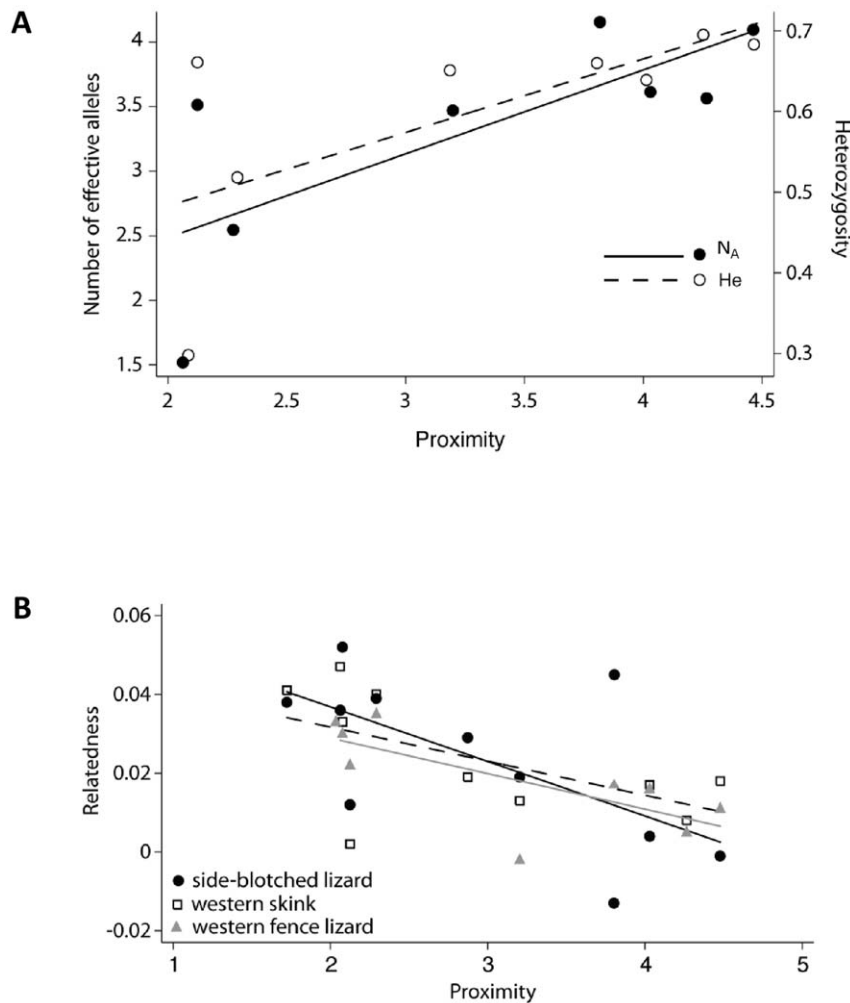
**Figure 2. Genetic clustering analysis reveals the most likely K.** Each column represents one individual and colors correspond to the percentage of assignment to each cluster. Patch names (Fig. 1a) are on the X-axis organized from west (left) to east (right). A black triangle indicates the location of the 23 freeway.  
doi:10.1371/journal.pone.0012767.g002

capercaillie (*Tetrao urogallus*) in the Black Forest in Germany showed significant pairwise  $F_{ST}$  between sites, ranging from 0.007 to 0.036 [36]. In their study area, which was approximately 10 times the size of ours, suitable forest habitat was fragmented by other forest types and grassland, as opposed to by residential and commercial development. A study [37] of white-ruffed manikins (*Corapipo altera*) showed similar results to the capercaillie. There was some genetic structuring shown between remnant forest fragments, however all significant pairwise  $F_{ST}$  could be attributed to one forest fragment. In addition, pairwise  $F_{ST}$  between forest fragments ranged from 0.001 to 0.029 for manikins, whereas in our study the pairwise  $F_{ST}$  were approximately 10 times higher. Finally, a study of great tits (*Parus major*) in forest parks within the city of Barcelona found many significant pairwise  $F_{ST}$  between parks (average 0.067), but the parks actually had higher genetic diversity than the surrounding forest, and there was significant gene flow both between parks and from the parks to the forest [38]. Overall, there are few comparable studies of

avian fine-scale genetic structure, particularly in urban landscapes, but wren tits in southern California appear to have the highest amount of genetic structure documented to date.

The Bayesian clustering analysis confirmed the loss of genetic connectivity for each species in our study area. Similar analyses in other bird studies have consistently shown that one genetic cluster is most likely [36,37,39,40], with only the great tit study finding two clusters [38]. For the lizards, in many of the small patches most or all individuals were given close to 100% assignment to that patch (e.g. S3 for side-blotched lizards, S5 and S7 for fence lizards, and S6 for skinks; Figure 2), which suggests a remarkable amount of genetic isolation within patches over relatively short geographic and temporal scales (Table S6). The short dispersal distances for all four species suggest that gene flow even within the natural landscape may be limited (for lizards, we did find a few significant  $F_{ST}$  values between sampling sites within continuous habitat), and therefore may be extremely restricted in a fragmented landscape.





**Figure 3. Relationship between genetic diversity (heterozygosity, number of effective alleles, and relatedness) and patch proximity<sup>a</sup> (log transformed).** A. wren tits ( $H_e$ :  $R^2 = 0.698$ ,  $p = 0.051$ ,  $d.f. = 7$ ;  $N_A$ :  $R^2 = 0.55$ ,  $p = 0.035$ ,  $d.f. = 7$ ) and B. three lizard species ( $R_{LR}$ : side-blotched lizard  $R^2 = 0.4$ ,  $p = 0.03$ ,  $d.f. = 10$ ; western skink  $R^2 = 0.33$ ,  $p = 0.05$ ,  $d.f. = 9$ ; western fence lizard  $R^2 = 0.52$ ,  $p = 0.002$ ,  $d.f. = 8$ ). <sup>a</sup> Patch proximity is the inverse of patch isolation. doi:10.1371/journal.pone.0012767.g003

In one of the few other studies using Bayesian genetic clustering analysis, red-backed salamanders (*Plethodon cinereus*) were found to have two genetic clusters on either side of a large highway running through the urbanized study area [41]. Our genetic clustering results suggest that the intense fragmentation from urbanization may be a particularly strong barrier to animal movement and gene flow for all four species.

Along with significant divergence between patches, we also found significant correlations between specific causes (roads) and measures (patch age) of fragmentation and genetic divergence in all four species (Table 2). Further, our landscape genetic results revealed that the areas surrounding and including Highway 23 in the city of Thousand Oaks, which are the oldest and most densely urbanized, consistently had the highest peaks of differentiation, again for all four species (Fig. 1b). The concordance of these results for all four species is remarkable given their differences in mobility, ecology, and taxonomy. A second area of high genetic divergence in the eastern portion of our study area, also characterized by a major road surrounded by a wide swath of residential development, was shared by two species, wren tits and skinks. Other species have also shown fine-scale genetic changes related to roads

and fragmentation in this region. Coyotes and bobcats exhibited significant genetic differentiation across Highway 101, the largest highway in the study area [42]. It is unknown if the species in our study would cross such a large barrier, but with short dispersal distances and small home range sizes, those events would likely be rare. Similarly, in smaller and less mobile species, a loss of genetic connectivity and diversity was found in two Jerusalem crickets (*Stenopelmatus 'santa monica'* and *Stenopelmatus 'mahogani'*) across the same region [16,43]. Genetic divergence in Jerusalem crickets was significantly associated with urban development and the presence of highways within the Simi Hills.

The significant genetic divergence and loss of genetic diversity over short geographic and temporal scales in these four vertebrates suggest that the urban matrix is relatively impenetrable for these animals. Anecdotal observations suggest that *S. occidentalis*, but not *P. skiltonianus* or *U. stansburiana*, will move through or persist in the residential areas of the urban matrix (RNF personal observation). However, reliable data on the urban movement and habitat use of these species does not exist. In fact, knowledge about use of the urban matrix by native animal species is extremely limited in general, but would be very valuable for understanding the

conservation and management implications of urbanization. Urbanized areas may be dangerous places for these small vertebrates. Residential neighborhoods often introduce predators such as domestic cats, which may regularly prey on native vertebrates [44]. Of course residential areas also include roads, which lizards and birds may actively avoid, or which may be a significant source of mortality [45,46,47].

### Loss of genetic diversity

When the landscape is fragmented and gene flow is restricted, as we have shown for these four species, genetic diversity may be reduced in populations within smaller or more isolated habitat patches. Although we found no relationships between patch age and genetic diversity, we found significant relationships between genetic diversity measures and patch size or isolation for all four species. All three lizards had increased relatedness in smaller patches and with increasing patch isolation (Fig. 3b). Other reptile species have shown increased relatedness within habitat patches that were fragmented by agriculture [48,49,50]. In wren-tits, although we did not find increased within-patch relatedness, we found lowered heterozygosity ( $H_c$ ) and fewer alleles ( $N_A$ ) in smaller patches (Fig. 3a). Decreased gene flow can result in decreased  $H_c$  and  $N_A$  in small patches as alleles are lost over the generations. This effect tends to be gradual and may not threaten populations in the short term, however, inbreeding within habitat patches tends to happen quickly and can lead to inbreeding depression [51]. Lizard relatedness values suggest that inbreeding is occurring within smaller and more isolated patches. The difference between taxa may be attributed to the increased effective isolation of lizards on suitable habitat patches as a result of more restricted dispersal ability compared to wren-tits. Our results suggest that populations within smaller and more isolated patches may have an increased risk of harmful genetic effects and, over the long-term, even extirpation. In fact, the absence of individuals from certain study patches (e.g. skinks and fence lizards absent from S4; Table 1) suggests that populations that were presumably present at the time of patch isolation may have been extirpated.

In a relatively short time, we have documented significant genetic divergence between isolated patches and decreased genetic diversity in all four species. However, although time since isolation (patch age) was strongly correlated with genetic divergence between patches, the effects on genetic diversity in these animals were significantly related to patch size and degree of patch isolation, but not to patch age. This would suggest that the habitat is still relatively suitable in habitat fragments, resulting in relatively stable populations that are not going through bottlenecks, such that more time since isolation is not as important a factor. But patches that are smaller from the outset simply cannot support as large a population, and therefore are more subject to the deleterious effects of genetic drift, specifically the loss of genetic diversity. Patches that are more isolated may in turn be less likely to receive new dispersers, i.e. they would benefit less from the “rescue effect” that could offset reductions in genetic diversity [52]. Presumably patches that were both small and isolated would suffer the most ill effects.

### Conservation implications

The extreme urbanization within the Simi Hills area has had a significant effect on lizard and bird population genetics. Unlike some other studies of landscape level genetic changes where a species’ habitat is naturally patchy, this study examined genetic responses to species living in habitat that was likely once relatively continuous [42]. While these species are still widely distributed and relatively abundant throughout the study area, genetic effects of

fragmentation have been manifested in a relatively short period of 40 years or less. This may be the most profound and potentially disturbing result of our study: the vulnerability even of species that are perceived to be common and thereby likely less affected by habitat fragmentation. This may be particularly true for low-vagility organisms, and for those with more specific habitat requirements. As a chaparral and coastal sage scrub requiring species, wren-tits are likely rare in developed areas and have been shown to go extinct in habitat patches as urbanization progresses [2,53,54].

For rarer species in the region, such as horned lizards (*Phrynosoma coronatum*) and whiptail lizards (*Aspidoscelis tigris*), whose distributions have already been reduced by urban development [55], the genetic effects of fragmentation may be even more profound. Many endangered species in southern California are declining because of habitat loss, and many of these species also have low dispersal abilities along with more specific habitat requirements (e.g. light-footed clapper rail, *Rallus longirostris obsoletus*; Belding’s savannah sparrow, *Passerculus sandwichensis beldingi*; red-legged frog, *Rana draytonii*; least bell’s vireo, *Vireo bellii pusillus*). It is also unknown how stressors, such as increasing local or global temperature and urbanization, might affect species in southern California. A recent study of *Sceloporus* lizards in Mexico found that 12% of local populations have gone extinct since 1975 [56]. Sites where these common lizards were extirpated were too hot for too many hours of the day, presumably due to increasing global temperatures, which caused lizards to seek refuge from the heat instead of spending time foraging. In addition, our results have implications for endangered species such as the California gnatcatcher, where lack of differentiation at certain loci (e.g. mtDNA; [57]) may not reflect important genetic differentiation detectable with other markers such as microsatellites.

## Materials and Methods

### Study Area

Southern California is characterized by a Mediterranean climate with cool, wet winters and hot, dry summers. Vegetation consisted of coastal sage scrub, chaparral, riparian habitat, and oak woodlands. Our study site is within SMMNRA, the USA’s largest urban national park (154,095 acres or 623.6 km<sup>2</sup>; www.nps.gov/samo/parkmgmt/statistics.htm), which is located in Los Angeles and Ventura counties, California, USA (Fig. 1a). Approximately half of the land within the park boundary is privately owned, although some public acquisitions continue. Habitat patches within our study area were within 12.5 kilometers (km) of each other but were separated by roads of all sizes, housing, and commercial development (Fig. 1a). Most building started in the middle of the 20<sup>th</sup> Century, and none of the habitat patches have been completely isolated for longer than 43 years (Table 1; [58]). Two major freeways (101 and 23) and many busy four-lane roads run through the study area (Fig. 1a). The peak average daily traffic in this area is approximately 180,000 cars per day for the 101 Freeway and 90,000 cars per day for Highway 23 (Caltrans, www.ca.dot.gov). Both freeways are mostly surrounded by commercial and residential development. Within the study area there are large core areas of relatively undisturbed habitat, although some low-impact human recreation does occur. Within the urban mosaic, habitat patches were surrounded by high- or low-density housing, highways and other roads, golf courses and other landscaped areas.

We collected samples from habitat fragments which we characterized as “small” (75–450 ha) or “large” (3200–4400 ha) and from larger areas of continuous habitat which we called

“core” areas (Fig. 1a). There were 7 small patches (S1-S7), 3 large patches (L1-L3) and 2 core areas (C1 and C2). Patch area ( $m^2$ ) and degree of isolation (PROX) were calculated using FRAGSTATS [59]. PROX is the sum of patch area divided by the nearest edge-to-edge distance squared between all of the patches within a defined search radius and the focal patch. PROX approaches 0 if the patch has no neighbors within the search radius (a 20 km radius encompassed our entire study site) specified in FRAGSTATS, therefore patches with smaller PROX numbers are more isolated. Building dates for roads, housing developments, and commercial areas were used to calculate the ages (in years) at which patches were 100% isolated up to the time of trapping for this study (patch age; Table 1). Patches were considered 100% isolated when they were completely surrounded on all edges by either commercial buildings, housing, or roads or a combination of these. We also made a matrix of patch ages (for pair wise comparisons) by calculating the number of years that each patch was separated from each other patch.

### Field sampling

To capture lizards we used arrays of pitfall traps and drift fencing. All samples for this study were collected between October 2000 and September 2005. Each array had seven 19-liter buckets buried in the ground with the lip of the bucket flush with the ground to act as a pitfall trap [55,60]. Buckets were arranged in a “Y” configuration and buried approximately 7.5 m apart. Between the buckets, short drift fencing (0.5 m tall) consisting of erosion cloth acted to intercept reptiles moving through the habitat and directed them towards the buckets. Shade and moisture were provided for each bucket to maximize the chance of survival for reptiles, amphibians, or small mammals that were trapped. Pitfall traps were checked daily for a week at one-month intervals [22]. Each reptile was identified to species and snout to vent length was measured in mm. Each individual was assigned a unique number, was permanently marked by toe clipping [61,62] and a small sample from the tip of the tail was taken. Toes and tail tips were stored in 70% ethanol at 4°C or −80°C depending on storage space.

To capture birds, we used mist-nets. Trapping occurred from August 2004 to May 2006. Generally, we would open mist-nets (9–12 m long, 30 cm mesh) at sunrise and close them as the temperature increased to a potentially unsafe level in mid-morning. We targeted wrentits by playing male territorial songs with portable speakers placed at the base of the net. Once a bird was caught in the net, it was immediately removed and a U.S. Fish and Wildlife Service band was placed on its leg. We also took measurements of culmen length (mm), culmen width (mm), unflattened wing chord length (cm), tail length (cm), tarsus length (cm) and mass (g). Culmen length was taken from the anterior end of the nares to the tip of the beak using calipers. For genetic samples, we punctured the brachial vein on the wing of each bird with a small gauge needle and collected the blood that pooled there with a small capillary tube. Bleeding usually stopped after 10 seconds which yielded approximately 100  $\mu$ l of blood. Blood was then placed in avian blood buffer [63].

All samples used in this study came from animals that were captured, handled, and released according to relevant national and international scientific guidelines. We used common field and handling methods that minimize stress and long-term effects of capture. We also researched methods alternative to toe-clipping of reptiles and determined that there were no less harmful yet permanent ways of marking individuals [62]. We obtained approval for our animal capture protocol from the UCLA Office of the Protection of Animals (OPRS).

We extracted genomic DNA with the Qiagen DNA mini kit (Qiagen Inc.). DNA samples were stored in TE buffer (10 mM Tris-Cl pH 8.0, 1 mM EDTA pH 8.0) at −20°C. We used six to eight microsatellite markers for each species (Table S6, J. Archie, Pers. Comm.; [64,65,66,67]). We used fluorescently-labeled forward microsatellite primers when available. Alternatively, we used a three-primer genotyping protocol, where the forward microsatellite primer had an M13 sequence attached to the 5′ end (5′-GTAAAACGACGGCCAG-3′) and a third primer with the complementary M13 sequence was dye-labeled [68,69]. The forward, reverse and M13-dye primers were then used in a three-primer PCR protocol using Multiplex Mix (Qiagen Inc.) and 0.01% Bovine Serum Albumin (BSA) to generate microsatellite alleles which are fluorescently labeled. Genotypes were run on an ABI 3700 sequencer and alleles were visualized using GENE-MAPPER (Applied Biosystems, Inc.).

### Genetic Analysis

We used the computer program CONVERT to translate our microsatellite genotype files into the correct input format for various analysis programs [70]. We used FSTAT 2.9.3 [71] to test for deviations from Hardy-Weinberg equilibrium (HWE) within samples using 1000 permutations. We also used FSTAT to test for linkage disequilibrium (LD) between loci. P-values were adjusted for multiple tests using a sequential Bonferonni correction [72]. For HWE and LD, all samples for each species were assumed to be a single population.

**Genetic divergence.** We used the program ARLEQUIN to estimate pair-wise  $F_{ST}$  values between patches using the infinite-allele model and 1000 permutations for significance [73,74]. We also calculated pair-wise  $F_{ST}$  between arrays within large and core patches with ARLEQUIN to show genetic divergence between sampling sites that were located within a patch of continuous habitat. For this calculation we also included some sampling sites from core areas of continuous habitat that were outside of the Simi Hills (our study area), but within SMMNRA, with an average of 4.28 km (range 1.8–6.6 km) separating these sites.

To examine patterns of sample clustering based on genetic similarity, we used the program STRUCTURE v. 2.3.1 [75]. We chose the LOCPRIOR model [76], assumed populations were not admixed and that allele frequencies were correlated between populations, and ran 100,000 MCMC chains with a 10,000 burn-in. We ran seven runs each of  $K = 1$  to  $K =$  number of sample sites (Fig. 1a) for each species. We compiled results from our STRUCTURE runs with the program STRUCTURE HARVESTER (Dent Earl, [http://taylor0.biology.ucla.edu/struct\\_harvest/](http://taylor0.biology.ucla.edu/struct_harvest/)). To determine the most likely  $K$ , we calculated the posterior probabilities of the mean of seven runs at each  $K$  (Table S3; [75]).

Isolation by distance, as revealed by a correlation between pairwise genetic and geographic (Euclidean) distances using a Mantel test, was performed using IBDWS 3.14 [77]. IBDWS uses a Reduced Major Axis (RMA) regression to estimate the slope and intercept of the isolation by distance relationship.

To test for the effect of major roads, highways, and patch age on genetic divergence, we performed partial Mantel tests [78] in IBDWS 3.14. Partial Mantel tests determined correlations of roads presence (RDS), highway presence (HWY), and patch age of isolation (AGE) on a genetic divergence matrix, while holding geographic distance constant. Tests were performed separately, one for each of these three variables, and all animals that were captured within a patch were used to calculate a patch average genetic divergence ( $F_{ST}$ ; as calculated in ARLEQUIN, see above). The presence of major roads and the presence of Highway 23 were used separately in the analysis because the highway in our

study area is larger and has more traffic than other roads. Also, several habitat fragments are only separated by major roads. Age of isolation was chosen because this measure incorporates not only when roads and freeways were built, but also when residential and commercial developments were erected.

We mapped genetic distance on the landscape using Alleles in Space (AIS) and the landscape shape interpolation [79]. We used a Delaunay triangulation-based connectivity network to identify midpoints between our sample sites, then the raw genetic distance ( $D_{ij}$ ) at each midpoint was calculated [79]. This genetic distance measure is similar to Nei's standard genetic distance ( $D_s$ ; [80]), where  $D_{ij}$  is 0 if individuals are completely genetically identical, and  $D_{ij}$  is 1 if individuals are completely genetically dissimilar. We did not calculate the residual genetic distance, because we did not find a significant isolation by distance effect in the Simi Hills samples for any species (see Results). By this method, a landscape of genetic distances between sampling sites are expressed as "surface heights" and are displayed as a 3-dimensional graph. To better visualize the AIS height output, we imported the output file into ArcGIS 9.3 (ESRI Corporation, Redlands, CA) and created a 2-dimensional color hot-spot map overlaid on the geographic study area. Colors correspond to "heights" of genetic distance between points (e. g. Fig. 1b).

**Genetic diversity.** We used the program GENALEX [81] to calculate the genetic diversity indices of within-patch expected heterozygosity ( $H_e$ ), observed heterozygosity ( $H_o$ ), number of effective alleles ( $N_A$ ), and relatedness ( $R_{LR}$ ) [82]. We used the Lynch & Ritland (1999) estimator of relatedness because it has been shown to perform well in simulations for a wide range of marker data and population structure [83]. We performed a rarefaction analysis using the web-based program RERAT [84] which uses multiple simulations to determine the change in relatedness values as additional microsatellite loci are added. In RERAT, we performed 100 simulations and used the Lynch and Ritland (1999) relatedness analysis for each of the four species. For lizards, cores and large patches had three pitfall trap arrays while small patches had one (Fig. 1a). To reduce bias because of array clustering, we calculated pair wise relatedness of all individuals caught in the same array, and then used the mean of those within-array measures to calculate within patch relatedness.

We used the program STATA 9 (StataCorp, College Station, TX) to transform variables until they approached normal distributions and then to examine the relationship between the indices of genetic diversity and the size, degree of isolation, and age of the habitat patches. We used unpaired t-tests (with unequal variance when necessary) and Bonferroni corrections to compare genetic diversity measures between small and large/core habitat patches. Degrees of freedom for t-tests were calculated using the Satterthwaite (1946) method [85]. We lumped large patches and core areas for this analysis because, for these small species, population size is likely equivalently large in the large patches and the core areas, and because the numbers of sites were relatively small for core areas ( $n = 2$ ) and large patches ( $n = 3$ ). To test for a relationship between patch isolation and genetic diversity, we used linear regression to examine the relationship of the genetic diversity indices with the size, pair wise age of isolation, and

proximity (PROX) of the habitat patches, where the degree of isolation of a patch is the inverse of proximity. Spearman's rank correlations were used to test for significant associations between patch age and genetic diversity.

## Supporting Information

**Table S1**  $F_{ST}$  between sample sites for 4 species. Significant pairwise  $F_{ST}$  values are in bold (see Fig. 1a for sample site locations).

Found at: doi:10.1371/journal.pone.0012767.s001 (0.22 MB DOC)

**Table S2** Pairwise  $F_{ST}$  and the number of significant comparisons between patches in and continuous habitat.

Found at: doi:10.1371/journal.pone.0012767.s002 (0.05 MB DOC)

**Table S3** Estimated posterior probabilities for  $K$ . Most likely number of genetic clusters ( $K$ ) identified with the program Structure is shown in bold.

Found at: doi:10.1371/journal.pone.0012767.s003 (0.07 MB DOC)

**Table S4** Mean genetic diversity measurements within patches (number of effective alleles,  $N_A$ ; relatedness,  $R_{LR}$ ; heterozygosity,  $H_e$ ).

Found at: doi:10.1371/journal.pone.0012767.s004 (0.12 MB DOC)

**Table S5** Spearman's Rho correlation coefficients. The number of individuals genotyped ( $N$ ), the number of alleles ( $A$ ), expected ( $H_e$ ) and observed ( $H_o$ ) heterozygosity.

Found at: doi:10.1371/journal.pone.0012767.s005 (0.04 MB DOC)

**Table S6** Microsatellite primers used for each species. The number of individuals genotyped ( $N$ ), the number of alleles ( $A$ ), expected ( $H_e$ ) and observed ( $H_o$ ) heterozygosity.

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## Author Contributions

Conceived and designed the experiments: KSD SPDR RNF. Performed the experiments: KSD. Analyzed the data: KSD. Contributed reagents/materials/analysis tools: KSD SPDR. Wrote the paper: KSD SPDR.

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# CONSERVATION THRESHOLDS FOR LAND USE PLANNERS





**Front Cover:**

*Encroachment, Gnatcatcher Habitat*

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Timothy Beatley, Ph.D.  
Associate Professor  
Department of Urban and Environmental Planning  
School of Architecture  
University of Virginia

Christopher J. Duerksen  
Managing Director  
Clarion Associates LLC

Richard L. Knight, Ph.D.  
Professor of Wildlife Conservation  
Department of Forest, Rangeland, and Watershed Stewardship  
Colorado State University

Bruce A. Stein, Ph.D.  
Vice President for Programs  
NatureServe



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## INTRODUCTION

While there are many threats to biological diversity in the United States, the loss and fragmentation of habitats and ecosystems have become the most significant (Wilcove et al. 1998). The survival of plant and animal species and whether our natural systems will continue to provide essential services—recycling of nutrients, flood and pest control, and maintenance of clean air, water, and soil—significantly depends upon where and how land is used, converted, and managed. Land use change resulting from development and associated human activities (e.g., agriculture, grazing, forest harvesting, and hunting) often alters the abundances and varieties of native species; introduces novel and potentially detrimental species to an area; and disrupts natural water and nutrient cycles, and natural disturbance patterns (e.g., fire) (U.S. Geological Survey 1998).

Everyday, land use planners are faced with decisions regarding whether and how land is developed, parcelized, and used, and in what pattern. For the most part, such land use decisionmaking occurs without taking into account individual and cumulative impacts to biological resources. Implementing biologically sensitive spatial planning early in the development process will help preserve our natural heritage for the future, since the most crucial time for planning is when the first 10 to 40 percent of the natural vegetation is altered or removed from the landscape (Forman and Collinge 1997). A growing interest exists among land use planners and developers to use the tools at their disposal to better protect biological diversity. However, these professionals often lack the necessary information to incorporate ecological principles into their decisionmaking and to transform their traditional planning approaches into progressive, ecologically-based conservation tools.

To encourage and facilitate better integration of ecological knowledge into land use and land management decisionmaking, the scientific community needs to provide planners with applicable ecological information and guidance. To this end, the Ecological Society of America (ESA) convened a

committee of leading scientists to identify principles of ecological science relevant to land use and to develop guidelines for land use decisionmaking.<sup>1</sup> The result was the development of eight general guidelines to assist land use planners in evaluating the ecological consequences of their decisions (see Box 1).

Conservation guidelines, such as those established by the ESA Land Use Committee, are designed to be flexible and to apply to diverse land use situations. As a result, they tend to be general in nature. For ecological principles to be put into

*“Spatial planning is most significant in nature conservation when 10-40% of the natural vegetation has been removed from a landscape.”*

Forman and Collinge (1997), *Landscape and Urban Planning* 37, p. 129

practice, however, land use planners will need more specific information on potential threshold responses of species and ecosystems to development activities, particularly in relation to habitat fragmentation. To facilitate the adequate preservation of contiguous or

connected natural areas, land use planners will need to know what science tells them about the minimum sizes of habitat patches species need to survive, or the amount of habitat necessary for the long-term persistence of native populations and communities in a region. In addition, they need information about the adequate size and placement of habitat corridors that would facilitate species movement and colonization among disjunct habitat patches, and about recommended widths of riparian buffers to protect water quality and provide wildlife habitat. Similarly, knowing the extent to which edges influence natural habitats would help land use professionals evaluate the effective area of any given habitat patch or corridor. Other fragmentation thresholds—such as the maximum distance between isolated patches tolerable in a landscape before ecological processes and patterns become disrupted—would arm decisionmakers with specific parameters that could be incorporated into land use design and modeling.

<sup>1</sup> “The Ecological Society of America (ESA) is a non-partisan, nonprofit organization of scientists founded in 1915 to: promote ecological science by improving communication among ecologists; raise the public’s level of awareness of the importance of ecological science; increase the resources available for the conduct of ecological science; and ensure the appropriate use of ecological science in environmental decision making by enhancing communication between the ecological community and policy-makers.”  
As cited in Ecological Society of America. “About ESA.” <[www.esa.org](http://www.esa.org)> (31 July 2002).



Given the inherent complexity of ecological systems, scientists are understandably reticent about providing exact prescriptions for land use planning and design because answers vary depending on the species, ecosystem, or scale in question. Nevertheless, by not promoting the use of even

partial knowledge about species or ecosystem responses to human disturbance and fragmentation, the result is that land use decisions—even the most well-intentioned—are being made completely uninformed by science.

### BOX 1. GUIDELINES FOR LAND USE PLANNING AND MANAGEMENT

In the face of rapid land use change, the Ecological Society of America's Land Use Committee recommends that land use planners and developers take into consideration the following eight guidelines to evaluate the potential impact of their decisions on our natural systems (see Dale et al. 2000 for full discussion):

#### 1. Examine the impacts of local decisions in a regional context.

The persistence of species and the sustainability of ecosystems are determined not only by immediate surroundings but also by larger landscape factors, such as how habitats are interspersed across the landscape. Thus, local land alterations may have broad-scale regional impacts. Land use planners should both identify the surrounding region that is likely to affect and be affected by a local project and examine how adjoining jurisdictions are using and managing their lands. Regional environmental data (e.g., land cover classes, hydrologic patterns, and habitats for species of concern) should be incorporated into the decision-making process to facilitate a regional assessment of impacts.

#### 2. Plan for long-term change and unexpected events.

Ecological processes, such as nutrient cycling, energy flow patterns, and disturbance regimes, may function over lengthy and variable time scales. In addition, ecosystems change over time. As a result, impacts posed by land use decisions are often long-term and unpredictable. Impacts may be delayed and not fully realized until years or decades later, or they may be cumulative such that a "unique trajectory of events" results that could not have been predicted from any single event. The complexity and variability of ecosystem responses dictate that land use decisions consider potential occurrences and implications of unanticipated and long-term events (e.g., variations in weather and disturbance patterns).

#### 3. Preserve rare landscape elements and associated species.

Rare landscape elements, such as wetlands, riparian and mountain zones, and old-growth forests, often provide critical habitats for rare and endangered species. To protect a region's biological diversity, the natural diversity within a landscape must be preserved. Land use planners should identify the location of rare and unique landscape elements, by methods such as inventory and analysis of vegetation types, geology, hydrology, and physical features, and by their associated species. Once such landscape elements are identified, development should be guided away from such areas and toward more common landscape features.

#### 4. Avoid land uses that deplete natural resources over a broad area.

Depletion of natural resources over time will lead to the irreversible disruption of ecosystems and associated processes. Consequently, land use planning and development should strive

to prevent the diminishment of natural resources (e.g., soil, water, and habitat types such as wetlands) in any given area by identifying vital or at-risk resources and by taking the necessary precautions to avoid actions that threaten resource sustainability. Certain land uses or land activities may be deemed altogether incompatible in particular settings.

#### 5. Retain large contiguous or connected areas that contain critical habitats.

Large habitat patches typically support a greater diversity and abundance of plants and animals and can maintain more ecosystem processes than small patches. Large intact habitats provide more resources, allowing larger populations of a species to persist, thus, increasing the chance of survival over time. Parcelization of large habitats often decreases the connectivity of systems, negatively affecting the movement of species necessary for fulfilling nutritional or reproductive requirements. To counter such effects, large intact areas and small areas that are well connected to other critical habitats should be protected.

#### 6. Minimize the introduction and spread of non-native species.

Non-native species often negatively affect the survival of native species and disrupt the functioning of ecosystems. The spread of non-natives is facilitated by the development of transportation infrastructure and by the creation of edge environments and artificial landscapes. Land use professionals should strive to minimize the potential introduction and spread of non-native species into natural environments.

#### 7. Avoid or compensate for effects of development on ecological processes.

Development may not only cause site-specific impacts, but may also disturb regional ecological processes. Ecological processes, such as fire, grazing, dispersal patterns, and hydrologic cycles, help to sustain plant and animal populations across a landscape. Thus, land uses that could negatively affect other systems or lands through the disruption of these processes should be avoided while those that benefit or enhance ecological attributes should be encouraged.

#### 8. Implement land use and land management practices that are compatible with the natural potential of the area.

The natural potential of a site, as determined in part by local physical and biologic conditions, should be factored into how land is used and managed. Land uses that do not take advantage of a site's natural potential or consider its limitations, will likely result in unnecessary resource loss and high economic costs.

For more information on ecological principles to guide land use planning decisionmaking, see Dale et al. (2000), Duerksen et al. (1997), and Dramstad et al. (1996).

## FROM GUIDELINES TO THRESHOLDS

The Environmental Law Institute (ELI) surveyed existing scientific literature to determine whether a body of knowledge has emerged within the scientific community relevant and applicable to national land use decision-making, specifically pertaining to biological conservation thresholds. A literature search of the major ecological, conservation, and land use journals was conducted using the Science Citation Index (ISI Web of Science) using search terms under the following categories: habitat fragmentation,<sup>2</sup> buffers,<sup>3</sup> corridors,<sup>4</sup> ecological thresholds,<sup>5</sup> and indicator species.<sup>6</sup> To increase applicability to current land use decisionmaking in the states, the search was confined to studies pertaining to the continental United States, as well as articles published between 1990-2001, and pre-1990 articles commonly cited within the scientific community. Only those articles containing quantitative information directly relevant to determining conservation thresholds for land use planning and land management were considered.<sup>7</sup> In addition to the literature search, review papers found in the gray literature (e.g., those produced by land management and regulatory agencies) were also included when possible and applicable.

ELI found adequate information on potential ecological threshold measures for the following areas: habitat patch area, percent of suitable habitat, edge effects, and buffers. Corridor design is reviewed in brief; however, specific guidance on corridor size was not feasible given inadequate available information within the scientific literature. This survey reflects scientific information largely related to habitat fragmentation and landscape ecology issues, with a focus on the spatial relationships (e.g., size, shape, location) and interactions of land attributes over large geographic areas.<sup>8</sup> This

review does not cover other important conservation elements such as how to account for the biological integrity or ecological significance of habitat patches, which land use planners should consider when determining which parcels of land to protect. In addition, the thresholds presented in this review does not adequately address the conservation of species or habitat types that are naturally rare or localized (e.g., those with patchy distributions or limited ranges).

This report summarizes the Institute's findings and provides a platform for identifying gaps in existing knowledge to help guide more in-depth ecological research directly applicable to land use planning. This report in no way attempts to misrepresent the complexity of species and ecosystem response to land conversion, degradation, and fragmentation by providing simplified prescriptions. Land use planners should cautiously interpret the presented threshold values and ranges and tailor them to their unique circumstances and geographic settings.

First and foremost, land use planners need to establish their priorities for conservation—whether they be water quality or quantity, wildlife habitat, or biodiversity. In addition, conservation targets need to be established—whether they be regionally rare or endangered species or unique landscape elements (e.g., wetlands, old growth forests, riparian zones), or other targets—because this will directly influence the value and scale of any threshold.<sup>9</sup> Thresholds should be chosen or developed to meet the needs of the resources a locality is most concerned with managing and conserving. Planners should place great emphasis on evaluating site-specific and regional physical and biological conditions that influence the resiliency of particular systems to human disturbance.

The threshold values presented in this report should not detract from the larger goals of conserving or restoring indigenous species, rare and representative habitats, ecosystem functions, and natural connectivity. Where possible, the ESA land use guidelines should be followed. Land use planners should strive to protect large, intact parcels of land, high quality and ecologically important habitat, and where appropriate, should connect protected natural areas. When development is deemed necessary, land use planners should promote more compatible land uses and avoid or minimize fragmenting habitat patches wherever possible.

<sup>2</sup> To locate papers with potential habitat fragmentation threshold information, the following search terms were used: minimum habitat size, habitat size, habitat requirement, habitat fragmentation, patch size, minimum fragment size, island biogeography, landscape connectivity, habitat connectivity, and metapopulation theory.

<sup>3</sup> To locate papers with potential threshold information on buffer width, the following search terms were used: riparian buffer, wetland buffer, buffer zone, buffer distance, forest buffer, buffer width, and buffer size.

<sup>4</sup> To locate papers with potential threshold information on corridor width, the following search terms were used: fragment connectivity, boundary permeability, landbridge, highway overpass, highway underpass, stream cross, habitat corridor, corridor, migration corridor, riparian corridor, and underpass.

<sup>5</sup> To locate papers with potential ecological threshold information, the following search terms were used: ecological threshold, conservation threshold, environmental threshold, and landscape threshold.

<sup>6</sup> To locate papers with potential threshold information relevant to indicator species, the following search terms were used: indicator species, indicator species and habitat fragmentation, and indicator species and thresholds.

<sup>7</sup> The majority of the papers encountered and selected focus on terrestrial species and to a lesser extent freshwater aquatic communities.

<sup>8</sup> As defined by Risser et al. (1984), "Landscape ecology considers the development and dynamics of spatial heterogeneity, spatial and temporal interactions and exchanges across heterogeneous landscapes, influences of spatial heterogeneity on biotic and abiotic processes, and management of spatial heterogeneity."

<sup>9</sup> Thresholds presented in this report reflect a taxonomic bias in the scientific literature toward birds and mammals. Thus, for many of the recommended threshold values, these two animal groups are assumed to be the conservation targets.

## BOX 2. DEFINITION OF TERMS

**Biological diversity (or biodiversity)** – the variety of life and its processes, which includes the abundances of living organisms, their genetic diversity, and the communities and ecosystems in which they occur (The Keystone Center 1991). Diversity at all levels from genes to ecosystems need to be maintained to preserve species diversity and essential ecosystem services like climate regulation, nutrient cycling, water production, and flood/storm protection (Dale et al. 2000).

**Biological (or ecological) integrity** – refers to a system's wholeness, including presence of all appropriate elements and occurrence of all processes at appropriate rates, that is able to maintain itself through time (Angermeier and Karr 1994).

**Boundary** – a zone comprised of the edges of adjacent ecosystems or land types (Forman 1995).

**Corridor** – a linear strip of a habitat that differs from the adjacent land on both sides, connecting otherwise isolated larger remnant habitat patches (Forman 1995, Fischer et al. 2000).

**Buffers** – linear bands of permanent vegetation, preferably consisting of native and locally adapted species, located between aquatic resources and adjacent areas subject to human alteration (Castelle et al. 1994, Fischer and Fischenich 2000).

**Ecosystem** – a geographic area including all the living organisms (e.g., people, plants, animals, and microorganisms), their physical surroundings (e.g., soil, water, and air), and the natural cycles (nutrient and hydrologic cycles) that sustain them. Ecosystems can be small (e.g., single forest stand) or large (e.g., an entire watershed including hundreds of forest stands across many different ownerships) (USFWS 1994).

**Ecosystem functions** – the biophysical processes that take place within an ecosystem, apart from any human context (e.g. nutrient, energy, and hydrologic cycling; or soil formation).

**Ecosystem services** – refer to the ecosystem goods (e.g., food, and medicine) and services (e.g., climate regulation, water purification, and flood control) that humans derive benefit, directly or indirectly, from ecosystem functions (Costanza et al. 1997).

**Ecosystem sustainability** – the tendency of a system to be maintained or preserved over time without loss of decline to elements such as its structure, function, diversity, and production. Sustainability is widely regarded as economically and ecologically desirable and the only viable long-term pattern of human land use (Dale et al. 2000).

**Edge** – the portion of an ecosystem or habitat near its perimeter, where influences of the surroundings prevent development of interior/core-area environmental conditions (Forman 1995).

**Edge effects** – the negative influence (e.g., such as the profound modifications of biological and physical conditions) of habitat or ecosystem edges on interior conditions of habitat or on associated species (Meffe and Carroll 1997, Lindenmayer and Franklin 2002).

**Habitat** – consists of the physical features (e.g., topography, geology, stream flow) and biological characteristics (e.g., vegetation cover and other species) needed to provide food, shelter, and reproductive needs of animal or plant species (Duerksen et al. 1997).

**Habitat fragmentation** – the breaking up of previously continuous habitat (or ecosystem) into spatially separated and smaller parcels. Habitat fragmentation results from human land use associated with forestry,

agriculture, and settlement, but can also be caused by natural disturbances like wildfire, wind, or flooding. Suburban and rural development commonly change patterns of habitat fragmentation of natural forests, grasslands, wetlands, and coastal areas as a result of adding fences, roads, houses, landscaping, and other development activities (Dale et al. 2000).

**Landscape** – a large heterogeneous land area (e.g., multiple square miles or several thousand hectares) consisting of a cluster of interacting ecosystems repeated in similar form (e.g., watershed) (Forman 1995, Duerksen et al. 1997).

**Land use** – the purpose to which land is used by humans (e.g., protected areas, forestry for timber production, plantations, row-crop agriculture, pastures, or human settlement) (Dale et al. 2000).

**Local population** – set of individuals of a species that live in the same habitat patch and interact with each other; most naturally applied to “populations” living in such small patches that all individuals practically share a common environment (Hanski and Simberloff 1997).

**Matrix** – the background ecosystem or land use type in a mosaic, characterized by extensive cover, high connectivity, and/or major control over the landscape functioning (Forman 1995). For example, in a large contiguous area of mature forest embedded with numerous small disturbance patches (e.g., timber harvest patches or clearcut areas), the mature forest constitutes the matrix element type because it is greatest in areal extent, is mostly connected, and exerts a dominant influence on the associated species and ecological processes (McGarigal 2003).

**Metapopulation** – a network of semi-isolated populations with some level of regular or intermittent migration and gene flow among them, in which individual populations may be extinct but then be recolonized from other subpopulations (Meffe and Carroll 1997).

**Mosaic** – a pattern of patches, linear corridors, and matrix in a landscape (Forman 1995).

**Minimum viable population** – The minimum viable population size is the smallest number of individuals required to maintain a population over the long-term (Forman 1995).

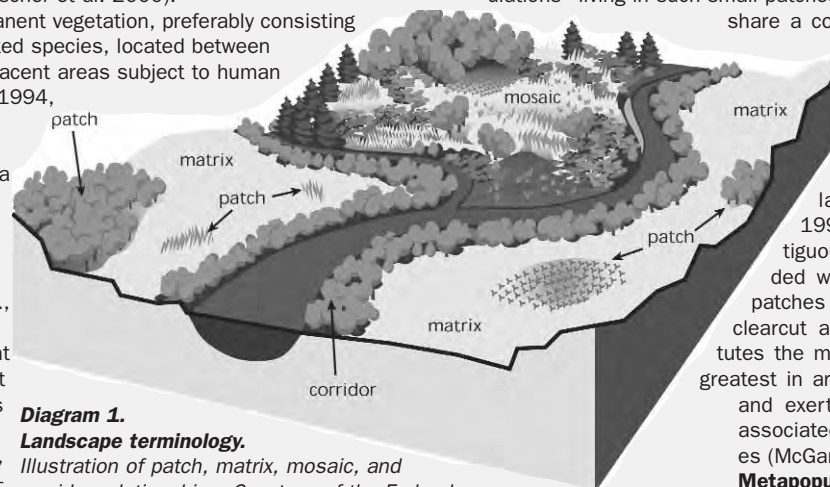
**Non-native (or exotic) species** – organisms (plants, animals, insects, and microorganisms) that occur in locations beyond their known historical, natural ranges or have been brought in from other continents, regions, ecosystems, or habitats (National Invasive Species Council 2001).

**Patch** – a relatively homogeneous type of habitat that is spatially separated from other similar habitat and differs from its surroundings (Forman 1995).

**Remnant patch** – habitat patches that escape disturbance (e.g., development) and are left remaining from an earlier more extensive span of habitat (e.g., woodlots in an agricultural area) (Dramstad et al. 1996).

**Scale** – the relative size or degree of spatial resolution of an area of interest. Small areas of interest (e.g., area around a house of single subdivision) are considered to be fine scale; in contrast to a larger area (e.g., a county or watershed), which is considered to be of coarse scale (Forman 1995, Duerksen et al. 1997).

**Suitable habitat** – habitat that meets the survival and reproductive needs of a species, allowing for a stable or growing population over time (Lamberson et al. 1994).



**Diagram 1.**

**Landscape terminology.**

*Illustration of patch, matrix, mosaic, and corridor relationships. Courtesy of the Federal Interagency Stream Restoration Working Group (FISRWG), Stream Corridor Restoration: Principles, Processes, and Practices (10/98).*



## THRESHOLDS FOR LAND USE PLANNING: ADDRESSING HABITAT FRAGMENTATION

**H**abitat fragmentation severely threatens biodiversity and ecosystem functioning wherever humans dominate the landscape. Land use planners play a significant role in determining whether and how landscapes and ecosystems are fragmented or maintain natural connectivity.

Habitat fragmentation is the process whereby contiguous natural areas are reduced in size and separated into discrete parcels. Fragmentation results from a reduction in the area of the original habitat due to land conversion for other uses, such as residential and commercial development. It also occurs when habitat is divided by roads, railroads, drainage ditches, dams, power lines, fences or other barriers that may prohibit the free movement and migration of plant and animal species (Primack 1993, Forman 1995). When habitat is destroyed, a patchwork of habitat fragments is left behind, often resulting in patches that are isolated from one another in a modified and inhospitable landscape matrix.<sup>10</sup> Fragmentation causes the microclimate to be altered due to changes in solar radiation, wind, and humidity; habitat patches become more isolated with a growing distance between remnant patches; and the resulting landscape is modified by changes in size and shape of the resulting patches (Saunders et al. 1991). These changes have varying impacts on species persistence and ecosystem sustainability.

Groups of organisms respond differently to habitat fragmentation. Some species, such as game species like white-tailed deer and bobwhite quail (referred to as edge species), may actually thrive under altered conditions (Bolger et al. 1997). However, many other species—often rare species and habitat specialists—are negatively affected. Species that depend upon the interior of forests, prairies, wetlands or other natural habitats will be absent from landscapes that lack sufficient natural areas containing true core habitat (Meffe and Carroll 1997). Although a fragmented landscape may enhance the abundance of certain generalist species, overall, fragmentation threatens the maintenance of biodiversity and the functioning of natural systems (Soulé 1991, Forman 1995).



*Varying shapes and configuration of habitat patches resulting from habitat fragmentation, Buchanan, Alabama. Courtesy of John R. Tolliver, USDA Forest Service, [www.forestryimages.org](http://www.forestryimages.org).*

To the detriment of many species, particularly those that are area-sensitive, habitat patches may lack the range of resources necessary to support permanent populations (Primack 1993, Forman 1995). Habitat fragmentation will reduce the foraging and nesting ability of animals and can lead to the rapid loss of species due to the creation of barriers to dispersal and colonization. In a fragmented landscape, normal dispersal will be disrupted when the land surrounding the remaining patches is inhospitable to species formerly thriving in the contiguous habitat (e.g., because it is degraded or is home to predators). For example, many bird species that dwell in the forest interior will not cross even short distances of open areas (Askins 1995). When species migration and dispersal is limited, new immigrants are less likely to supplement diminishing populations, thereby, increasing extinction vulnerability (Askins 1995).

The negative effects of habitat fragmentation are compounded by an altered physical environment (*see* “Edge Effects”). Land conversion and land transformation can cause major alterations in hydrologic regimes, mineral and nutrient cycles, radiation balance, wind and dispersal patterns, and soil stability (Harris 1984 as cited in Collinge 1996; Hobbs 1993 as cited in Forman 1995). Changes in such ecosystem properties and processes in turn affect native species composition, abundance, and long-term persistence, further degrading the biodiversity and the integrity of the affected natural areas.

<sup>10</sup> Matrix is the background ecosystem or land use type in a mosaic, characterized by extensive cover, high connectivity, and/or major control over the landscape functioning (Forman 1995) (*see* Box 2).





## UNDERSTANDING THE EFFECTS OF FRAGMENTATION

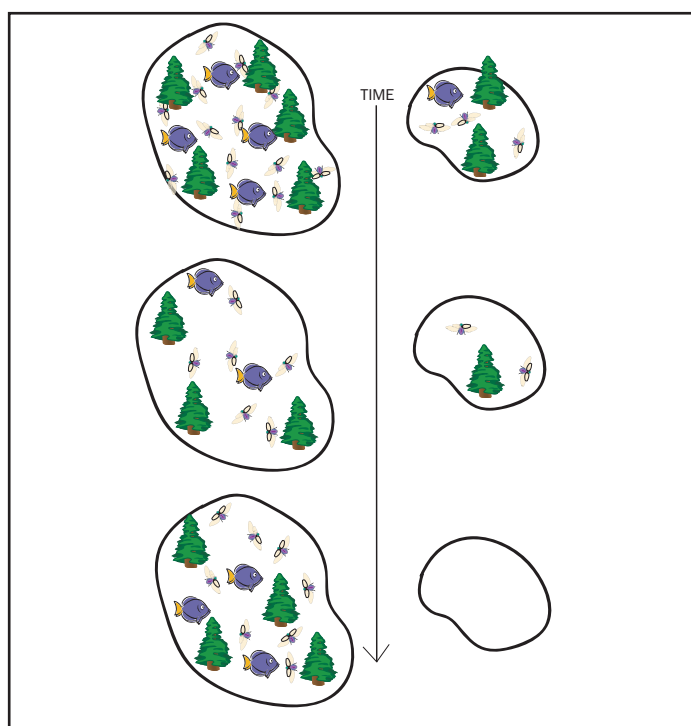
Over the past 25 years, the scientific community has devoted much energy to understanding the various components of fragmentation—the influence of fragment size, shape, configuration, heterogeneity, connectivity, among other factors—and how they effect the sustainability and persistence of species and natural processes in a landscape. Ideally, scientists would understand the influence and interaction of these characteristics on the continued survival of species and the integrity of ecosystems. Due to gaps in scientific knowledge, available information was only found within the literature to present potential threshold responses related to patch area, proportion of suitable habitat, edge effects, and buffers.

This paper provides land use decisionmakers with concrete information culled from the scientific literature in order to translate the land use guideline #5 offered by the Ecological Society of America (*see* Box 1) for on-the-ground practice. Recommendations on “how to retain large contiguous or connected areas that contain critical habitat” are presented, with specific information on how to best protect habitat patches and sufficient natural area, to minimize edge effects, and to design riparian buffers and habitat corridors.

### HABITAT PATCHES

A common consequence of land development is the fragmentation of an originally connected natural landscape into a mosaic of disconnected habitat patches.<sup>11</sup> The size of the remaining habitat fragments significantly influences the type, abundance, and diversity of species that can persist in the affected region. In general, large patches better sustain wildlife populations and ecosystem functions over time than small patches. Holding other factors constant—such as patch shape, condition, and configuration—larger areas of habitat tend to support larger population sizes and a greater number of interior, specialist, and native species due to increased habitat diversity and more core area (Harris 1984, Dramstad et al. 1996, Forman 1995). The probability of a species population being extirpated generally increases with decreasing patch size.<sup>12</sup> This is due to the tendency of larger patches to retain a greater array of the natural resources and ecological functions provided by healthy ecosystems than smaller patches with more edge, increased susceptibility to invasion by exotics or predators, and more disturbed conditions

(Soulé 1991, Metro 2001) (*see* “Edge Effects”). Area-sensitive forest bird species in the mid-Atlantic United States, for example, have been found to exhibit lower species diversity and higher extinction and turnover rates in landscapes with smaller mean forest patch size (Boulinier et al. 2001).



**Diagram 2. Patch size and local extinction.** Probability of a local species population going extinct increases with decreasing habitat patch size. A larger patch generally supports a larger population size for a given species than a smaller patch, making it less likely that the species will go locally extinct in the larger patch. Modified from Dramsted et al (1996), *Landscape Ecology Principles in Landscape Architecture and Land-Use Planning*, p. 20.

In general, to ensure the survival of individual species, population levels must remain large enough to protect against extinction from random natural events (e.g., floods, fires, droughts) and to maintain sufficient genetic variation to adapt to changing environmental conditions (e.g., changes in rates of predation, competition, disease, and food supply) (Gilpin and Soulé 1986, Meffe and Carroll 1997). A common tool used to determine the size of a population(s) needed to ensure long-term survival is a Population Viability Analysis (PVA). A PVA uses quantitative methods to predict the likely future status of a population or set of populations of conservation concern—often those that are at risk of extinction (Morris et al. 2002). This technique can take into account the many environmental, demographic, and genetic variables that determine extinction probabilities for individual species (Meffe and Carroll 1997).

<sup>11</sup> A patch is a relatively homogeneous type of habitat that is spatially separated from other similar habitat and differs from its surroundings (Forman 1995).

<sup>12</sup> What is being discussed in this report is to the local extinction of a species population from a particular habitat or region (termed extirpation or population extinction), rather than the overall elimination of the species worldwide (termed global extinction).

Because plant and animal population size is the best predictor of extinction probability, habitat patches should be large enough to maintain viable populations of important species—including rare, endangered, and economically important species—and to maintain the ecological processes that support these communities. Based on Population Viability Analyses, general guidelines have been proposed for minimum viable population sizes:<sup>13</sup> 1) populations less than 50 individuals being too small and vulnerable to extinction due to their rapid loss of genetic variability and inability to withstand natural catastrophes; and 2) populations of 1,000 to 10,000 individuals being adequate to ensure long-term persistence (Meffe and Carroll 1997). Such numbers, however, should be viewed with scrutiny because much debate still exists about what size constitutes a minimum viable population for the many different species that make up natural systems (Saunders et al. 1991).

#### MANAGING FOR ADEQUATE HABITAT PATCH SIZE

For purposes of this review, minimum patch area is the smallest habitat patch that should be protected in order to sustain a species, a diversity of species or communities, or functioning of ecosystems. The literature suggests that, depending on the species or habitat in question, minimum critical patches range from as little as 0.0004 hectares (0.001 acres) (based on the needs of certain invertebrates) up to 220,000 hectares (550,000 acres) (based on the needs of certain mammals) to sustain target species or communities (*see* Appendix B). This wide range reveals that a generic “minimum” critical patch size or habitat requirement does not exist; thresholds are entirely dependent on the target species in question.

Ultimately, the amount of habitat necessary to maintain healthy wildlife populations varies according to many factors, such as taxonomic group, body size, foraging and resource requirements, and dispersal patterns of the species (Bender et al. 1998). Taxonomic groups, such as invertebrates and plants, which have smaller dispersal ranges and tend to respond to their environment at smaller spatial scales, are reported to need less habitat area (e.g., less than 10 hectares or 25 acres) (McGarigal and Cushman 2002).

Larger patch areas are recommended to support bird, mammal, and fish species. Minimum habitat requirements for birds ranged from one hectare up to 2,500 hectares (6,250 acres), with the majority (75 percent) of the values found within the literature to be under 50 hectares (125 acres).<sup>14</sup> Minimum patch size required by mammals ranges from one hectare to 10 hectares for small mammals and up to 220,000 hectares for large-bodied or wide-ranging mam-

mals (e.g., bears, cougars). Larger bodied vertebrates and wide-ranging predators tend to require larger territories to meet resource and reproductive needs (Soulé 1991). Minimum habitat area is greater for predators, such as bears, with recommended patch sizes greater than 900 and 2,800 hectares and cougars with 220,000 hectares (Mattson 1990, Mace et al. 1996, Beier 1993, respectively).<sup>15</sup> In contrast, estimates for habitat requirements for small mammals, such as rodents and rabbits, varied from one hectare to 10 hectares (Soulé et al. 1992, Barbour and Litvaitis 1993, Bolger et al. 1997). Only one study was found to provide evidence on possible watershed area needed to sustain fish species, finding that suitable patch sizes larger than 2,500 hectares might increase the chance of bull trout occurrence in Idaho (Rieman and McIntyre 1995).

Overall, the majority of the findings in this survey pertain to birds and mammals (*see* “A Closer Look at Habitat Patch Size” in Appendix A for specific information on numbers and trends). Few studies were found to recommend patch sizes to sustain plant, invertebrate, or fish populations. Keeping in mind this sample represents a narrow array of species and habitats, the protection of habitat patches of 55 hectares (137.5 acres) or more appears to capture 75 percent of species requirements reviewed in this select survey (*see* Figure 1). Such minimum land parcels, however, are not likely to capture particularly area-sensitive species, like wide-ranging predators or particularly sensitive interior bird species, found to need habitat patches greater than 2,500 hectares (or about 6,175 acres) (Trine 1998, Mattson 1990, and Beier 1993).

Given the great scientific uncertainty and gaps in the knowledge base on minimum habitat requirements of species and ecosystems, land use planners should adopt a conservative approach. The goal should be to maintain sufficiently large intact and well-connected habitat patches that would support the most area-sensitive species, species of greatest environmental concern (e.g., rare, threatened, or endangered species), or focal species, such as keystone species,<sup>16</sup> link species,<sup>17</sup> or umbrella species.<sup>18</sup> Declines in these groups of organisms may have wide ranging implications, negatively affecting the persistence of other associated species and ecosystems (Dale et al. 2000).

Land use planners should carefully consider the conservation needs of species with large-area or specialized life history requirements or that depend upon a combination of different habitats (e.g., large-ranging predators; interior species, or rare species); these species are likely to survive only in rel-

<sup>13</sup> One hectare is equal to approximately 2.5 acres.

<sup>14</sup> The minimum viable population size is the smallest number of individuals required to maintain a population over the long-term (Forman 1995); for example, the size of a population that would have a 95 percent probability of persisting for 100 years (Boyce 1992).

<sup>15</sup> Recommended conservation threshold values are based on the goal of capturing 75 percent of the requirements found for species, communities, and habitats surveyed in this literature review; thus, the third quartile was used by calculating the value for which 75 percent of the threshold values lie below this value (after numerical ranking).

<sup>16</sup> Keystone species are species that have greater effects on ecological processes than would be predicted by their abundance or biomass alone (Dale et al. 2000).

<sup>17</sup> Link species are species that exert critical roles in the transfer of matter and energy across trophic levels of a food web or that provide critical links for energy transfer within complex food webs (Dale et al. 2000).

<sup>18</sup> Umbrella species are species that either have large area requirements or use multiple habitats and thus overlap the habitat requirements of other species (Dale et al. 2000).

<sup>13</sup> The minimum viable population size is the smallest number of individuals required to maintain a population over the long-term (Forman 1995); for example, the size of a population that would have a 95 percent probability of persisting for 100 years (Boyce 1992).

<sup>14</sup> Recommended conservation threshold values are based on the goal of capturing 75 percent of the requirements found for species, communities, and habitats surveyed in this literature review; thus, the third quartile was used by calculating the value for which 75 percent of the threshold values lie below this value (after numerical ranking).

atively large areas or in very specific habitat types (potentially very small, localized areas), which should be actively targeted for protection (Saunders et al. 1991, Ruggiero et al. 1994, Collinge 1996). To help guide conservation planning, umbrella species (e.g., vertebrate mammals such as cougars and grizzly bears) have been proposed as targets for conservation, because their protection may ensure the protection of other secondary species (Franklin 1993). By protecting areas large enough to maintain viable populations of wide-ranging species, sufficient habitat may be maintained to ensure survival of other species dependent on the same habitat. Land use planning that allows for the persistence of focal species—like rare and endangered species, keystone or umbrella species—may help direct land conservation. Land use planners will need the help of local biologists to identify appropriate focal and area-sensitive species in their region to better implement habitat conservation strategies.

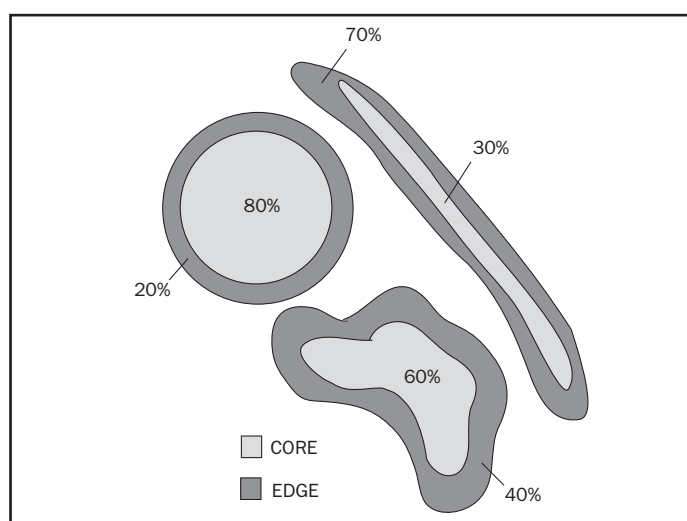
Even though protecting large expanses of connected habitat is the ultimate goal, this may not be practicable in the often highly developing landscapes in which land use planners often find themselves working. In these settings, land use professionals should try and conserve what habitat remains and, where possible, work with land management agencies and land trusts to identify potential areas for habitat restoration. Working to conserve even the smallest remaining natural areas is important, particularly in human-dominated landscapes. A series of small- or medium-sized reserves may capture a greater diversity of habitat types, environmental heterogeneity, and biological diversity than the preservation of one large fragment (Tscharrntke et al. 2002) (see “Role of small patches”). Protecting natural habitats with the greatest conservation significance locally and regionally—regardless of size—is vital to preserving biological diversity and ecosystem services. No matter how small habitat patches may be, they still have ecological and/or aesthetic values, whether providing habitat for small organisms like amphibians or insects; providing green space for recreational activities; helping moderate temperature and provide shade in urban areas; or decreasing run-off from streets, pavements, and other impermeable surfaces.

#### OTHER PATCH AREA DESIGN CONSIDERATIONS

The size of any given habitat patch is only one factor determining whether or not the patch will support species persistence, biological diversity, and ecosystem functions. Other factors to consider are the shape, location/configuration, condition, and boundaries of patches, as well as the role of small habitat patches. The following is general guidance on ways to counteract the negative impacts of habitat fragmentation and habitat loss at a landscape scale.

*Land use planners should strive to protect and maintain habitat patches larger than 55 hectares (137.5 acres).*

- Patch shape:** Patch size and shape determine the distance of the patch’s edge to the habitat interior and the amount of core area remaining in any remnant habitat patch (see “Edge Effects”) (Collinge 1996). Shape determines the edge to interior ratio of a habitat patch, which should be as low as possible to minimize edge effects (Wilcove et al. 1986, Saunders et al. 1991, Collinge 1996). Circular habitat reserves are recommended to minimize contact between the protected core habitat and adjacent environmental or human pressures (Wilcove et al. 1986). In contrast, long, thin remnants have proportionally more edge, and thus, more negative edge effects (Forman and Godron 1981, Saunders et al. 1991).



**Diagram 3. Patch shape and edge.** The edge to interior ratio of a habitat patch is affected by patch shape. A more convoluted, irregular, or linear patch will have a higher proportion of edge, thus, increasing the number of edge species and decreasing the number of interior species.

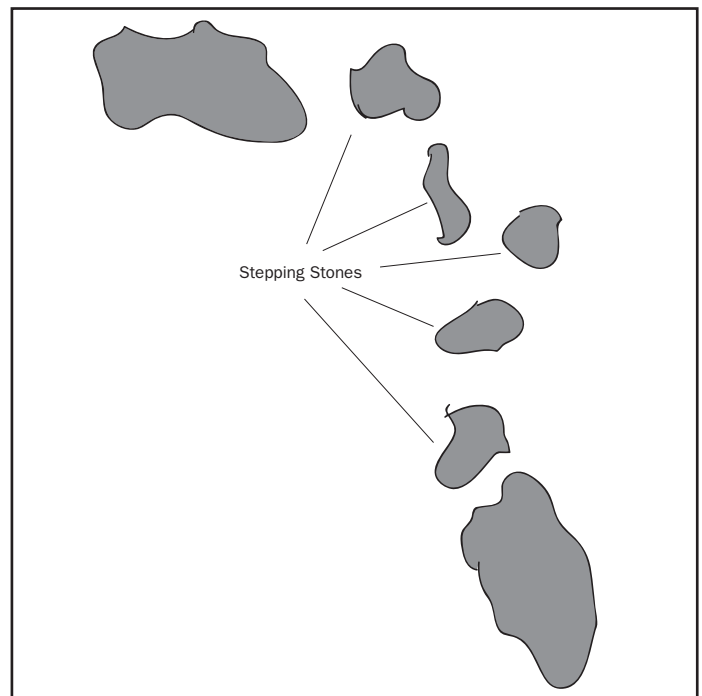
- Patch location/configuration:** The landscape context in which patches reside may have an even greater effect on the function and sustainability of a habitat fragment than the characteristics of the patch itself (Forman 1995). The distances between suitable habitat patches and the nature of the matrix between these patches will influence species survival (Ruggiero et al. 1994, Andren 1997). In general, more connected habitats are better than isolated habitats because patches in close proximity are likely to enhance species dispersal, recolonization, and persistence (Fahrig and Merriam 1994). Even where wildlife populations may decline or disappear in isolated patches due to random events or patch conditions, recolonization may occur if species are able to successfully disperse from nearby habitat (Pulliam et al. 1992). To maintain demographic linkages, suitable patches should be positioned to provide stop-over points or “stepping stones” for species dispersal (Forman and Godron 1981). The allowable distance between patches will depend

upon individual species' dispersal capabilities, which vary within and among species groups (Ruggiero et al. 1994, Bender et al. 1998). When making land use planning decisions, practitioners should consider the contribution of patches to the overall landscape structure and how well the location of any given patch relates or links to other patches (Dramstad et al. 1996).

- Boundary zone:** The contrast between a patch edge and the surrounding landscape matrix (also referred to as the boundary zone) affects the severity of edge effects and the dispersal abilities of wildlife populations. The higher the contrast between patch types or patches and their surrounding matrix, the greater the edge effects (Franklin 1993). Boundaries in a landscape could be either “hard” or “soft.” Hard boundaries usually result from human activities, such as clearcutting and development, and have linear borders with high vegetation contrast, such as between a forest and cultivated field. Soft edges, which dominate natural landscapes, tend to have varying degrees of structural contrast with curved habitat boundaries (Forman 1995). To minimize edge effects at the local scale and facilitate the movement of species between a patch and the surrounding matrix, land use planners should mimic naturally occurring edges and provide gradual thinning of vegetation (e.g., smaller shrubs grading into larger shrubs and taller trees at the edge of a wooded patch) rather than an abrupt transition from vegetated to denuded areas (Forman and Godron 1981, Forman 1995, Duerksen et al. 1997).
- Patch condition:** The quality of the habitat patch itself will also influence the ability of remnant species and systems to persist or function over the long-term (Fahrig and Merriam 1994, Forman 1995). Large patches with degraded habitat—such as those dominated by non-native species, or with diminished biological diversity, severe erosion, or modified hydrologic patterns—may have less conservation value than small patches of high biological integrity.<sup>19</sup> The biological integrity of land parcels and whether or not they contain unusual or distinctive landscape features (e.g., cliffs, caves, meadows, thermal features, and vernal pools), old-growth forests or mature habitats, or rare, threatened, or endemic species, are also factors that land use planners should consider when selecting which lands to conserve (Dramstad et al. 1996, Duerksen 1997, Lindenmayer and Franklin 2002).
- Role of small patches:** While large patches generally are recommended to provide sufficient habitat to sustain populations of species—particularly area-sensitive

species—small patches also play a vital role in regional conservation. Although larger patches may contain greater habitat diversity than smaller ones, a collection of multiple small patches may capture a greater array of habitats, and perhaps more rare species, than a single large habitat patch (Forman and Godron 1981, Saunders et al. 1991, Forman 1995, Tschartnke et al. 2002). Small wetlands of less than two hectares, for example, can support surprisingly high species richness of amphibians (Richter and Azous 1995 as cited in Metro 2001). Proximity to core habitat and local habitat heterogeneity, rather than riparian habitat area, may better predict reptile and amphibian richness (Burbink et al. 1998). In addition, small isolated riparian habitat patches have been found to be vital stop-over sites for en-route migratory birds in the southeastern United States (Skagen et al. 1998). If strategically positioned between larger habitat patches, smaller patches can serve as “stepping stones” to allow for greater species dispersal and recolonization (Murphy and Weiss 1988; Burel 1989 and Potter 1990 as cited in Fahrig and Merriam 1994; Forman 1995).

Many of the above described factors influence not only the effective habitat patch size, but also other fragmentation thresholds, such as the proportion of suitable habitat or the amount of edge in a landscape. Thus, land use planners should keep these design considerations in mind when interpreting the thresholds presented below.



**Diagram 4. Stepping stone patches.** Protecting habitat patches strategically positioned between larger habitat patches can be a way to enhance species dispersal and colonization in a landscape, and to increase local species population persistence. Modified from Duerksen et al. (1997), *Habitat Protection Planning: Where the Wild Things Are*, p 14.

<sup>19</sup> Biological integrity refers to “a system’s wholeness, including presence of all appropriate elements and occurrence of all processes at appropriate rates” (as cited in Angermeier and Karr 1994).





**Figure 1.** Minimum patch area requirements (in hectares) needed to maintain populations or communities of birds, mammals, fishes, invertebrates, or plants species in the United States, as cited in the scientific literature. Numbers represent the recommended minimum patch area sizes; two numbers along one line indicate a recommended range (see Appendix A for specific findings). Lines extend from zero to the recommended minimum patch area sizes to indicate the span of habitat needed for protection.

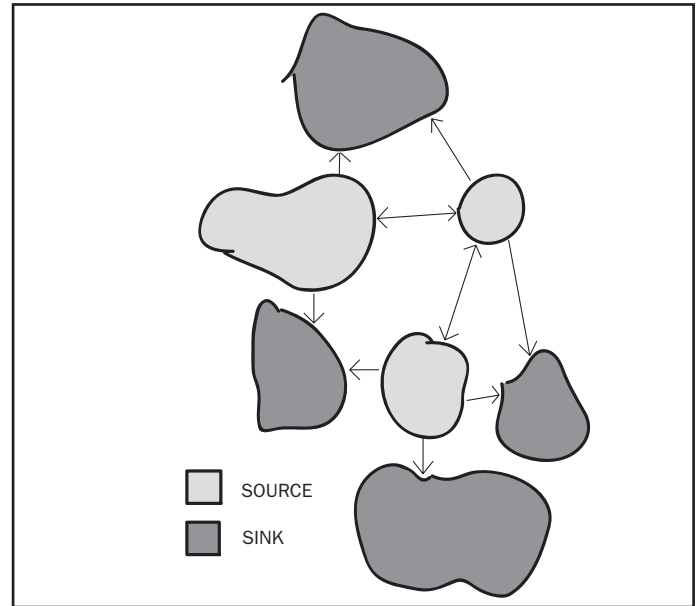


## SUITABLE HABITAT IN LANDSCAPE

Landscapes are complex assemblages of many habitat fragments that together help sustain large-scale biological systems. As a result, meeting minimum patch sizes for species in a given landscape may be inadequate to ensure their persistence (Fahrig 2001). The configuration and nature of the landscape surrounding a patch also greatly determine whether a region will support species persistence and diversity (Lindenmayer and Franklin 2002).

In addition to considering the size of patches, land use planners must consider the total amount of suitable habitat in a given landscape. Local populations of plants and animals are often linked together by dispersal, essentially forming a larger “metapopulation” (Hanski and Simberloff 1997).<sup>20</sup> Individual species from such subpopulations migrate between habitat patches, interacting and breeding with other individuals, which influences the overall survivorship of the species in a region. In addition, the quality and availability of habitat patches can greatly determine the viability of a metapopulation. Some habitat patches may be of higher quality allowing for the local species population to benefit from higher reproductive rates than death rates. These “source” populations produce excess individuals that could emigrate into neighboring patches to settle and breed, thus, expanding the overall population and helping to buffer it from local extirpation. On the other hand, some habitat patches may be of poor quality, where local productivity is less than mortality. Referred to as “sink” populations, these areas lack immigration of individuals from source populations, leading to the extirpation of the local population (Pulliam 1988). For species populations that exhibit a metapopulation structure, land use planners should strive to protect existing source habitat patches, as well as restore habitat that may serve to support future source populations. However, land use planners should be cautious not to designate critical habitat solely by the proportion of the local population present; a source habitat could support as little as 10 percent of the metapopulation, which is responsible for maintaining the other 90 percent of the total population (Pulliam 1988). Rather, land use planners should work with ecologists to identify source habitat by demographic characteristics (e.g., death and birth rates of species).

Metapopulation theory reveals that the local extinction of a subpopulation can be prevented by occasional immigration from neighboring patches, termed the “rescue effect,” which is considered important in maintaining small populations and high levels of species diversity (Brown and Kodric-Brown 1977, Stevens 1989). Local extinctions may commonly occur within small habitat patches; about 10-20 percent of certain local populations of plants, arthropods, amphibians, birds, and small mammals within various habi-



**Diagram 5. Metapopulation and Source/Sink Dynamics.** Local populations of organisms in different habitat patches may be linked demographically, forming an interdependent metapopulation. “Source” habitat patches, which supplement local populations in “sink” habitat patches, should be targeted for protection. Ideally, land use planners should protect entire metapopulations. Modified from Mette and Carroll (1994), *Principles of Conservation Biology*, p 188.

tat types have been found to go extinct per year (Fahrig and Merriam 1994). Thus, a set of interconnected habitat patches should be conserved to sustain sufficiently large metapopulations that would allow for regional species persistence.<sup>21</sup> Habitat patches must also be configured to facilitate dispersal and recolonization between patches, particularly those used for breeding and foraging (Saunders et al. 1991, Fahrig and Merriam 1994, Boulinier et al. 2001, Fahrig 2001). Land use planners should strive to identify particular subpopulations, habitat patches, or links between isolated patches that are critical for the maintenance of the overall metapopulation of priority species (Meffe and Carroll 1997).

Not only is the quality of the habitat patches themselves important, but also the condition of the matrix between isolated habitat patches. If the matrix is able to support populations of species present in the original contiguous habitat or allows for adequate species dispersal or migration between fragments, then communities in remnant patches may retain diverse and viable populations of native plants and animals (Askins 1995). Estimating the proportion of suitable habitat in a landscape is a larger scale method of determining how much suitable habitat should be conserved to ensure the persistence of species in a region.

#### MANAGING FOR THE AMOUNT OF NECESSARY HABITAT IN A LANDSCAPE

Scientists generally offer recommendations on the proportion of suitable habitat that should be conserved in a

<sup>20</sup> A metapopulation is a set of local populations that interact by individuals moving between the local populations (or subpopulations) (Hanski and Gilpin 1991).

<sup>21</sup> A local extinction refers to the extinction of a single, local population in a given geographic area; a local extinction does not entail that the entire species has gone extinct within its known range.

landscape based on two scientific trends. First, species disappear in a landscape with the loss of a certain amount of habitat, and different species go extinct at different thresholds of habitat loss (Fahrig 2002). Thus, scientists have estimated extinction thresholds to determine the proportion of suitable habitat needed to sustain specific species.<sup>22</sup> The “extinction threshold” is the minimum amount of habitat required for a population to persist in a region below which the population will go extinct (Fahrig 2001, Fahrig 2002).<sup>23</sup> Extinction thresholds are essentially the converse of population viability estimates derived from PVAs (described above).

Second, threshold values may be based on the amount of habitat below, which the negative effects of habitat fragmentation may compromise species persistence. This is termed “habitat fragmentation thresholds” (Andrén 1994, Fahrig 1998). As the proportion of suitable habitat decreases in a

<sup>22</sup> From a species perspective, suitable habitat has been interpreted as habitat utilized for nesting, with associated expected birth and death rates that allow for a stable or growing population (Lamberson et al. 1994).

<sup>23</sup> The extinction threshold may be estimated by: 1) the minimum amount of habitat below which the equilibrium population is zero; or 2) the minimum amount of habitat below which the probability of longterm population survival is less than one (Fahrig 2002).

landscape, the reduction in patch sizes and the increasing isolation of these fragments begins to significantly affect the abundance, distribution, or diversity of species in the landscape due to alterations in species movement or the spread of disturbance (e.g., wildfire, flooding, invasion by exotic species), among other factors (Gustafson and Parker 1992, Andrén 1994). The recommendations presented in this review are largely based on existing literature reviews of both extinction thresholds and habitat fragmentation thresholds (see Andrén 1994, Fahrig 2001).

Studies of suitable habitat range between 5 percent to 80 percent of the landscape depending on the species, geographic region, and parameters in question (see Appendix C). Seventy-five percent of the surveyed studies reported that suitable habitat should be up to 50 percent of the total landscape, whereas 50 percent of the studies reported at least 20 percent of habitat (see Figure 2). Given the constraints presented by the available literature (see “A Closer Look at Proportion of Suitable Habitat” in Appendix A for explanation on limitations), the conservation of greater proportions of habitat—such as a minimum of 60 percent—is recom-

### BOX 3. PLANNING AT THE RIGHT SCALE

Natural communities vary greatly in the area in which they occur. In order to determine which land parcels and how much habitat to protect, land use planners should plan at the appropriate scale for the target system or species. Ideally, planning would occur across multiple scales to capture the greatest habitat and species diversity (see Box 2 for a definition of scale).

#### 1. Coarse scale

Certain habitats and species, termed “matrix” habitats and “coarse-scale” species, will require planning to occur at a very large scale to capture their wide-ranging needs. Natural communities—such as spruce-fir forests (Northeast), longleaf pine forests (Southeast), tallgrass prairie (Midwest), and sagebrush (West)—can span as much as one million contiguous acres. Matrix communities are historically dominant habitat and exist across widespread physical gradients, such as broad ranges of elevation, precipitation, and temperature. Coarse-scale species (also termed wide-ranging species) require large areas to access the quantity of habitat or the different habitat types needed for survival (e.g., prairie chicken, fox, badger, marten, and pike minnow). Migratory species (e.g., migratory birds or salmon) and top-level predators (e.g., caribou, wolves, and bears) may depend upon not only matrix communities, but also associated habitat patches (described below), connecting corridors, and aquatic systems. To address the needs of such expansive communities and wide-ranging species, land use planners will need to take a landscape scale and regional approach; an area of several thousand acres up to one million acres may need to be conserved. This scale of planning will likely demand an inter-jurisdictional perspective and inter-municipal cooperation.

#### 2. Intermediate scale

Planning may need to occur at a smaller scale—on the order of several hundred to a thousand acres—to conserve “large patch” community types and “intermediate-scale” species. Occurring in large patches, but not as vast an area as matrix types, are communities like red maple-black ash swamps or northern hardwood forests. Large patch communities may span a thousand acres but

are bound by certain physical factors (e.g., coastal salt marshes being defined by low topographic position and predictable tides) or by a single dominant ecological process (e.g., fire, flooding, or drainage). Intermediate-scale species are those that depend on a single large patch or several different kinds of habitats (e.g., amphibians that depend on both wetland and upland complexes).

#### 3. Fine scale

Land use planners will need to plan at a more “fine” or site-specific scale to ensure that “small patch” communities and local-scale species are protected. Small patch communities are communities that naturally occur in narrow, localized, or discrete areas (e.g., fens, bogs, glades, caves, or cliffs) or occur only where specific or narrow physical factors and local environmental conditions are present (e.g., seepages, outcrops, certain types of soil). Local-scale species are species with limited movement and dispersal abilities or specific habitat needs that restrict their populations to a single community or habitat type. Belonging to this category are many rare and threatened species, insects, and plants. Occurrences of small patch communities and local-scale species may be found in only a couple of acres up to several hundred acres.

Given the natural variability in occurrence of communities and species and their wide-ranging geographic needs land use planners will need to plan at multiple scales to capture the biological diversity of a region, as well as to plan at the right scale for designated conservation targets.

The conservation thresholds found within this literature survey are predominately based on matrix and large patch communities, as well as coarse- and intermediate-scale terrestrial species. Thus, the findings and recommendations in this report do not fully address the conservation needs for small patch communities, local-scale species, and aquatic environments. To ensure the protection of restricted communities and rare species, land use planners will need to collaborate with local ecologists to identify priority conservation areas for their region.

*The above information is based on research by The Nature Conservancy (TNC) (see Poiani and Richter 2000, and TNC 1998).*

mended to sustain long-term populations of area-sensitive species and rare species.

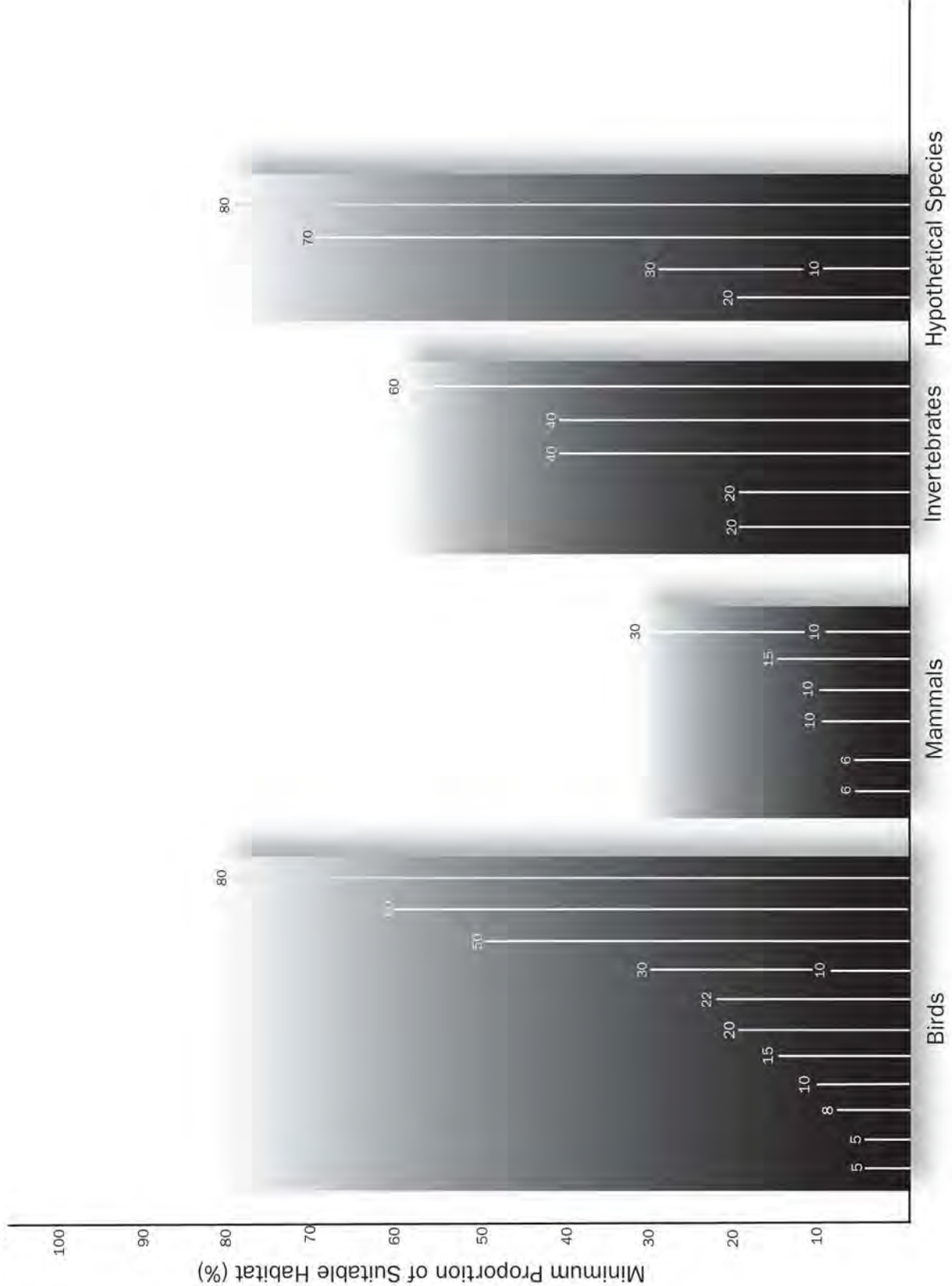
Scientists have proposed that more robust species (e.g., large dispersal range, high fecundity, high survivorship)—usually the more common widespread species—may persist in even the most extensively fragmented systems with only 25 to 50 percent of suitable habitat. In contrast, rare species and habitat specialists like the Northern spotted owl may require up to 80 percent of suitable habitat to persist in a region (Lande 1987, Lande 1988, Lamberson et al. 1992). Land use planners should take into account the more sensitive and rare species within their region to develop critical thresholds for proportions of suitable habitat relevant to their geographic setting (Mönkkönen and Reunanen 1999). Such an approach may also provide for the protection of more common and robust species that depend on similar habitat types.

In addition to the proportion of suitable habitat, other considerations should be factored into land use decisionmak-

*Land use planners should strive to conserve at least 20% to 60% of natural habitat in a landscape.*

ing, such as the spatial arrangements of remaining habitat patches and the matrix between patches. In landscapes that are highly fragmented—including most urban, suburban, and even rural areas with less than 30 percent of remaining suitable habitat—the spatial arrangement of habitat patches greatly affects species survival (Andrén 1994). For example, wetland bird communities are found to depend not only on their local habitat, but also on the amount of wetlands within a surrounding three kilometer buffer (Fairbairn and Dinsmore 2001).

The condition of the surrounding matrix in which habitat patches are embedded also influences the effective size of the remaining fragments and the degree to which the patches are isolated (Andrén 1994, Lindenmayer and Franklin 2002). In turn, these factors affect whether or not species will be able to successfully disperse among habitat patches and whether important ecosystem processes, such as fire and hydrologic cycling, will occur on the landscape (Fahrig and Merriam 1994) (*see* “Patch location/configuration”).



**Figure 2.** Recommended minimum proportions of suitable habitat (in percentages) needed to maintain populations or communities of birds, mammals, invertebrates, or hypothetical species (as determined by models) in the United States, as cited in the scientific literature. Numbers represent the recommended minimum proportions of habitat; two numbers along one line indicate a recommended range (see Appendix B for specific findings). Lines extend from zero to the recommended proportion to indicate the span of habitat needed for protection.



## EDGE EFFECTS

Habitat fragmentation inevitably results in the creation of edge environments. Edges occur where a habitat—such as a forest, prairie, or wetland—meets a road, clearcut, housing development, or some other natural or artificial transition or boundary (Soulé 1991). Habitat fragments differ from the original contiguous natural habitat in that they have a greater amount of edge per area and the habitat core is closer to an edge environment. Patch edges may have significantly different conditions than the contiguous system or habitat interior, with altered fluxes of wind, sun exposure, water, and nutrients that greatly affect animal and plant communities (Saunders et al. 1991, Murcia 1995). This change in energy, nutrient, or species flow results from increased amounts of edge and reduced interior habitat, and has been termed the “edge effect.”

Increased amounts of edge along habitats create a disturbed environment that allows for the establishment of pest and predator species, which penetrate the fragment interior and adversely affect the diversity and abundance of interior species (Primack 1993). Mammalian predators (e.g., raccoons, foxes, coyotes, feral cats), egg-eating birds (e.g., crows and blue jays), and brood parasitizers (e.g., brown-headed cowbirds) concentrate their hunting along forest edges, thus, increasing the intensities of predation on native species (Soulé 1991).<sup>24</sup> Habitat fragmentation also increases the vulnerability of remnant patches to invasion by exotic and pest species (Soulé 1991, Askins 1995). Higher frequency and intensity of disturbances, like fire and wind damage, may also result due to increased edge (Soulé 1991). Edges like roads and trails introduce such disturbances as pedestrian, pet, and vehicular traffic, causing animals to avoid such areas (Duerksen et al. 1997). Each of these edge effects has significant impact on the vitality and composition of the species in the remaining habitat patch.

Information on environmental and species response to edges helps determine how large patch sizes should be designed to provide sufficient interior habitat, as well as how far development, such as roads, trails, and housing, should be from remnant core areas.

## MANAGING FOR EDGE INFLUENCE

The intensity of edge effects has been measured by a number of different methods. The influence of an edge (termed “edge influence”) may be defined as the distance between the border to the point where microclimate and vegetation do not significantly differ from the interior conditions of the habitat. From a species perspective, edge influence may be defined as the distance from an edge to the area where species densities, survival rates, or reproductive rates



*Creation of edge by deforestation, Willamette National Forest, Oregon. Photo courtesy of Steve Holmer, American Lands Alliance.*

do not differ from those in the interior habitat (Forman 1995, Murcia 1995). Edge influence has also been measured by the behavioral response of animal movement, such as flushing distance, from a disturbance associated with edge environments.<sup>25</sup>

The intensity of edge effects is influenced by many physical factors, such as the shape and size of the patch, the direction the edge faces (i.e., aspect), and the structural contrast of its boundaries (Soulé 1991).

As discussed earlier, larger, circular patches will have more interior habitat and less edge than a rectangular or oblong patch of the same size (Forman and Godron 1981) (*see* “Patch shape”). The orientation of edges affect the amount of exposure to solar radiation, with edges facing the equator tending to have wider edge influence (Forman and Godron 1981, Murcia 1995). The more structurally different the boundaries between different habitat types, the greater the edge effects.

To decrease the influence of edge, buffers are recommended to “soften” the transition between natural and artificial environments (*see* “Boundary zone”). A remnant forest patch directly abutting cropland or urban development will have significant edge effects in contrast to a forest adjacent to a buffer of small shrubs or secondary vegetation. In addition, some habitat types may be more susceptible to negative edge effects; for example, grasslands have been found to exhibit wider edges than forest edges (Forman 1995).

Scientists offer a wide range of findings on the distance edge effects penetrate into ecosystems in the United States, with results ranging from only eight meters up to five kilometers. Based on the response of birds to edge environments, edge effects may penetrate into a habitat patch from about 16 meters up to almost 700 meters; mammals may avoid edge environments from 45 meters up to 900 meters; and microclimate changes may extend from eight meters up to 240 meters into habitat (*see* Appendix E). The majority of the surveyed studies (75 percent) estimates edge influence to be approximately 230 meters or less (*see* Figure 3).

Based on this select review, land use planners should take a conservative approach to mitigating edge effects. To pro-

<sup>24</sup> Cowbird females lay their eggs in the nests of other bird species, relying on these hosts to incubate and raise their chicks. Brown-headed cowbirds have been found to parasitize over 220 host species. (*see* <http://www.audubon.org/bird/research/cowbird-info.html>).

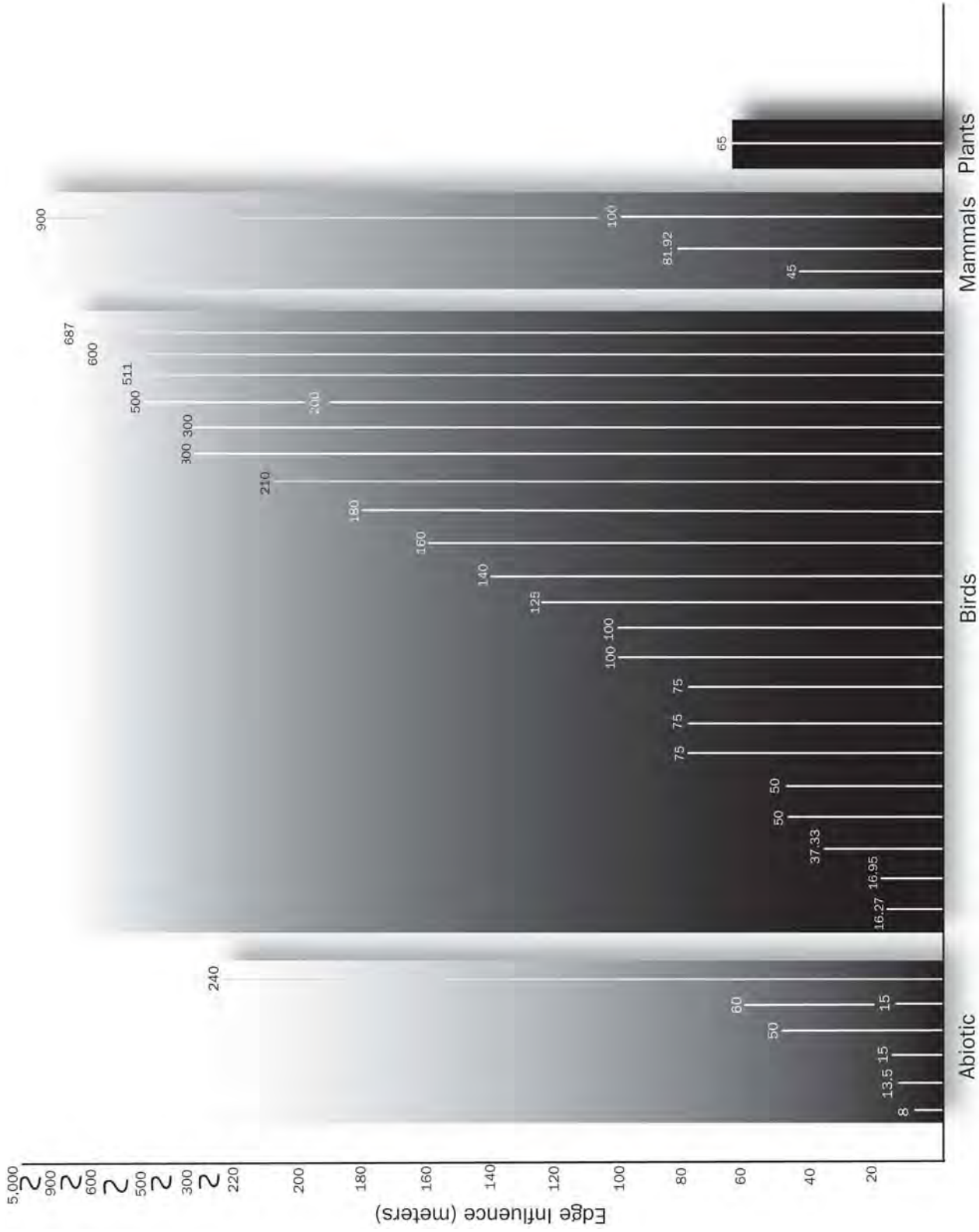
<sup>25</sup> Flushing distance is the distance that an animal may flee in response to a disturbance, such as in response to pedestrian or pets on a trail or vehicular traffic on roads (Duerksen et al. 1997).



vide for sufficient suitable habitat, land use planners should buffer remnant patches by at least 300 meters from all edge peripheries, particularly for matrix and large patch community remnants; naturally small patch communities may not require such a wide buffer (*see* Box 3). The area within the buffer should not be counted as suitable habitat provided for species conservation. In addition, roads, trails, and other development should be placed at least 300 meters away from interior habitat to minimize impact. Ideally, land use planners and ecologists should

*To avoid the negative effects of edges, land use planners should consider buffering up to 230 to 300 meters around edge peripheries.*

work collaboratively to determine the intensity of edge effects by the response of species or groups of species that are most sensitive to patch size in the ecosystems or regions of concern (Forman 1995). Measuring edge distance by the most sensitive species—often vertebrates of conservation concern—would mean that the influence of edges may actually be hundreds or thousands of meters, thus, requiring much larger patch sizes to meet habitat requirements.



**Figure 3.** Distances (in meters) that edge effects penetrate into habitats in the United States, as cited in the scientific literature. Edge width is measured by abiotic, bird, mammal, or plant responses; abiotic responses include microclimate changes, such as changes in temperature, humidity and light. Numbers represent edge width distance findings; two numbers along one line indicate a range of edge width distance (see Appendix C for specific findings). Lines extend from zero to the determined edge widths to indicate the span of habitat that is affected by edge effects.

## RIPARIAN BUFFERS

Although generally comprising a small proportion of the landscape—often less than 1 percent—riparian areas are regional hot spots that support a disproportionately high number of wildlife species and provide a wide array of ecological functions and values (Naiman et al. 1993, Fischer and Fischenich 2000, National Research Council 2002). The support of high levels of species diversity and ecological processes in these areas is due in part to regular disturbance events, like floods, as well as to climatic and topographic variation and the availability of water and nutrients (Naiman et al. 1993).

Riparian areas are ecosystems adjacent to or near flowing water, such as rivers, lakes, shorelines, and some wetlands. They are transitional areas between aquatic and upland terrestrial systems and exhibit gradients in environmental conditions, ecological processes, and living organisms (National Research Council 2002). Unfortunately, riparian systems are continuously threatened by adjacent or upstream human activities. For example, agricultural, industrial, or urban development can increase levels of light, temperature, stormwater runoff, sedimentation, pollutant loading, and erosion, which degrade water quality and diminish suitable aquatic habitat (Castelle et al. 1994). In the last 200 years,

over 80 percent of riparian land in North America and Europe has disappeared (Naiman et al. 1993).

To ameliorate the negative impacts of adjacent land uses, a common regulatory and management practice is to establish protected areas, or buffers, around aquatic resources like rivers, streams, lakes, and wetlands. At least 15 states and seven local jurisdictions in the United States have adopted riparian buffer regulations, protecting widths ranging from six meters to over 300 meters in size (Johnson and Ryba 1992).

Buffers are vegetated zones, usually linear bands of permanent vegetation, preferably native species, located between aquatic resources and adjacent areas subject to human alteration (Castelle et al. 1994, Fischer and Fischenich 2000). Buffers can help regulate riparian microclimate and provide necessary shading for the in-stream growth and reproduction of aquatic life; stabilize stream banks and prevent channel erosion; provide organic litter (e.g., leaf litter) and woody debris, which are important sources of food and energy for fish and aquatic invertebrate communities; remove or regulate sediment, nutrients, or other contaminants (e.g., pesticides, herbicides) from runoff; provide flood attenuation and storage to decrease damage to property; and provide wildlife habitat (Castelle et al. 1994, O’Laughlin and Belt 1995, Wenger 1999, Fischer and Fischenich 2000, National Research Council 2002).



*Riparian buffer establishment, North Hather Creek, Innoko, Alaska. Courtesy of U.S. Fish and Wildlife Service.*

## MANAGING FOR ADEQUATE BUFFER WIDTH

Recommended buffer widths are commonly determined by one of two methods: uniform versus variable widths. Uniform-width buffers are commonly adopted because they are easier to enforce, require less specialized knowledge, time, and resources to administer, and allow for greater regulatory predictability (Castelle et al. 1994). Uniform widths are often based on a single resource protection goal, usually related to water quality. In contrast, with variable-width buffers, the size or width of the strip is adjusted along its length to account for multiple functions, adjacent land use, and site and stream conditions. The width of the strip may be adjusted depending on the value of the aquatic resources, the intensity of surrounding land use, and the type and condition of vegetation, topography, soils, or hydrology, among other variables. For example, a larger width may be required for buffers surrounding more pristine or highly valued wetlands or streams; in close proximity to high impact land use activities; or with steep bank slopes, highly erodible soils, or sparse vegetation (Castelle et al. 1994, Fischer and Fischenich 2000).

Although the method of varying buffer width is generally believed to provide more adequate protection for aquatic resources, it may be less efficient because variable strips can retain less material than a uniform-width buffer of equivalent average width (Weller et al. 1998). Thus, providing policymakers with scientific guidance on uniform buffer widths allows for the implementation of practicable land management practices that protect aquatic resources.

For this report, riparian buffer widths are measured from the top of the bank or level of bankfull discharge of one side of a water body;<sup>26</sup> therefore, a 50 meter buffer on a 10 meter stream would create a zone at least 110 meters wide (Wenger 1999, Fischer and Fischenich 2000).

As with other conservation thresholds, the scientific literature does not support an ideal buffer width applicable in all circumstances. This survey found recommended buffer widths ranging from one meter up to 1600 meters, with 75 percent of the values extending up to 100 meters (see “A Closer Look at Buffer Width” in Appendix E for further discussion). At minimum, a riparian buffer should encompass “the stream channel and the portion of the terrestrial landscape from the high water mark towards the uplands where vegetation may be influenced by elevated water tables or flooding, and by the ability of soils to hold water” (Naiman et al. 1993).

*Land use planners should strive to establish 100-meter wide riparian buffers to enhance water quality and wildlife protection.*

The necessary buffer size varies considerably based on the specific management goal. In general, recommended buffer sizes are significantly greater if the intent is to protect ecological functions, such as providing wildlife habitat and supporting species diversity, as opposed to water quality functions.

Based on the majority of scientific findings, land use practitioners should plan for buffer strips that are a minimum of 25 meters in width to provide nutrient and pollutant removal; a minimum of 30 meters to provide temperature and microclimate regulation and sediment removal; a minimum of 50 meters to provide detrital input and bank stabilization; and over 100 meters to provide for wildlife habitat functions.<sup>27</sup> To provide water quality and wildlife protection, buffers of at least 100 meters are recommended (see Figure 4).

## OTHER BUFFER DESIGN CONSIDERATIONS

The width of any given buffer is just one aspect, albeit important, which determines its ability to provide a variety of functions. Other factors to consider are the linear extent, vegetation composition, and level of protection of buffers. The following is general guidance on the design and development of buffers.

- **Vegetation:** Buffers should have diverse vegetation that is both native and well-adapted to the region. Maintaining a diverse array of species and vegetation structure (e.g., herbaceous ground cover, understory saplings, shrubs, and overstory trees) is recommended to allow for greater tolerance to possible fluctuations in environmental conditions (e.g., water levels, temperature, herbivory), and to provide for greater ecological functions (e.g., wildlife habitat) (see Fischer and Fischenich 2000 for further guidance on vegetation type, diversity, and propagation techniques).
- **Extent:** In part, the effectiveness of a buffer in meeting management objectives is a function of the linear extent of the aquatic system that is protected (Wenger 1999). Protection efforts should prioritize the establishment of continuous buffer strips along the maximum reach of stream, rather than focusing on widening existing buffer fragments (Weller et al. 1998). Protection of the headwater streams as well as the broad floodplains downstream is also recommended. Headwater streams and downstream floodplains generally encompass less than 10 percent of total landmass; thus, this level of protection is practicable (Naiman et al. 1993). Ideally, buffers

<sup>26</sup> The bankfull discharge is the maximum level of discharge that a stream channel can convey without flowing onto its floodplain. This stage plays a vital role in forming the physical dimensions of the channel because the flows near the bankfull stage move the most sediment over the long-term and the processes of sediment transport and deposition are the most active in forming the channel (Dunne and Leopold 1978).

<sup>27</sup> While a 100-meter buffer is recommended to provide for adequate wildlife values, some natural riparian habitat is too narrow to support such an area. In these cases, land use planners should consider the utility of narrower buffers, especially where they might function as wildlife corridors (see “Habitat Connectivity”).



should extend along all perennial, intermittent, and ephemeral streams, lakes, shorelines, and adjacent wetlands (Weller et al. 1998, Wenger 1999), so long as such buffering would not create detrimental upland habitat fragmentation as might be the case in areas of high stream densities (Lindenmayer and Franklin 2002).

- **Buffer protection:** To ensure that buffers function adequately, all major sources of disturbance and contamination should be excluded from the buffer zone, including dams, stream channelization, water diversions and

extraction, heavy construction, impervious surfaces, logging roads, forest clear cutting, mining, septic tank drain fields, agriculture and livestock, waste disposal sites, and application of pesticides and fertilizers (Wenger 1999, Pringle 2001). Another consideration is the level of legal protection afforded to the area. Whether the buffer is in preservation status or protected under a conservation easement that allows for some level of activity, for example, will also determine its ability to provide desired functions.

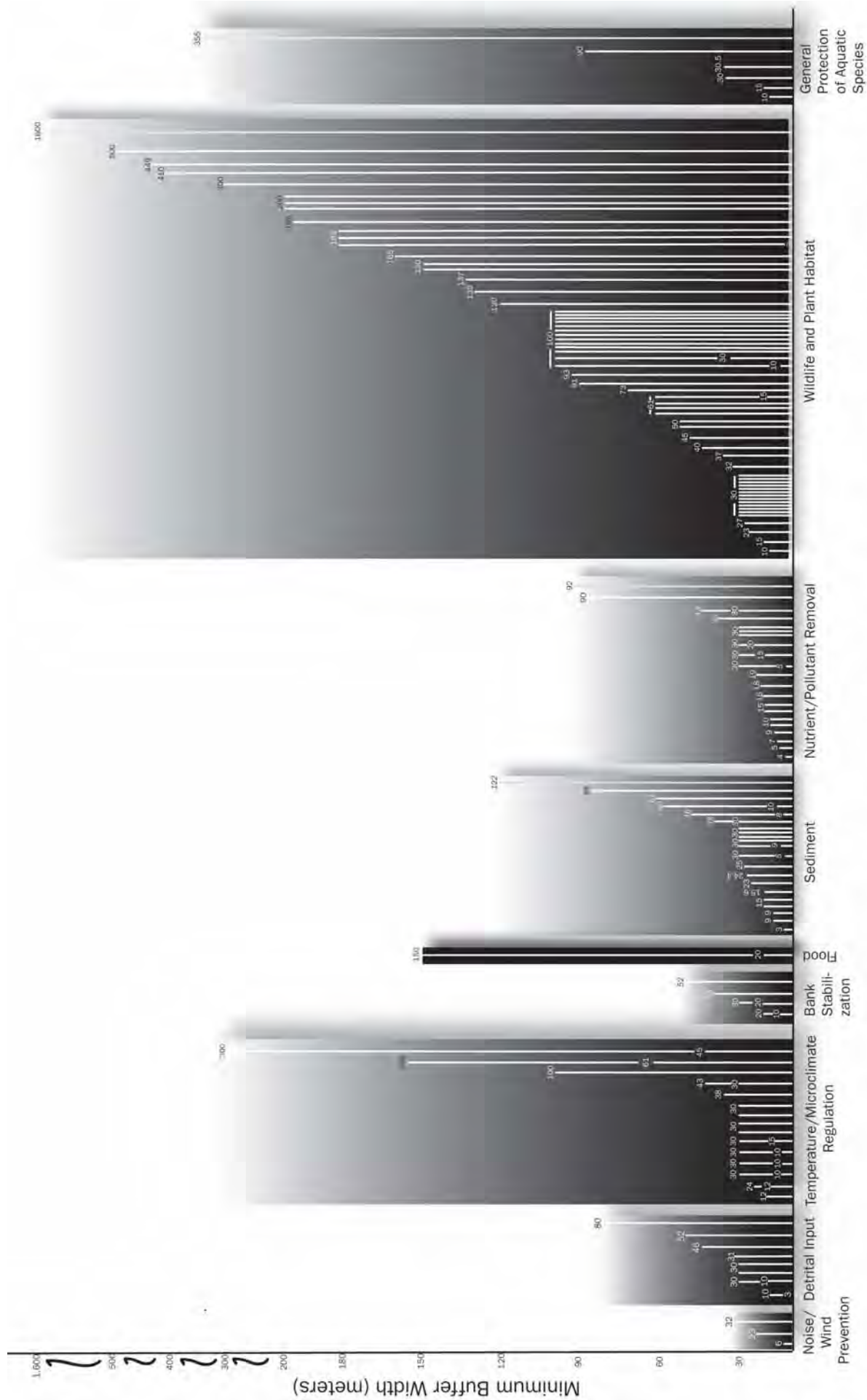
#### BOX 4. UNDERSTANDING THE EFFECTS OF LAND USE

The many different uses of land—whether for agriculture, silviculture, recreation/open space, or commercial or residential development—will have varying impacts on the ecosystems, habitats, and species in a region. The types, extent, and combinations of land uses within a matrix will affect the viability of habitat patch sizes, the amount of suitable habitat, the severity of edge effects, and the utility of buffers and corridors in a given landscape.

Certain land use types are likely to be more compatible with biodiversity conservation in certain landscapes, depending on the natural arrangement of physical features, habitats, and species, and the effect of previous land uses (Forman 1995). A study on breeding bird communities in central Pennsylvania, for example, found that forests within agricultural landscapes had fewer forest-associated species, long-distance migrants, forest-canopy and forest-understory nesting species, and a greater number of edge species than forest landscapes primarily disturbed by silviculture, irrespective of the effect of disturbance (Rodewald and Yahner 2001). In Colorado, ranchlands and protected reserves were found to be more compatible with species of conservation concern (including songbirds, carnivores, and plant communities) than exurban developments, which tended to support only human-adapted species (Maestas et al. *in press*).

To plan for long-term sustainability, land use planners will need more guidance on the level of compatibility of different land uses in various regions and ecosystems. As a general rule, a landscape mosaic should be planned first according to its ecological constraints (e.g., water availability, forest and soil productivity, natural flooding/fire cycles) and natural site potential (e.g., natural potential for productivity and for nutrient and water cycling) (Dale et al. 2000). In terms of hierarchical planning, a general recommendation is for land use planners to first plan “for water and biodiversity; then for cultivation, grazing, and wood products; then for sewage and other wastes; and finally for homes and industry” (Forman 1995 *as cited in* Dale et al. 2000, p.658).





**Figure 4.** Recommended minimum riparian buffers (in meters) from each side of a water body (e.g. stream bank) needed to prevent noise/wind damage; provide detrital input; moderate temperature/microclimate; stabilize banks; provide flood attenuation; control sediment; reduce nutrients/pollutants; and provide wildlife habitat functions and general protection of aquatic systems in the United States, as cited in the scientific literature. Numbers represent the recommended minimum buffer widths; two numbers along one line indicate a recommended range (see Appendix D for specific findings). Lines extend from zero to the recommended buffer widths to indicate the span of habitat needed for protection.

## HABITAT CONNECTIVITY

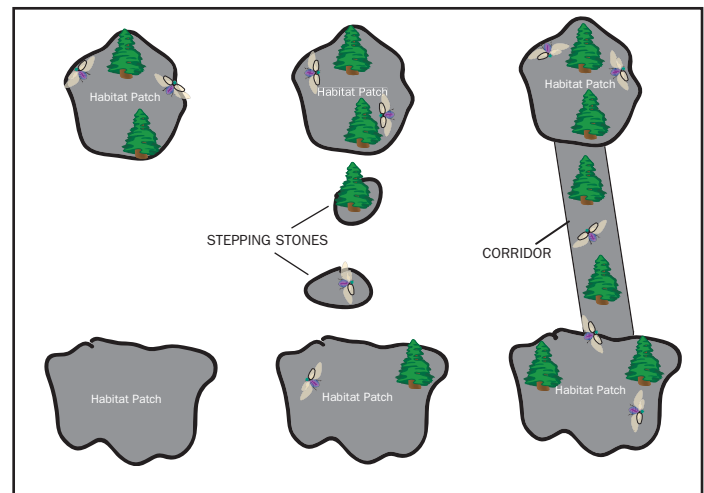
Conservation biologists generally agree that species viability and diversity are enhanced by well-connected habitats (Fahrig and Merriam 1985, Gilpin and Soulé 1986, Primack 1993, Noss and Cooperrider 1994, Meffe and Carroll 1997, Beier and Noss 1998, Lehtinen et al. 1999). Because small, isolated reserves are unlikely to maintain viable populations over the long-term, and because climate change and disturbances require that organisms be able to move over large distances, corridors are recommended as one conservation measure to counter the negative effects of habitat fragmentation and patch isolation (Noss 1991).

Not only can riparian buffers help ensure water quality protection and habitat for plants and animals adjacent to waterbodies, but they can also act as dispersal routes for species and connect remnant patches.<sup>28</sup> Although riparian corridors are useful for some terrestrial wildlife, linkages outside riparian areas may be required to maintain connectivity for non-associated upland species (McGarigal and McComb 1992).

Corridors (also referred to as conservation corridors, wildlife corridors, or dispersal corridors) are intended to permit the direct spread of many or most taxa from one region to another (Brown and Gibson 1983 as cited in Noss 1991). They should facilitate foraging movements, seasonal migrations, dispersal and recolonization, and escape from disturbance (Saunders et al. 1991, Soulé 1991). Whether or not corridors actually provide connectivity will depend largely on the species in question and its dispersal capabilities and movement patterns across the landscape (Saunders et al. 1991). Given the species-specific nature of this issue, generalizations about the biological value of corridors are under debate among the scientific community (Noss 1987, Simberloff and Cox 1987, Simberloff et al. 1992, Franklin 1993, Beier and Noss 1998) (for further discussion see Appendix A “Further Analysis”).

### MANAGING FOR OPTIMAL CORRIDOR WIDTH

An important design consideration when maintaining or establishing habitat corridors is width. Corridor width can influence the dispersal behavior of species, resulting in changes in home range size, shape, and use. In addition, corridor width is positively correlated with the abundance and species richness for birds, mammals, or invertebrates (Lindenmayer and Franklin 2002). As is true for other conservation thresholds, in general, the wider the better. Wider corridor bands are recommended to provide interior habitat conditions, which allows for the movement and/or habitation of interior species. In addition, greater habitat area is



**Diagram 6. Habitat Connectivity.** Habitat connectivity can be increased by the protection of stepping stone patches or by the establishment of a corridor. Modified from Dramsted et al. (1996), *Landscape Ecology Principles in Landscape Architecture and Land-Use Planning*, p. 37.

more likely to provide sufficient cover for species from predators, domestic animals, or human disturbance (Forman and Godron 1981). Corridors that are too narrow may consist entirely of edge, thus, deterring the use by interior or area-sensitive species or causing an increase in mortality from predation (Wilcove et al. 1986).

Although corridor width has been identified as an important design element, few studies explicitly examined minimum corridor width requirements. This survey found a limited number of studies that provide indirect evidence on effective corridor sizes, however, none of the reviewed studies explicitly tested different corridor widths with the goal of determining an optimal size. Although they did not directly examine recommended corridor width, three studies did find corridor widths of 32 meters and 100 meters to encourage the movement of butterflies and reduce species turnover rates for breeding birds, respectively (Haddad and Baum 1999, Haddad 1999 for butterflies; Schmiegelow et al. 1997 for birds).

Data limitations on the relationship between corridor width and species response prevent the development of recommendations on optimal corridor size. For any given set width, corridor effectiveness will vary with other attributes, such as length, habitat continuity, habitat quality, and topographic position in the landscape, among other factors (Lindenmayer and Franklin 2002) (see “Other Corridor Design Considerations”).

First and foremost, land use planners should strive to limit the degree of isolation between existing habitat patches and optimize the natural connectivity to allow for the dispersal of sensitive native species through the most appropriate means. This may be done by establishing habitat corridors, maintaining specific structural conditions within the landscape, or setting aside stepping stone patches (Lindenmayer and Franklin 2002) (see “Inter-patch distance”).

<sup>28</sup> A riparian corridor is a strip of vegetation adjacent to an aquatic system that connects two or more larger patches of habitat through which an organism is likely to move (Fischer et al. 2000). Corridors are not only riparian but also can be positioned in upland environments as well.

Simultaneously, land use planners should minimize the connectivity of artificial habitats like clearcuts, agricultural fields, and roadsides that tend to spread exotic and pest species (Noss 1991).

#### OTHER CORRIDOR DESIGN CONSIDERATIONS

Corridor width is one important factor that determines whether a corridor will enhance landscape connectivity. Other factors to consider are the condition of the landscape matrix, the distances between remnant patches, and the extent and configuration of the corridors themselves.

- **Condition of landscape matrix:** The landscape matrix in which corridors are embedded greatly influences corridor use. If conditions in the matrix are suitable (e.g., sufficient original vegetation cover exists), then species reliance on corridors may be minimized. On the other hand, if matrix conditions are inhospitable or degraded (e.g., are highly developed or fragmented; have disrupted ecological processes or disturbed conditions; or are highly invaded by exotic species), then corridor systems linking remnant patches may be required to retain landscape connectivity (Rosenburg et al. 1997 *as cited in* Lindenmayer and Franklin 2002). Given that land use planners often work in extensively developed or developing areas, the latter case is the most likely. Understanding the relationship between the landscape matrix and the movements of target organisms will be

fundamental in determining the best placement of corridors to enhance connectivity (Lindenmayer and Franklin 2002).

- **Inter-patch distance:** The distance between remnant patches will affect the conservation value of corridors. When distances between remnant patches are short as compared to the movement ability of target species, a stepping stone approach may be the most effective mechanism for promoting dispersal (*see* “Patch location/configuration”). On the other hand, if the distance separating habitat fragments is relatively far, corridors may be the right mechanism to provide landscape connectivity (Haddad 2000).
- **Corridor configuration and extent:** Networks of intersecting corridors may provide for more effective migratory pathways, allowing greater opportunities for animal foraging and predator avoidance (Forman and Godron 1981). Ideally, a corridor would “encompass the entire topographic gradient and habitat spectrum from river to ridgetop” (Noss 1991). Such an expansive corridor network may allow for the representation of different native habitat and land cover types in a region. In addition, having such a broad system of corridors would help enhance overall resiliency in case of the destruction of individual corridors by unexpected disturbances (Noss 1991).

#### BOX 5. CONSERVATION THRESHOLDS: A STARTING POINT

The following summarizes findings from a select sample of scientific papers pertinent to species and ecosystems in the United States on critical thresholds related to minimum habitat patch area, proportion of suitable habitat, edge influence, and riparian buffer width. Recommendations are based on the goal of capturing 75 percent of the requirements found for species, communities, and habitats surveyed; thus, the third quartile was used by calculating the value for which 75 percent of the threshold values lie below this value (after numerical ranking). These guidelines should be interpreted very cautiously because they are based on a small sample, and may not be applicable for specific species, habitats, and geographic settings of concern. Land use planners and land managers should consider these results as a baseline from which to launch more tailored and in-depth assessments.

##### Habitat Patch Area

In general, land use planners should strive to maintain and protect habitat patches greater than 55 hectares (137.5 acres). The goal should be to maintain larger parcels greater than 2,500 hectares (or about 6,175 acres) to protect more area-sensitive species.

##### Proportion of Suitable Habitat

In general, land use planners should strive to conserve at least 20 percent up to 50 percent of the total landscape for wildlife habitat, where possible.\* The conservation of greater proportions of habitat—such as a minimum of 60 percent—may be needed to sustain long-term populations of area-sensitive species and rare species.

##### Edge Influence

In general, to avoid the negative effects of edges on habitats, land use planners should consider establishing buffer zones up to at least 230 to 300 meters from the periphery of edges.

##### Riparian Buffer Width

In general, land use planners should plan for riparian buffer strips that are a minimum of 25 meters in width to provide for nutrient and pollutant removal; a minimum of 30 meters to provide temperature and microclimate regulation and sediment removal; a minimum of 50 meters to provide detrital input and bank stabilization; and over 100 meters to provide for wildlife habitat functions. To provide water quality and wildlife protection, buffers of at least 100 meters are recommended.

##### Landscape Connectivity

Land use planners should strive to reduce the distances between habitat patches and to optimize the natural connectivity of the landscape. This may be done by establishing habitat corridors that connect previously isolated patches; by maintaining the natural, structural conditions within the landscape; or by setting aside stepping stone patches. Simultaneously, land use planners should minimize the connectivity of artificial habitats like clearcuts, agricultural fields, and roadsides.

\*The 50 percent recommendation is based on capturing 75 percent of the threshold values surveyed; 20 percent is based on capturing 50 percent of threshold values surveyed. The latter recommendation is provided because land use planners are often working in highly developed regions where protecting 50 percent or more of the landscape is impractical.

## RECOMMENDATIONS FOR FUTURE RESEARCH AND ACTION

### THE ROLE OF THE SCIENTIFIC COMMUNITY

More scientific research is needed to help inform specific land use decisions being made everyday in the United States—decisions that significantly determine the future of domestic biodiversity. This survey of the scientific literature found that out of all land management strategies geared toward reducing the effects of urbanization and sprawl, the most substantial guidance available is on how to best develop riparian buffers. Conversely, science offers very little consensus opinion to land use planners on how to determine which habitat patches to conserve and where; the amount of habitat to protect in a region or conversely the maximum amount of impervious surface to allow; the ways in which to mitigate against the negative consequences of habitat edges; or how best to design and plan for corridors. In addition, because development will continue to occur and because private lands are increasing becoming more important in species conservation, more information is needed on the level of compatibility of the various types and combinations of land uses with biodiversity. To better inform decisionmaking, the scientific community needs to provide more specific information to land use practitioners on how to implement ecologically conscious growth.

In addition, scientists should address the taxonomic bias in the literature. A recent review of 134 papers on habitat fragmentation found that over half of the research focuses on birds, the vast majority being songbirds. Mammals and plants come second, making up about 18 percent; invertebrates and reptiles/amphibians are the most understudied, with only 9 percent and 4 percent, respectively (McGarigal and Cushman 2002). Our survey found similar results. Most of the fragmentation research used for this study looks at the effects of fragmentation on bird species and, to a lesser extent, mammals. Sixty-six percent of the surveyed research on edge effects; 57 percent on patch area; 44 percent on proportion of suitable habitat; and 32 percent of the wildlife papers on buffers measured effects on bird species.

*“Fragmentation effects are difficult to translate into management rules-of-thumb for several reasons: (1) they tend to be highly specific to the taxa, spatial scales, and ecological processes considered; (2) they vary according to the landscape type and its structure; and (3) their influence on species distribution and abundance may be obscured by local effects such as changes to certain microhabitat features (e.g., habitat degradation).”*

Villard (2002), Ecological Society of America, Ecological Applications 12(2), p.319

Mammals made up 24 percent of the research on proportion of suitable habitat; 21 percent on patch area; 11 percent of research on buffers; and 9 percent on edge effects. Fish, invertebrate, and plant response made up anywhere from zero to 13 percent of the research. This focus has left particularly large gaps in research on reptiles and amphibians, invertebrates, and plants.

If the scientific community wishes to help curtail the loss and endangerment of species, then it will need to start addressing other taxonomic groups. The most at-risk species in the United States are flowering plants and freshwater species. In terms of species numbers, flowering plants have by far the greatest number of at-risk species (over 5,000 species are at-risk). In terms of the proportion, species that rely on freshwater habitats—mussels, crayfishes, stoneflies, amphibians, and fishes—exhibit the highest level of risk. With only 14 percent of bird species being at risk and 16 percent of mammal species, these groups are the least threatened (Master et al. 2000).

Above all else, this literature search reveals the inadequacy of the information currently available for land use planners to use in their day-to-day decisions, which have profound effects on biological diversity. The scientific community should be commended for developing theories, such as metapopulation concepts, which have important implications for applied management like endangered species recovery. However, due to the simplified assumptions implied within metapopulation models, their application to real landscapes is severely limited (Fahrig and Merriam 1994). In addition, whether metapopulations are actually common in real landscapes is largely unknown (Lindenmayer and Franklin 2002). Similarly, the SLOSS debate on whether a single large reserve is better than a group of small ones, which consumed the academic community for many years, failed to produce concrete management recommendations (Forman 1995).<sup>29</sup> In order for ecological principles to be put into practice, land use professionals will need general rules of thumb and specific guidelines to implement on-the-ground.

<sup>29</sup> SLOSS stands for Single Large Or Several Small, which refers to whether conservation reserves are best designed as one large tract of protected land versus several smaller tracts of the equivalent area (Meffe and Carroll 1997).



Only about 10 percent of the papers reviewed in this survey provided quantitative information useful for developing conservation thresholds relevant to land use planning. Similarly, most of the papers published in the *Journal of Applied Ecology* during a large proportion of the last 30 years have been devoid of practical applications or management recommendations (Pienkowski and Watkinson 1996). Given the complexity surrounding habitat fragmentation, it is understandable that the scientific community is apprehensive about presenting or extrapolating research findings such that they can be easily applied to land use planning and management. Scientists even warn that providing general thresholds “may be more dangerous than useful because many species can be lost if the threshold is determined by averaging over the requirements of many species” (Mönkkönen and Reunanen 1999).

Without adequate information on land use thresholds, land use decisionmaking will continue to be uninformed by the best available science. Although reaching consensus in the scientific community on these thresholds may be an impractical goal, if enough resources are directed to answer specific land use threshold questions, research results may begin coalescing on some general range of values, which would provide useful guidance. Hopefully, this literature review will prompt scientific research that is relevant to and usable by everyday land use practitioners.

### THE ROLE OF THE POLICY COMMUNITY

Although more scientific study is needed to provide ecologically-based and scientifically defensible advice on land use planning and land management thresholds, substantial research has already been conducted. The policy community could play a more active role as a conduit between the scientific community and land use planners—to help interpret the available research, help with dissemination, and communicate back to scientists on research gaps and needs. Periodical reviews of the literature, such as this survey, should be conducted to provide land use planners and land management practitioners with the most up-to-date and best available scientific information. In addition, where possible, scientific research will need to be translated into easily applied management recommendations. To ensure that land use decisions are well-informed, mechanisms should be in place to communicate current scientific understanding to the general public. Scientific institutes, such as the National Academy of Sciences, among others, should conduct or commission studies on areas where particular research gaps are found. Clear arguments, particularly those that are economically based, need to be conveyed to the land use community so that they understand why they should make land use decisions with biodiversity in mind.

### THE ROLE OF THE LAND USE PLANNING COMMUNITY

The failure of land use planners to communicate their needs to the scientific community may be another reason that science inadequately addresses land use planning concerns. Land use practitioners should be encouraged to better communicate with scientists about the type of information that they need and in what format it would be most useful. An exchange about what is working on-the-ground and what is not, and about public concerns regarding land use alteration and biodiversity, would be of great benefit.

However, given the diverse habitat requirements of species and the great uncertainty and unpredictability of species and ecosystem response to habitat alteration, land use planners should not wait for the development of *the magical threshold value* before applying known general ecological guidelines, such as those presented by the Ecological Society of America’s Land Use Committee. To ensure that our natural resources will be conserved for future generations, spatial planning needs to proceed immediately using the best available information.

Land use planners should err on the side of caution and adopt the most conservative threshold ranges, particularly since factors, such as global climate change, are likely to intensify land use impacts. The future change of our climate—predicted to rise globally by an average about 4° Fahrenheit (2° Celsius) by the year 2100—is likely to alter the level and timing of temperature and precipitation and to increase the frequency of environmental disturbances (like floods, droughts, hurricanes, and fires), causing shifts in suitable ecosystem and species ranges, as well as the composition of species and flows of energy and nutrients (Field et. al. 1999). For species and ecosystems to be able to withstand such drastic environmental perturbations, sufficient intact and well-connected habitat will be essential. Thus, larger patch sizes, greater habitat area, wider buffers, and more corridors are likely required under future global warming than presented in this review.

Land use planners should realize that, ultimately, there is no replacement for site-specific assessments. It is both difficult and often misleading to develop thresholds that generalize across landscapes and across ecoregions (Mönkkönen and Reunanen 1999). Since thresholds will fail to be meaningful when generalized across landscapes, ecosystems, and states, thus unable to capture the unique variation in nature, land use planners and managers need to work in close collaboration with ecologists (Mönkkönen and Reunanen 1999). Land use professionals should use the articles and research highlighted in this review only to the extent that they are appropriate for their region and to launch more in-depth analyses. This review predominately covers thresholds and guidelines for planning at a large (coarse) scale. This report,

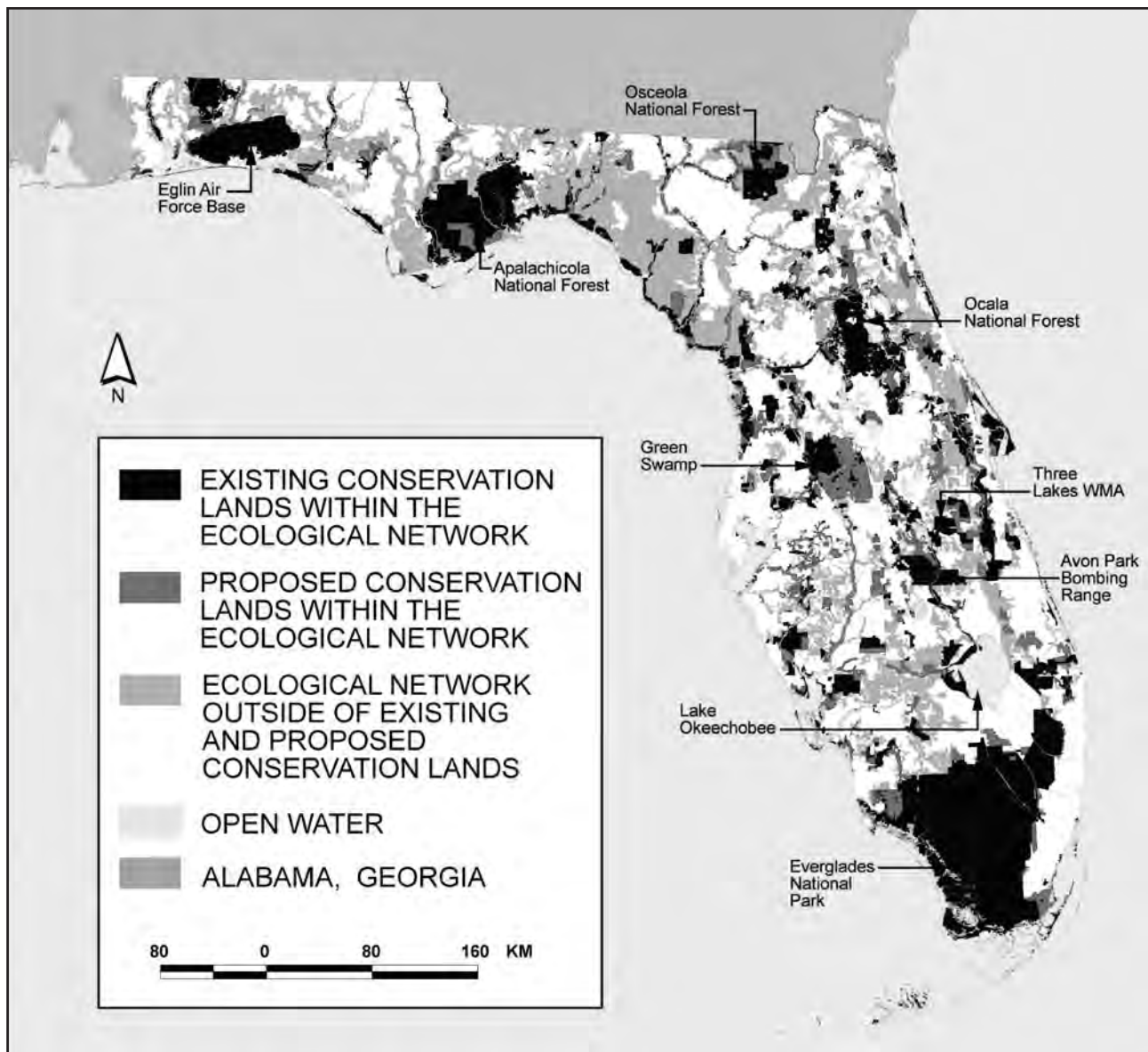


however, does not focus on the conservation of rare or localized species or habitat types, and species other than birds and mammals. It does not provide guidance on how to protect lands of greatest biological value. Rather than simply adopting the types of measures discussed in this review, land use planners should collaborate with scientists to better protect small patch communities and local-scale species and to better identify site-specific and regional conservation needs.

Although land use planners are asked to make local, site-specific decisions on a daily basis, it is still vital to maintain a landscape perspective. Numerous, small development projects that independently may not contribute to significant habitat loss, degradation, or fragmentation, may cumulatively have devastating consequences. Site-specific land use decisions would be more ecologically mindful if better informed by scientific information. Yet, to really make a difference for

biodiversity, land use planners will need to begin considering their cumulative and landscape-scale impacts.

Biodiversity needs to be a central component directly considered in all land use and community planning projects. An overarching land use vision with a statewide or county-wide blueprint for protecting ecosystems, representative and rare species, and broader patterns of biodiversity would serve as an important framework to guide the implementation of the specific thresholds outlined in this report. For example, Florida developed a model that identifies areas with priority conservation significance and landscape linkages (i.e., corridors) captures most of the major ecological communities and known occurrences of rare species for the entire state (Hector et al. 2000). Conserving regional biodiversity and accounting for land use impacts over a large scale—both spatially and temporally—will likely require inter-municipal cooperation and state-level leadership, as in the case of Florida.



**Diagram 7. Florida Ecological Network.** Results from the Florida Statewide Greenways GIS decision support model. Courtesy of the University of Florida.



## CONCLUSION

Land use decisions have profound effects on biological diversity. Land use planners, however, have many opportunities to tailor their traditional land use tools to better address biodiversity conservation. To the extent possible, planning decisions should be based on the best available science. Although the current scientific literature provides much guidance to land use planners on how to incorporate ecological knowledge into their actions, significant gaps exist in the information provided by the scientific community. The more that is known about how human mediated fragmentation impacts ecosystems, the more it is revealed that species and communities interact in complex,

dynamic, and often unpredictable ways on multiple temporal and spatial scales. For science to meet the needs of local land use planners, on-going and dedicated collaboration needs to exist between the scientific, policy, and land use planning communities. Although a consensus may never develop in the scientific community on broad conservation thresholds, more effective and targeted guidance can be developed to help land use planners make more ecologically informed decisions. Without this information, little incentive exists for land use planners and land managers to factor biodiversity considerations into their decisions at all.



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## APPENDIX A. FURTHER ANALYSIS

Titles and abstracts of 1,458 papers within scientific and land use planning journals were reviewed to determine whether they provide specific information on conservation thresholds that could help guide land use planning in the United States. A total of 160 papers (11 percent) were selected for inclusion in this study: 20 papers with quantitative information on minimum patch area; 27 papers on minimum proportion of suitable habitat; 25 papers on edge width distance; and 88 papers on minimum buffer width.<sup>30</sup>

### A CLOSER LOOK AT HABITAT PATCH SIZE

Only 20 papers were found in the scientific literature to provide specific information on minimum patch area requirements pertaining to ecoregions within the United States; these papers provided 28 citations on threshold patch size.<sup>31</sup> The majority of papers that address habitat patch size focus primarily on estimating the area of habitat needed to sustain specific target species—as measured by species occurrence, population densities, or breeding success—and to a lesser extent species diversity or community assemblages. As reported in previous literature reviews, little is known about the amount of patch area needed to maintain essential ecosystem functions, such as primary productivity, nutrient and hydrologic cycling, or disturbance regimes (Forman 1995).

This survey reveals a taxonomic bias in scientific literature. Out of the total 28 citations, 16 citations (57 percent) pertain to birds and six citations (21 percent) to mammals. Minimum patch area requirements reported in the literature ranged from one hectare to over 2,500 hectares for birds, and from one hectare to over 220,000 hectares for mammals. Only two studies provide three relevant citations on patch size requirements for plant species: an estimated two hectares needed to sustain a representative tree community type (Elfstrom 1974), and at least 10 hectares needed to conserve an old growth forest if surrounded by secondary forest, or 100 hectares if surrounded by clearcuts (Harris 1984). Two additional studies provide patch area information for invertebrates, which indicate that habitat requirements for invertebrates may range from a minimum of 0.0004 hectares (four meters squared) up to one hectare. One study provides

information for fishes, predicting a 50 percent chance of bull trout occurrence in watershed patches larger than 2,500 hectares (Rieman and McIntyre 1995).

Reported habitat patch size thresholds vary widely, even within the same taxonomic group and for the same species. This lack of convergence on minimum critical patch size reflects the large range of habitat needs exhibited by different species across different ecosystems and that species response to habitat fragmentation is very complex. This natural and inherent complexity is compounded by the lack of consistency in methodology researchers used to measure minimum habitat requirements—with differing study designs as well as parameters measured. Minimum patch area is commonly determined for target species by measuring species occurrence on a site, species densities, or nesting/breeding success. To a lesser extent studies evaluate the persistence of species diversity or community assemblages. Since different parameters are measured, different results are produced. For example, according to this survey, neotropical wood thrushes require anywhere from one hectare up to greater than 2,500 hectares of habitat depending on the variable measured (evidence of breeding versus nesting success and occurrence of nesting predation) (Robbins et al. 1989 and Trine 1998).

By in large, this review reiterates a viewpoint expressed by the scientific community several years ago: simply not enough is known about minimum critical size that should be protected in order to maintain species diversity and species composition in any given ecosystem (Lovejoy and Oren 1981 *as cited in* Saunders et al. 1991; Noss and Harris 1986). Given the lack of information on the habitat patch size requirements of species, communities, or ecosystems in the United States, land use planners should work with land and natural resource agencies and local scientists to identify the habitat patches most in need of protection.

### A CLOSER LOOK AT PROPORTION OF SUITABLE HABITAT

Twenty-seven papers were encountered within the scientific literature reporting extinction or habitat fragmentation thresholds on the proportion of suitable habitat needed for an array of species. The papers surveyed provide 26 different estimates of the amount of habitat needed, depending on the species and taxa in question, and the parameter measured. The majority of findings—42 percent (11 citations)—relate to the amount of habitat recommended to maintain bird

<sup>30</sup>These numbers only include papers that provided specific threshold information, which was factored into the assessment (see Appendices). Review papers and background papers are not included in these figures if they failed to provide relevant quantitative information.

<sup>31</sup> Because papers provide multiple findings/recommendations related to minimum patch area size requirements, the number of papers does not necessarily equal the number of citations.



species or populations. Based on this review, bird species in the United States may require anywhere from 5 percent to 80 percent of suitable remaining habitat.

The second most commonly researched group is mammals. About 23 percent of the findings (six citations) pertained to mammalian response to habitat loss and habitat isolation, which suggests that this taxonomic group may require anywhere from 6 percent to 30 percent of suitable habitat. This range, however, should not be considered representative for all mammalian groups, because it only includes small mammals (e.g., chipmunks, rabbits, squirrels) (*see* Appendix C). An important focal group—wide-ranging predators and large-bodied mammals—failed to be represented in this select review, thus, the proportions are skewed to the smaller range relevant to smaller bodied mammals.

Four studies (five citations) provide thresholds for invertebrates, ranging from 20 percent up to 60 percent of required protected habitat. Additionally, four studies base their findings on models predicting response by hypothetical species, which reveal that threshold responses may occur anywhere from as large a range as 20 percent to 90 percent of habitat loss.

As revealed by the diverse range of values offered by scientists, it is clear that no common threshold exists for the amount of habitat needed to support different populations of species or needed to minimize the negative effects of habitat fragmentation in a landscape. The lower range of proportions (e.g., 5 to 30 percent) tend to be habitat fragmentation thresholds, as determined by evidence that species are in some way negatively affected by habitat loss or habitat isolation. A significant proportion of these studies is based on predicted species response to habitat loss and fragmentation by models (at least seven of the citations). The larger proportions (e.g., 60 to 80 percent) tend to be based on models that predict the amount of habitat needed to sustain long-term species persistence or to prevent the consequences of extensive habitat fragmentation in a landscape.

Given the sparse and diverse findings, land use planners should apply these thresholds with great caution. As reported in earlier reviews, most of the habitat fragmentation studies are performed during short time periods (e.g., one or two seasons), and only provide a snap shot of how species may respond to habitat loss and isolation (Andrén 1994). In these studies, the damage to populations resulting from habitat alteration could have occurred previously (Mönkkönen and Reunanen 1999)—particularly for historically modified landscapes like eastern deciduous forests (Meier et al. 1995, Mitchell et al. 2002). Thus, the long-term consequences of fragmentation are likely not revealed in this select review because a time lag often exists between the fragmentation of a landscape and the associated response by species, populations, or systems (Andrén 1994).

Twenty-five studies surveyed provide 32 findings on the distance that edges might affect habitats in the United States. Like the other conservation thresholds, the focal species of choice is birds. Sixty-six percent of the findings (21 citations within 12 articles) measure the influence of edges related to bird response, revealing that edge influence for birds extends anywhere from about 16 meters to up to almost 700 meters. Studies measuring bird or bird nest abundance report that edge effects extend between 180 and 687 meters where as those measuring predation and nesting success range from 50 to beyond 600 meters. Bird response (e.g., flushing distance) to disturbances such as roads and human traffic extends from 16.27 meters to 300 meters.

Secondarily, the influence of edges is measured by abiotic responses. Edge effects based on microclimate conditions—such as changes in light, temperature, humidity, nutrients, and moisture—are found to extend from eight meters up to 240 meters based on five studies (six citations) (Ranney et al. 1981, Laurance and Yensen 1991, Brothers and Spingarn 1992, Matlack 1993, and Chen et al. 1995).

To a lesser extent, the scientific literature provides information on the effects of edges on mammals and plants. Three studies have found that mammals avoid edge environments from at least 45 meters to 900 meters. For example, studies reveal that wide-ranging grizzly bears are displaced from 100 to 900 meters due to traffic along roadways (Mills 1996, Miller et al. 2001, and Weaver et al. 1996). One study provides evidence on the influence of edges on plant communities, finding that almost no recruitment of seedlings occurs within 65 meters of forest clear-cut edges in Oregon (Jules 1998).

Within this review, no single study is found to report edge influence in relation to invertebrate communities in the United States. As is true for the other thresholds, research has been conducted more extensively in tropical forests outside of the United States, and may serve to address knowledge gaps. For example, a study in Brazil reveals that edge effects may be more intense for invertebrate groups. Edge effects may penetrate up to 50 meters as measured by bird density; 80 meters as measured by soil moisture; 100 meters as measured by canopy height, foliage density, and leaf-litter invertebrate abundance and richness; 200 meters as measured by leaf-litter invertebrate species composition and invasion of disturbance adapted beetles; and 250 meters for invasion of disturbance-adapted butterflies (Laurance et al. 1997).

To get a better handle on the intensity of edge influence in the United States and, consequently, the amount of habitat needed to reduce the effects of edges and related disturbances, land use planners will need more site-specific guidance from ecologists. Land use planners and land managers

will also need more information on effective measures that can be taken to better “soften” the many different types of edges affecting the large array of habitat types in the United States.

### A CLOSER LOOK AT BUFFER WIDTH

Eighty-eight papers (156 citations) are found to provide recommendations on riparian buffer widths.<sup>32</sup> Of all the conservation thresholds surveyed, buffer prescriptions are the most studied and best documented. Substantial research has been conducted on the effective size of buffers, particularly related to water quality considerations, to assist regulatory and land management agencies in developing scientifically sound minimum buffer width (Castelle et al. 1994). Several literature reviews have been conducted to help inform state and local governments in developing riparian protection plans and ordinances (*see* Johnson and Ryba 1992, Furfey et al. 1997, Wenger 1999, Fischer 2000, Fischer et al. 2000, and Metro 2001). In April 2000, the U.S. Army Corp of Engineers released national recommendations for riparian buffer strip and riparian corridor design (Fischer and Fischenich 2000). This baseline research significantly informed the buffer width recommendations in this report.

One review offers the following buffer prescriptions: a three to 10 meter buffer to provide detrital input; 10 to 20 meters for stream stabilization; five to 30 meters for water quality protection; 20 to 150 meters for flood attenuation; and 30 to 500 meters or more for riparian habitat (Fischer and Fischenich 2000). The Institute’s review reveals wider buffer ranges to provide a variety of functions, with a range of six to 32 meters to reduce noise and wind damage; 10 to 52 meters to stabilize stream banks; three to 80 meters to provide detrital input; four to 92 meters to remove nutrients and pollutants; three to 122 meters to remove sediments; 20 to 150 meters to provide flood attenuation; 10 to 300 meters to regulate temperature and microclimate; and three to 1600 meters to provide wildlife habitat (*see* Appendix E).

Findings in this review primarily relate to river and stream systems, however, a small number of papers explicitly address wetlands (*see* Buhlmann 1998 and Joyal et al. 2001). Although not all wetlands lie within riparian zones (e.g., isolated wetlands), they serve as vital resources and provide essential functions, such as flood storage, water purification, sediment trapping, and wildlife habitat (Mitsch and Gosselink 1993). Thus, placing buffers around these areas to protect them from nearby development activities is also advised.

Predicting the adequacy of a buffer strip to provide sufficient wildlife habitat and to protect natural species diversity is quite challenging. The width recommendations primar-

ily focus on birds and are based on various methods—ranging from determining species presence or nesting within the area to determining species abundance, diversity, or community assemblages. Few studies attempt to measure species survival over time; thus, it is questionable whether the recommended buffers will ensure persistence of the target species and communities over the long-term.

As mentioned above, the actual effective size and adequacy of any given buffer is determined by the management target, as well as other site-specific factors, such as site and watershed conditions; intensity of adjacent land use; slope steepness; stream order; soil characteristics (depth, texture, erodibility, moisture, pH); floodplain size and frequency of inundation; hydrology; buffer characteristics (e.g., type, density, and structure of vegetation, and buffer length); and landowner/manager objectives (Naiman et al. 1993, Castelle et al. 1994, Wenger 1999, Todd 2000). For example, larger buffers may be necessary when the buffer strip is in poor condition (e.g., comprised of sparse exotic vegetation, disturbed/erodible soils); is located on steep bank slopes (e.g., greater than 10 percent to 15 percent);<sup>33</sup> is surrounded by intense land uses; or is located within watersheds with increased impervious surfaces that results in high nutrient, chemical, and sediment inputs, and runoff (e.g., adjacent to urban/suburban areas or intensive agricultural farmland). Such factors should be considered when evaluating the applicability of the general recommended buffer sizes (*see* Wenger 1999, Fischer and Fischenich 2000, Metro 2001). In addition, management decisions should not only be based on site-specific characteristics but also on basin or watershed level needs to maintain the hydrologic connectivity and natural variability of these systems (Naiman et al. 1993, Pringle 2001).<sup>34</sup>

### A CLOSER LOOK AT CORRIDORS

To determine whether or not corridors are effectively enhancing species conservation, scientists evaluate whether (and how) patch occupancy, species abundance and diversity, colonization, and immigration rates change with and without the presence of corridors (Beier and Noss 1998).

Many studies lend support to the premise that corridors retain important species or provide faunal habitat (Bennett 1998). Few studies, however, provide clear evidence that corridors are required for species movement in landscapes (Hobbs 1992). Many species simply do not respond or require corridors (Rosenburg et al. 1997, Bowne et al. 1999, Hannon and Schmiegelow 2002). For example, male-hooded warblers preferentially travel across open areas, even in

<sup>33</sup> Herson-Jones et al. 1995 (found that greater than 10 percent slopes are steep slopes) and Nieswand et al. 1990 (found that greater than 15 percent slopes are steep) (as cited in Wenger 1999).

<sup>34</sup> Hydrologic connectivity refers to water-mediated transfer of matter, energy, or organisms within or between elements of the hydrologic cycle (Pringle 2001).

<sup>32</sup> Some papers recommend multiple buffer widths, for example, they may suggest different widths for different species or functions of concern. Thus, the number of papers does not equal the number of citations.

landscapes with corridors connecting habitat patches (Norris and Stutchbury 2001). For species like the Northern spotted owl, which has been found to disperse randomly, the presence of corridors will likely not enhance its survival (Murphy and Noon 1992 *as cited in* Lindenmayer and Franklin 2002). Because of the complexity of animal behavior, land use planners should not assume that establishing corridors between habitat patches in a region will automatically guarantee enhanced and effective dispersal and recolonization among the separated wildlife populations.

The benefits of corridors should be weighed against their potential repercussions. Scientists warn that corridors may potentially transmit diseases, fires, or other catastrophes among habitats and populations, as well as increase invasions by non-native invasions or exposure to predation (Simberloff and Cox 1987, Noss 1991, Noss and Cooperrider 1994). To add to the complexity of this issue, many corridor studies—

both those that claim corridor benefits and those that claim costs—suffer from design flaws that limit their ability to discern the real conservation value of corridors (Beier and Noss 1998).

A recent scientific review is able to shed some light on the corridor controversy; a review by Beier and Noss (1998) presents evidence from well-designed studies that suggest that corridors seem to be providing sufficient connectivity to enhance the viability of wildlife populations. Conversely, a lack of evidence backs the assertion that the presence of corridors actually has a greater adverse impact than their absence (Beier and Noss 1998, Hobbs 1992). Although wildlife corridors should not be automatically assumed to be an essential component of all land conservation strategies (Lindenmayer and Franklin 2002), planners should consider corridors as one potentially valuable conservation tool (Beier and Noss 1998, Hobbs 1992).

## APPENDIX B. MINIMUM PATCH AREA

Minimum patch area requirements (in hectares) found within the scientific literature (as of December 2001) to maintain populations or communities of animal or plant species in the United States. One hectare is about 2.5 acres.

TAXA	PATCH AREA	FINDING	STATE	CITATION
<b>Birds</b>				
	≥ 1 ha	Minimum area requirement for breeding wood thrushes is 1 ha, although nesting success on fragments of that size would be extremely low.	MD, PA, VA, WV	Robbins et al. 1989
	> 1	Five species of chaparral-requiring birds were supported by census plots larger than 1 ha.	CA	Soulé et al. 1992
	≥ 2 ha (seed-eating birds) ≥ 40 ha (insect-eating birds)	The minimum area point <sup>1</sup> for insect-eating birds was estimated to be at least 40 ha, in contrast to 2 ha for seed-eating birds. This is interpreted as the habitat size needed to support a representative bird community.	NJ	Forman et al. 1976 <sup>2</sup> Galli et al. 1976 <sup>2</sup>
	≥ 5 ha (marsh)	Ten of the 25 species did not occur in marshes less than 5 ha.	IA	Brown and Dinsmore 1986
	≥ 5, ≥ 30, ≥ 40, ≥ 50, ≥ 55 ha	Estimates of minimal area requirements for five area-sensitive species ranged from 5 to 55 ha.	IL	Herkert 1994
	≥ 6.5 ha, 15.4 -32.6 ha	Black tern required 6.5 ha in heterogeneous landscapes, but required 15.4 - 32.6 ha in homogeneous landscapes.	SD	Naugle et al. 1999
	≥ 10 ha (forest)	Forest patches ≥ 10 ha had much greater bird diversity than patches < 3.25 ha	GA	McIntyre 1995
	> 80 ha	In fragments < 80 ha, nesting success was low (43%), and nest predation was high (56%).	PA	Hoover et al. 1995
	< 20 ha, >2500 ha	Based on a study of cowbird parasitism and nest predation on 3 large forest tracts (1100 - 2200 ha) in southern Illinois, maintaining wood thrush populations in the midwest might require > 2500 ha reserves. In the east even a small woodlot (< 20ha) may sustain a population.	IL	Trine 1998
<b>Mammals</b>				
	> 1 ha	Control plots larger than 1 ha supported most species of rodents.	CA	Soulé et al. 1992
	≥ 5 ha	Cottontails may become vulnerable to extinction if large patches ≥ 5.0 ha are not maintained.	NH	Barbour and Litvaitis 1993
	≥ 10 ha	Fragments < 10 ha did not support populations of native rodents.	CA	Bolger et al. 1997

TAXA	PATCH AREA	FINDING	STATE	CITATION
	≥ 900 ha (9 km <sup>2</sup> )	More than 80% of bear sightings occurred in blocks of undisturbed habitat ≥ 9 km <sup>2</sup> .	MT	Mace et al. 1996 <sup>3</sup>
	≥ 2800 ha (28 km <sup>2</sup> )	Grizzly bears in the Yellowstone ecosystem should have security blocks 28 km <sup>2</sup> in size.	MT, ID, WY	Mattson 1990 <sup>3</sup>
	≥ 220,000 ha (2200 km <sup>2</sup> )	Model predicts low extinction risk for cougars in areas as small as 2200 km <sup>2</sup> , but w/ increasing risk with little immigration.	CA	Beier 1993
<b>Fishes</b>				
	> 2500	Found support that suitable patch size (as defined by watersheds above 1600 m elevation) influences the occurrence of bull trout. Predicted probability of occurrence is 0.5 for patches larger than 2500 ha.	ID	Rieman and McIntyre 1995
<b>Invertebrates</b>				
	≥ .0004 ha (4m <sup>2</sup> )	Vegetation patches ≥ 4m <sup>2</sup> , as well as open areas, were important to the distribution and abundance of carabid beetles.	OH	Crist and Ahern 1999
	≥ 1 ha	Observed minimum patch size for occupancy by populations of 3 butterfly species is 1 ha.	model	Hanski 1994
<b>Plants</b>				
	≥ 2 ha (5 acres)	Minimum area point <sup>1</sup> for tree communities was estimated to be about 2 ha.	NJ	Elfstrom 1974 <sup>2</sup>
	≥ 10, ≥ 100 ha	Conserving an old-growth forest might require 10 ha if surrounded by comparable forest, but 100 ha if surrounded by a clearcut.	—	Harris 1984 <sup>4</sup>

— Indicates that the geographic location was not determined because the recommendation was cited secondarily from another review article.

**model** indicates that the research was conducted through modeling and therefore is not specific to any geographic area.

<sup>1</sup> Minimum area point is the point on a species-area curve, which shows the relationship between species number and habitat area, where there is an abrupt change in the slope. The minimum area point has been considered an index of how large a community must be to representative of the community type (Forman 1995).

<sup>2</sup>As cited in Forman 1995

<sup>3</sup>As cited in Weaver et al. 1996

<sup>4</sup>As cited in Franklin 1993



## APPENDIX C. PROPORTION OF SUITABLE HABITAT

Recommended minimum proportions of suitable habitat found within the scientific literature (as of December 2001) to maintain long-term persistence of viable populations or communities of species or to minimize the negative consequences of habitat fragmentation in the United States.

TAXA	PROPORTION OF SUITABLE HABITAT	FINDING	STATE	CITATION
<b>Birds</b>				
	≥ 5%	When < 5% of area was covered by habitat, there was an effect on bird density.	WI	Ambuel and Temple 1983 <sup>1</sup>
	≥ 5%	When < 5% of area was covered by habitat, there was an effect on bird community.	—	Howe 1984 <sup>1</sup>
	> 8%	When 8% of area was covered by habitat, there was an effect on land bird community.	—	Nilsson 1978 <sup>1</sup> Nilsson 1986 <sup>1</sup>
	≥ 10%	When < 10% of area was covered by habitat, there was an effect on species richness.	—	Soulé et al. 1988 <sup>1</sup> Bolger et al. 1991 <sup>1</sup>
	>10-30%	The negative effects of patch size and isolation on native species may not occur until the landscape consists of only 10-30% of the original habitat.	review	Andrén 1994
	> 15%	When 15% of area was covered by habitat, there was an effect on bird density.	—	Askins et al. 1987 <sup>1</sup>
	> 20%	When 20% of area was covered by habitat, there was an effect on bird community.	MD	Lynch and Whigham 1984 <sup>1</sup>
	> 22%	When 22% of area was covered by habitat, there was an effect on land bird community	—	Whitcomb et al. 1981 <sup>1</sup>
	> 50%	Numerous species were more likely to inhabit wetlands in landscapes where less than 50% of the upland matrix was tilled.	SD	Naugle et al. 2001
	≥ 60%	A model assuming 60% suitable habitat suggests a high likelihood for the longterm persistence of Northern spotted owls.	model	Lamberson et al. 1994
	> 80%	Metapopulation model predicted that the Northern spotted owl population would go extinct if the proportion of old-growth forest was reduced to less than 20% of landscape.	model	Lande 1988 <sup>4</sup> Lamberson et al. 1992 <sup>4</sup>
<b>Mammals</b>				
	> 6%	When 6% of area was covered by habitat, there was an effect on chipmunk density.	—	Henderson et al. 1985 <sup>1</sup>
	> 6%	When 6% of area was covered by habitat, there was an effect on pika abundance.	—	Smith 1974 <sup>1</sup> Smith 1980 <sup>1</sup>
	≥ 10%	When < 10% of area was covered by habitat, there was an effect on mammal species richness.	—	Soulé et al. 1992 <sup>1</sup>
	> 10%	When 10% of area was covered by habitat, there was an effect on Columbian ground squirrel presence/absence.	—	Weddell 1991 <sup>1</sup>
	> 10-30%	The negative effects of patch size and isolation on the native species may not occur until the landscape consists of only 10-30% of the original habitat.	review	Andrén 1994
	> 15%	When 15% of area was covered by habitat, there was an effect on small mammal presence.	—	Lomolino et al. 1989 <sup>1</sup>

TAXA	PROPORTION OF SUITABLE HABITAT	FINDING	STATE	CITATION
<b>Invertebrates</b>				
	≥ 20%	The threshold for changes in movement patterns of beetles occurred at 20% coverage of cells.	CO	Wiens et al. 1997
	≥ 20%	Clover patches became significantly more isolated below 20% habitat, which disrupted the predator foraging behavior of ladybird beetles, decreasing their ability to serve as biocontrol agents of aphids.	model	With et al. 2002
	≥ 40%	Habitat specialists of grasshoppers exhibited limited movement and disjunct populations—which can affect population persistence—when preferred habitat occupied less than 40% of the landscape.	model	With and Crist 1995
	≥ 40, ≥ 60%	Rare species were disproportionately affected by fragmentation and did not occur in patches with less than 40% habitat. Over half of the species were never observed in plots with less than 60% habitat remaining.	OH	Summerville and Crist 2001
<b>Hypothetical Species</b>				
	> 10-30%	As habitat loss continues beyond the threshold (occurring somewhere in the range of 70-90% habitat loss) decline in population performance should become much more severe. But model predicts that habitat fragmentation begins to occur when about 60% of original vegetation remains.	model	Gardner et al. 1987 <sup>2</sup>
	≥ 20%	The threshold value of habitat amount is 20% habitat, below which the effects of habitat fragmentation on population persistence may become evident.	—	Andrén 1994 <sup>3</sup> Fahrig 1998 <sup>3</sup>
	> 70%	Models of forest landscapes forecast that patches of old-growth forest can become fragmented even when about 70% of the landscape cover remains.	model	Franklin and Forman 1987
	> 80%	Terrestrial species with low demographic potential could not persist in landscape even with 80% of suitable habitat in landscape.	model	Lande 1987 <sup>4</sup>

— Indicates that the geographic location was not determined because the recommendation was cited secondarily from another review article.

**model** indicates that the research was conducted through modeling and therefore is not specific to any geographic area. review indicates papers that base recommendation on a survey of the literature.

<sup>1</sup> As cited in Andrén 1994

<sup>2</sup> As cited in Dooley and Bowers 1998

<sup>3</sup> As cited in Fahrig 2001

<sup>4</sup> As cited in With and Crist 1995

## APPENDIX D. EDGE INFLUENCE

Distances (in meters) that edge effects penetrate into habitats in the United States as found within the scientific literature (as of December 2001), according to abiotic, bird, mammal, and plant response.

TAXA/SUBJECT	EDGE INFLUENCE	FINDING	STATE	CITATION
<b>Abiotic</b>				
	8 m	Microclimatic differences ceased to exist beyond 8 m into forest fragments.	IN	Brothers and Spingarn 1992
	13.3 m	Model indicated that elevated soil temperatures may extend up to 13.3 m from edge.	model	Laurance and Yensen 1991
	≥ 15 m	In deciduous forest patches, microclimate changes were estimated to extend at least 15 m from the forest edge to the interior.	WI	Ranney et al. 1981 <sup>2</sup>
	50 m	Significant edge effects were detected in light, temperature, litter moisture, vapor pressure deficit, humidity, and shrub cover, affecting the forest microenvironment up to 50 m from the edge.	PA, DE	Matlack 1993
	15-60 m (solar radiation) > 240 m (humidity and wind speed)	Solar radiation gradients extend 15–60 m into upland old-growth forest and humidity and wind speed gradients at > 240 m.	—	Chen et al. 1995 <sup>9</sup>
<b>Birds</b>				
	16.27 m, 16.95 m, 37.73 m	Maximum flushing* distance in response to pedestrians and dogs was 16.27 m (American robin), 16.95 m (vesper sparrow), and 37.73 m (western meadowlark).	CO	Miller et al. 2001
	50 m	Predation and parasitism rates are often significantly greater within 50 m of an edge.	—	Paton 1994 <sup>3</sup>
	50 m	Murrelet nest success was higher when nests were more than 50 m from the forest edge.	—	Nelson and Hamer 1995 <sup>4</sup>
	75 m	Estimated that edge-related nest predation extended 75 m into forested buffer strip.	ME	Vander Haegen and Degraaf 1996
	75 m, 100 m	For the majority of species found to have reduced numbers near trails due to nest predation and brood parasitism by brown-headed cowbirds, the zone of influence of trails appears to be around 75 m; however, Townsend's Solitaires exhibited reduced numbers as far as 100 m away from trail.	CO	Miller et al. 1998
	75 m, 125 m, 140 m, 160 m, 210 m, 300 m	Buffer zones that would prevent flushing by approximately 90% of the wintering individuals of a species are: American kestrel, 75 m; merlin, 125 m; prairie falcon, 160 m; rough-legged hawk, 210 m; ferruginous hawk, 140 m; and golden eagle, 300 m.	CO	Holmes et al. 1993
	100 m	Flushing distances of waterbirds in response to pedestrians, all-terrain vehicles, automobiles, and boats, indicate that human disturbance extends up to 100 m.	FL	Rodgers and Smith 1997

TAXA/SUBJECT	EDGE INFLUENCE	FINDING	STATE	CITATION
	180 m	Avian densities were altered up to 180 m away from homes on the perimeter of ex-urban developments.	CO	Odell and Knight 2001
	200–500 m	The abundance of interior habitat bird species was reduced within 200 to 500 m of an edge.	CA	Bolger et al. 1997b <sup>1</sup>
	≥ 300 m	Nest parasitism by brown-headed cowbirds decreased with distance away from forest edge but extended ≥ 300 m into the forest.	—	Brittingham and Temple 1983 <sup>5</sup>
	511 m, 687 m	Most Cooper hawk nests occurred 511 m from paved roads and 687 m from human habitation.	Northeast	Bosakowski et al. 1992
	600 m	Effect of increased predation extends 600 m into habitat.	—	Wilcove et al. 1986 <sup>1</sup>
<b>Mammals</b>				
	≥ 45 m	The influence of a clearcut on small mammals (California red-backed vole and deer mouse) extends at least 45 m into the forest from its edge.	—	Mills 1996 <sup>6</sup>
	81.92 m	Maximum flushing distance of mule deer in response to pedestrians and dogs was 81.92 meters.	CO	Miller et al. 2001
	100–900 m	Human traffic along open roads displaces most grizzly bears from 100–900 meters.	—	Mattson et al. 1987 <sup>7</sup> McLellan and Shackleton 1988 <sup>7</sup> Aune and Kasworm 1989 <sup>7</sup> Kasworm and Manley 1990 <sup>7</sup> Mace et al. 1996 <sup>7</sup>
<b>Plants</b>				
	65 m	Populations in forest remnants within 65 m of forest clear-cut edges have almost no recruitment of young plants.	OR	Jules 1998
<b>General</b>				
	5000 m	In different habitats and for different taxa, edge effects may penetrate up to 5 km.	—	Janzen, 1986 <sup>8</sup>

\* Flushing distance is the distance that an animal may flee in response to a disturbance, such as in response to pedestrian or pets on a trail or vehicular traffic on roads.

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**model** indicates that the research was conducted through modeling and therefore is not specific to any geographic area.

<sup>1</sup> As cited in Metro 2001.

<sup>2</sup> As cited in Collinge 1996

<sup>3</sup> As cited in Hartley and Hunter 1998

<sup>4</sup> As cited in Meyer and Miller 2002

<sup>5</sup> As cited in Robbins et al. 1989

<sup>6</sup> As cited in Lidicker 1999

<sup>7</sup> As cited in Weaver et al. 1996

<sup>8</sup> As cited in Laurance and Yensen 1991

<sup>9</sup> As cited in Brososfske et al. 1997

## APPENDIX E. RIPARIAN BUFFER WIDTH

Recommended minimum riparian and wetland buffer widths (in meters) to maintain water quality and wildlife functions within ecoregions of the United States, as found within the scientific literature (as of December 2001).

<b>FUNCTION</b>	<b>TAXA/SUBJECT</b>	<b>BUFFER WIDTH</b>	<b>CITATION</b>
<b>Miscellaneous</b>			
	Noise	≥ 6 m (mature evergreen)	Harris 1985 <sup>3</sup>
	Wind damage prevention	≥ 23 m	Pollock and Kennard 1998 <sup>3</sup>
	Noise	≥ 32 m (heavily forested)	Groffman et al. 1990 <sup>5</sup>
<b>Detrital Input</b>			
	Organic litterfall	1/2 SPTH	FEMAT 1993 <sup>3</sup>
	Large Woody Debris	1 SPTH	FEMAT 1993 <sup>3</sup>
	Large Woody Debris	1 SPTH	Spence et al. 1996 <sup>3</sup>
	Woody Debris	3–10 m	Fischer and Fischenich 2000
	Woody Debris	10–30 m	Wenger 1999
	Organic litterfall	≥ 30 m	Erman et al. 1977 <sup>3</sup>
	Woody Debris	≥ 30 m (forested watersheds)	Pollock and Kennard 1998 <sup>3</sup>
	Woody Debris	≥ 31 m	Bottom et al. 1983 <sup>4</sup>
	Woody Debris	≥ 46 m	McDade et al. 1990 <sup>3</sup>
	Organic litterfall	≥ 52 m	Spence et al. 1996 <sup>3</sup>
	Woody Debris	≥ 80 m	May 2000 <sup>3</sup>
<b>Temperature and microclimate regulation</b>			
	Microclimate	3 SPTH	FEMAT 1993 <sup>3</sup>
	Shade	10–30 m	Osborne and Kovacic 1993 <sup>3</sup>
	Temperature control	10–30 m	Wenger 1999
	Water temperature	10–30 m	Castelle et al. 1994
	Shade	11–24 m	Brazier and Brown 1973 <sup>5</sup>
	Water temperature	≥ 12 m	Corbett and Lynch 1985 <sup>4</sup>
	Water temperature	15–30 m	Hewlett and Fortson 1982 <sup>4</sup>
	Shade	23–38 m	Steinblums et al. 1984 <sup>5</sup>
	Shade	≥ 30 m	Spence et al. 1996 <sup>3</sup>
	Shade	≥ 30 m	FEMAT 1993 <sup>3</sup>
	Shade	≥ 30 m	May 2000 <sup>3</sup>
	Maintenance of water temperature within 1°C of former mean	≥ 30 m	Lynch, Corbett, and Mussalem 1985 <sup>1</sup>
	Water temperature	30–43 m	Jones et al. 1988 <sup>4</sup>
	Air temperature, solar radiation, wind, humidity	≥ 45–300 m	Brosofske et al. 1997
	Microclimate regulation	≥ 100 m	May 2000 <sup>3</sup>
	Microclimate regulation	61–160 m	Knutson and Naef 1997 <sup>3</sup>
<b>Bank Stabilization</b>			
	Bank Stabilization	1/2 SPTH	FEMAT 1993 <sup>3</sup>
	Bank Stabilization	10–20 m	Fischer and Fischenich 2000



FUNCTION	TAXA/SUBJECT	BUFFER WIDTH	CITATION
	Stream/channel stabilization	20–30 m	Corbett and Lynch 1985 <sup>4</sup>
	Stream stabilization/sediment control	≥ 38 m	Cederholm 1994 <sup>3</sup>
	Bank Stabilization	≥ 52 m	Spence et al. 1996 <sup>3</sup>
<b>Flood Attenuation</b>			
	Floodplain storage	20–150 m	Fischer and Fischenich 2000
<b>Sediment Removal</b>			
	Sediment removal	≥ 3m (sand), ≥ 15 m (silt), ≥ 122m (clay)	Wilson 1967 <sup>5</sup>
	Sediment removal	5–30 m	Fischer and Fischenich 2000
	Sediment removal	8–46 m (depending on slope)	SCS 1982 <sup>4</sup>
	Sediment (85% removal)	≥ 9 m (grass filter strips, 7%, 12% slopes)	Ghaffarzadeh et al. 1992 <sup>4</sup>
	Suspended solids (84% removal)	≥ 9 m (vegetated filter strip)	Dillaha et al. 1989 <sup>1</sup>
	Sediment removal	9–30 m	Wenger 1999
	Sediment removal	10–60 m	Castelle et al. 1994
	Sediment removal	≥ 15 m	Budd et al. 1987 <sup>4</sup>
	Sediment removal	≥ 15.6 m	Broderson 1973 <sup>4</sup>
	Sediment removal	≥ 23 m	Schellinger and Clausen 1992 <sup>4</sup>
	Suspended sediment (92% removal)	≥ 24.4 m (vegetated buffer)	Young et al. 1980 <sup>4</sup>
	Sediment removal	≥ 25 m	Desbonnet et al. 1994 <sup>4</sup>
	Sediment removal	≥ 30 m	Erman et al. 1977 <sup>3</sup>
	Sediment removal	≥ 30m	Moring 1982 <sup>3</sup>
	Sediment removal	≥ 30 m	May 2000 <sup>3</sup>
	Sediment (75% removal)	30–38 m	Karr and Schollosser 1977 <sup>4</sup>
	Sediment (75–80% removal)	≥ 30 m	Lynch, Corbett, and Mussalem 1985 <sup>1</sup>
	Sediment (80% removal)	≥ 61 m (grass filter strip and vegeated buffers)	Horner and Mar 1982 <sup>1</sup>
	Sediment (50% removal)	≥ 88 m	Gilliam 1988 <sup>4</sup>
<b>Nutrient/Pollutant Removal</b>			
	Nitrogen, Phosphorus, Potassium, and Fecal Bacteria	≥ 4 m (grass filter strip and forested buffers)	Doyle et al. 1997 <sup>1</sup>
	Nitrates and Phosphates (90% removal)	≥ 5 (grass filter strip)	Madison et al. 1992 <sup>1</sup>
	Nutrient removal	5–30 m	Fischer and Fischenich 2000
	Nitrates (almost complete removal)	≥ 7 m	Lowrance 1992 <sup>1</sup>
	Removal of Phosphorus (79%) and Nitrogen (73%)	≥ 9 m (vegetated filter strip)	Dillaha et al. 1989 <sup>1</sup>
	Nitrogen and Phosphorus	≥ 10 m	Corley et al 1999 <sup>1</sup>
	Nutrient and Metal	≥ 10 m	Petersen et al. 1992 <sup>4</sup>
	Nutrient removal	10–90 m	Castelle et al. 1994
	Nitrate Concentrations	15–30 m	Wenger 1999

FUNCTION	TAXA/SUBJECT	BUFFER WIDTH	CITATION
	Nutrient and metal	≥ 15 m	Castelle et al. 1992 <sup>4</sup>
	Phosphorus	≥ 15 m (hardwood buffer)	Woodard and Rock 1995 <sup>1</sup>
	Nutrient and metal	≥ 16 m	Jacobs and Gilliam 1985 <sup>4</sup>
	Estradiol (98% decrease)	≥ 18 m (grass filter strip)	Nichols et al. 1998 <sup>1</sup>
	Nitrogen and Phosphorus (80 and 89% removal, respectively)	≥ 19 m (riparian forest buffer)	Shisler, Jordan, and Wargo 1987 <sup>1</sup>
	Nitrates (up to 100%)	20–30 m	Fennessy and Cronk 1997 <sup>3</sup>
	Fecal coliform reduction	23–92 m	SCS 1982 <sup>5</sup>
	Pollutant removal	≥ 30 m	May 2000 <sup>3</sup>
	Fecal coliform reduction	≥ 30 m	Grismer 1981 <sup>5</sup>
	Nutrient reduction to acceptable levels	≥ 30 m	Lynch, Corbett, and Mussalem 1985 <sup>1</sup>
	Nutrient and metal removal	30–43 m	Jones et al. 1988 <sup>5</sup>
	Nutrient and metal removal	≥ 36 m	Young et al. 1980 <sup>4</sup>
<b>Wildlife and Plant Species</b>			
	General wildlife	3–183 m	FEMAT 1993 <sup>3</sup>
	General wildlife habitat	≥ 10 m	Petersen et al. 1992 <sup>5</sup>
	General species diversity	10–100 m	Castelle et al. 1994
	General bird habitat	≥ 15 m	Milligan 1985 <sup>5</sup>
	Fish (Cutthroat trout, rainbow trout, and steelhead)	15–61 m	Knutson and Naef 1997 <sup>3</sup>
	Birds	≥ 15–200 m	Stauffer and Best 1980
	Aquatic wildlife habitat	20–150 m	Fischer and Fischenich 2000
	General wildlife habitat	≥ 23 m	Mudd 1975 <sup>5</sup>
	General wildlife habitat	≥ 27 m	WDOE 1981 <sup>5</sup>
	Invertebrates (aquatic insects)	≥ 30 m	Erman et al. 1977 <sup>3</sup>
	Invertebrates (macroinvertebrate diversity)	≥ 30 m	Gregory et al. 1987 <sup>3</sup>
	Fish (cutthroat trout)	≥ 30 m	Hickman and Raleigh 1982 <sup>3</sup>
	Invertebrates (benthic communities)	≥ 30 m	Newbold et al. 1980 <sup>5</sup>
	Amphibians (frogs and salamanders)	≥ 30 m (riparian forest buffer)	NRCS 1995 <sup>3</sup>
	Fish (brook trout)	≥ 30 m	Raleigh 1982 <sup>5</sup>
	Fish (rainbow trout)	≥ 30 m	Raleigh et al. 1984 <sup>3</sup>
	Fish (chinook salmon)	≥ 30 m	Raleigh et al. 1986 <sup>5</sup>
	Invertebrates (benthic communities)	≥ 30 m	Roby et al. 1977 <sup>5</sup>
	Amphibians, Reptiles, Vertebrates	≥ 30 m (riparian forest buffer)	Rudolph and Dickson 1990 <sup>1</sup>
	Fish (salmonid egg development)	≥ 30 m	Spackman and Hughes 1995 <sup>1</sup>
	Plants (vascular plant diversity)	≥ 30 m	Spackman and Hughes 1995 <sup>1</sup>
	Fish (fish diversity and densities)	≥ 30 m	Stewart et al. 2000
	Mammals (beavers)	30–100 m	Jenkins 1980 <sup>9</sup>
	General wildlife habitat	≥ 32 m	Groffman et al. 1990 <sup>5</sup>
	Birds (Willow flycatcher nesting)	≥ 37.5 m	Knutson and Naef 1997 <sup>3</sup>

<b>FUNCTION</b>	<b>TAXA/SUBJECT</b>	<b>BUFFER WIDTH</b>	<b>CITATION</b>
	Birds (diversity and assemblages)	≥ 40 m	Hagar 1999
	Birds (assemblages and persistence)	≥ 45 m	Pearson and Manuwal 2001
	Mammal (gray squirrel)	≥ 50 m	Dickson 1989 <sup>1</sup>
	Birds (neotropical migrants, interior species)	≥ 50 m	Tassone 1981 <sup>3</sup>
	Birds (raptors)	50–1600 m	Richardson and Miller 1997 <sup>7</sup>
	Fish (trout, salmon)	≥ 61 m	Castelle et al. 1992 <sup>3</sup>
	Mammals (deer)	≥ 61 m	NRCS 1995 <sup>3</sup>
	General wildlife	≥ 61 m	Zeigler 1988 <sup>5</sup>
	Mammals (small)	67–93 m	Jones et al. 1988 <sup>5</sup>
	Reptiles (gravid mud turtles, Florida cooters, slider turtles)	≥ 73 m (90% protection)	Burke and Gibbons 1995
	Birds	75–200 m	Jones et al. 1988 <sup>3</sup>
	Mammal (beaver)	≥ 91 m	NRCS 1995 <sup>3</sup>
	Mammals (large)	≥ 100 m	Jones et al. 1988 <sup>5</sup>
	Birds (neotropical migrants)	≥ 100 m	Fischer 2000
	Wildlife habitat	≥ 100 m	Fischer, Martin, and Fischenich 2000; and Fischer and Fischenich 2000
	Birds (yellow-billed cuckoo breeding habitat)	≥ 100 m	Gaines 1974 <sup>2</sup>
	Birds (neotropical migrant diversity and functional assemblages)	≥ 100 m	Hodges and Kremetz 1996
	Birds (forest bird nesting habitat)	≥ 100 m	Keller et al. 1993
	Reptiles (Western pond turtle nesting habitat)	≥ 100 m (stream buffer)	Knutson and Naef 1997 <sup>3</sup>
	Aquatic wildlife	≥ 100 m	May 2000 <sup>3</sup>
	Birds (red-shouldered hawk and forest bird breeding habitat)	≥ 100 m	Mitchell 1996 <sup>2</sup>
	Birds (pileated woodpecker nesting habitat)	≥ 100 m	Small 1982 <sup>3</sup>
	Birds (neotropical migrant abundance)	≥ 100 m	Triquet, McPeck, and McComb 1990 <sup>2</sup>
	Terrestrial riparian wildlife communities	100–300 m (300 m for forest interior species)	Wenger 1999
	Reptiles (spotted turtles nesting habitat)	120 m (wetland buffer)	Joyal et al. 2001
	Reptiles (turtles)	≥ 135 m (wetland buffer)	Buhlmann 1998 <sup>1</sup>
	Birds (Pileated woodpecker)	≥ 137 m	Castelle et al. 1992 <sup>3</sup>
	Birds (species diversity)	≥ 150 m	Spackman and Hughes 1995 <sup>2</sup>
	Birds (reduce edge-related nest predation)	≥ 150 m	Vander Haegen and DeGraaf 1996
	Amphibians (salamanders)	≥ 165 m	Semlitsch 1998
	Birds (Bald eagle, nesting ducks, herons, sandhill cranes)	≥ 183 m	Knutson and Naef 1997 <sup>3</sup>
	Mammals (fawning of mule deer)	≥ 183 m	Knutson and Naef 1997 <sup>3</sup>

FUNCTION	TAXA/SUBJECT	BUFFER WIDTH	CITATION
	Plants (minimize non-native vegetation)	≥ 198 m	Hennings 2001 <sup>3</sup>
	Birds (Rufous-sided towhee)	≥ 200 m	Knutson and Naef 1997 <sup>3</sup>
	Reptiles (Blanding's turtles nesting habitat)	≥ 410 m (wetland buffer)	Joyal et al. 2001
	Reptiles (False map turtles, slider turtles, lotic turtles dispersal)	≥ 449 m	Bodie and Semlitsch 2000
	Birds (complete assemblages)	≥ 500 m	Kilgo et al. 1998 <sup>1</sup>
<b>General Protection of Aquatic Systems</b>			
	Multiple functions	1–90 m	Todd 2000
	Multiple functions	≥ 10 m	Fischer and Fischenich 2000
	Multiple functions	≥ 15 m	Fischer, Martin, and Fischenich 2000
	Multiple functions	30 m	Furfey et al. 1997
	Sediment/contaminant control, general water quality maintenance	30.5 m (+0.61 m per 1% slope)	Wenger 1999
	Wetland and river integrity	≥ 335 m	Schaefer et al. 1991 <sup>6</sup>

**SPTH**, or site potential tree height, is used as a standard measurement to allow for multiple riparian functions. SPTH is measured in various ways. FEMAT (1993) defines SPTH the height of a site potential tree as the average maximum height of the tallest dominant trees of 200 years or more of age for a given site class (For further discussion, refer to Metro 2001).

<sup>1</sup> As cited in Fischer and Fischenich 2000.

<sup>2</sup> As cited in Fischer 2000.

<sup>3</sup> As cited in Metro 2001.

<sup>4</sup> As cited in Furfey et al. 1997

<sup>5</sup> As cited in Johnson and Ryba 1992

<sup>6</sup> As cited in Burke and Gibbons 1995

<sup>7</sup> As cited in Fischer, Martin, and Fischenich 2000

<sup>8</sup> As cited in Hagar 1999

<sup>9</sup> As cited in Allen 1983

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1616 P Street, N.W., Suite 200  
Washington, D.C. 20036  
Telephone: (202) 939-3800  
Fax: (202) 939-3868  
[www.eli.org](http://www.eli.org)





# Fractured Genetic Connectivity Threatens a Southern California Puma (*Puma concolor*) Population

Holly B. Ernest<sup>1,2,\*</sup>, T. Winston Vickers<sup>1</sup>, Scott A. Morrison<sup>3</sup>, Michael R. Buchalski<sup>1,2</sup>, Walter M. Boyce<sup>1</sup>

**1** Wildlife Health Center, School of Veterinary Medicine, University of California Davis, Davis, California, United States of America, **2** Wildlife and Ecology Unit, Veterinary Genetics Laboratory, School of Veterinary Medicine, University of California Davis, Davis, California, United States of America, **3** The Nature Conservancy, San Francisco, California, United States of America

## Abstract

Pumas (*Puma concolor*; also known as mountain lions and cougars) in southern California live among a burgeoning human population of roughly 20 million people. Yet little is known of the consequences of attendant habitat loss and fragmentation, and human-caused puma mortality to puma population viability and genetic diversity. We examined genetic status of pumas in coastal mountains within the Peninsular Ranges south of Los Angeles, in San Diego, Riverside, and Orange counties. The Santa Ana Mountains are bounded by urbanization to the west, north, and east, and are separated from the eastern Peninsular Ranges to the southeast by a ten lane interstate highway (I-15). We analyzed DNA samples from 97 pumas sampled between 2001 and 2012. Genotypic data for forty-six microsatellite loci revealed that pumas sampled in the Santa Ana Mountains (n = 42) displayed lower genetic diversity than pumas from nearly every other region in California tested (n = 257), including those living in the Peninsular Ranges immediately to the east across I-15 (n = 55). Santa Ana Mountains pumas had high average pairwise relatedness, high individual internal relatedness, a low estimated effective population size, and strong evidence of a bottleneck and isolation from other populations in California. These and ecological findings provide clear evidence that Santa Ana Mountains pumas have been experiencing genetic impacts related to barriers to gene flow, and are a warning signal to wildlife managers and land use planners that mitigation efforts will be needed to stem further genetic and demographic decay in the Santa Ana Mountains puma population.

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\* Email: [hernest@uwyo.edu](mailto:hernest@uwyo.edu)

‡ Current address: Department of Veterinary Sciences, University of Wyoming, Laramie, Wyoming, United States of America

## Introduction

Genetic diversity, demography, and abundance – biological characteristics that influence population viability – can vary across a species' distribution. Species that are generally perceived as wide-ranging and abundant are sometimes relegated to status as “least conservation concern”, in spite of indicators signaling concern and frequently, lack of data. Pumas (*Puma concolor*; also known as mountain lion, cougar, and in Florida, panther) epitomize this dilemma. Although pumas in California have not been subjected to hunting since 1972, and were designated as a Specially Protected Mammal in 1990 [1], there is minimal active management and little scientifically validated data on statewide or regional population numbers. Pumas in southern California have one of the lowest annual survival rates among any population in North America, on par with rates seen in hunted populations (unpublished data). They are under increasing threats from habitat loss and fragmentation, and mortality from vehicle strikes, depredation permits, poaching, public safety kills, wildfire, and

poisoning [2,3]. Timely evaluation of potential threats to population viability is imperative in order to prioritize conservation activities to prevent collapse of some populations.

The human population of southern California is over 20 million [4] and expected to exceed 30 million by 2060 [5]. This increasing population will likely result in further loss, fragmentation, and degradation of natural habitats in the region. Habitat fragmentation south of greater Los Angeles has effectively turned the Santa Ana Mountain range in mostly Orange and Riverside counties into a ‘mega-fragment’ of habitat, surrounded to the west, north, and east by dense urban land uses. The only remaining montane and foothill habitat linkage connecting the Santa Ana Mountain range to other mountains of the Peninsular Range is a southeasterly swath of habitat bisected by a very heavily traveled 10-lane highway, Interstate 15 (I-15) (Figure 1).

Population viability of pumas in the Santa Ana Mountains (a geography henceforth referred to as distinct from the broader Peninsular Ranges to the east) has been of conservation concern



**Figure 1. Topographic map depicting location of Santa Ana Mountains, eastern Peninsular Ranges in southern California, and adjacent regions.** Inset shows location in the state of California.  
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for decades. Population monitoring and modeling in the 1980s highlighted that urbanization and highways were fragmenting puma habitat (e.g., [6]), and that in turn motivated efforts to protect habitat connectivity in the region (e.g., [7,8]). As part of a statewide assessment of puma genetic diversity and population structure, Ernest et al. [9] employed an 11-locus microsatellite panel and found that, for a limited sample size ( $n = 14$ ) Santa Ana pumas had lower genetic diversity than other populations in California. Since 2001, pumas in the region have been the subject of an ongoing study by the Karen C. Drayer Wildlife Health Center of the University of California, Davis (UCD) School of Veterinary Medicine. Telemetry data from 74 pumas in the UCD study has confirmed that minimal connectivity (only one GPS-collared puma over ten years was documented to transit successfully; unpublished data) exists between the Santa Ana Mountains and the eastern Peninsular Ranges across I-15, confirming that previous connectivity concerns were warranted.

We conducted a detailed appraisal of the genetic diversity, relatedness, and population structure of southern California puma populations. Using 97 samples collected over 12 years as part of the UCD study, and a 46-locus microsatellite panel, we evaluated levels of genetic diversity, estimated effective population sizes and tested whether genetic data supported a hypothesis of recent bottleneck in the populations. We assessed whether genetics reflected our telemetry observations of infrequent puma crossings of I-15 between the Santa Ana Mountains and the Peninsular Ranges to the east. Additionally we explored inter-population gene flow at multiple time scales by employing methods that reflect

recent (a few generations) and more historical (tens or more generations). Finally, we tested our hypothesis that the Santa Ana population had lower genetic diversity than those sampled from other regions in California.

## Materials and Methods

### Samples

We obtained blood or tissue samples for analysis of nuclear DNA from pumas captured for telemetry studies, and from those found dead or killed by state authorities for livestock depredation or public safety in San Diego, Orange, Riverside, and San Bernardino counties of southern California ( $n = 97$ ) during 2001–2012 (Figure 2). Pumas captured for telemetry were captured and sampled as detailed in [10]. Forty-two samples were collected to the west of I-15 in the Santa Ana Mountains, and 55 samples were collected in the Peninsular Ranges to the east of I-15. A small number of additional samples were collected from deceased animals in San Bernardino County just to the north of the Peninsular Range across Interstate Highway 10. For population genetic comparisons with pumas sampled elsewhere throughout California, a 257 sample subset of our statewide puma DNA data archive was employed (regions and sample sizes detailed in Table 1 and depicted in Figure 1 in [9]).

### Ethics Statement

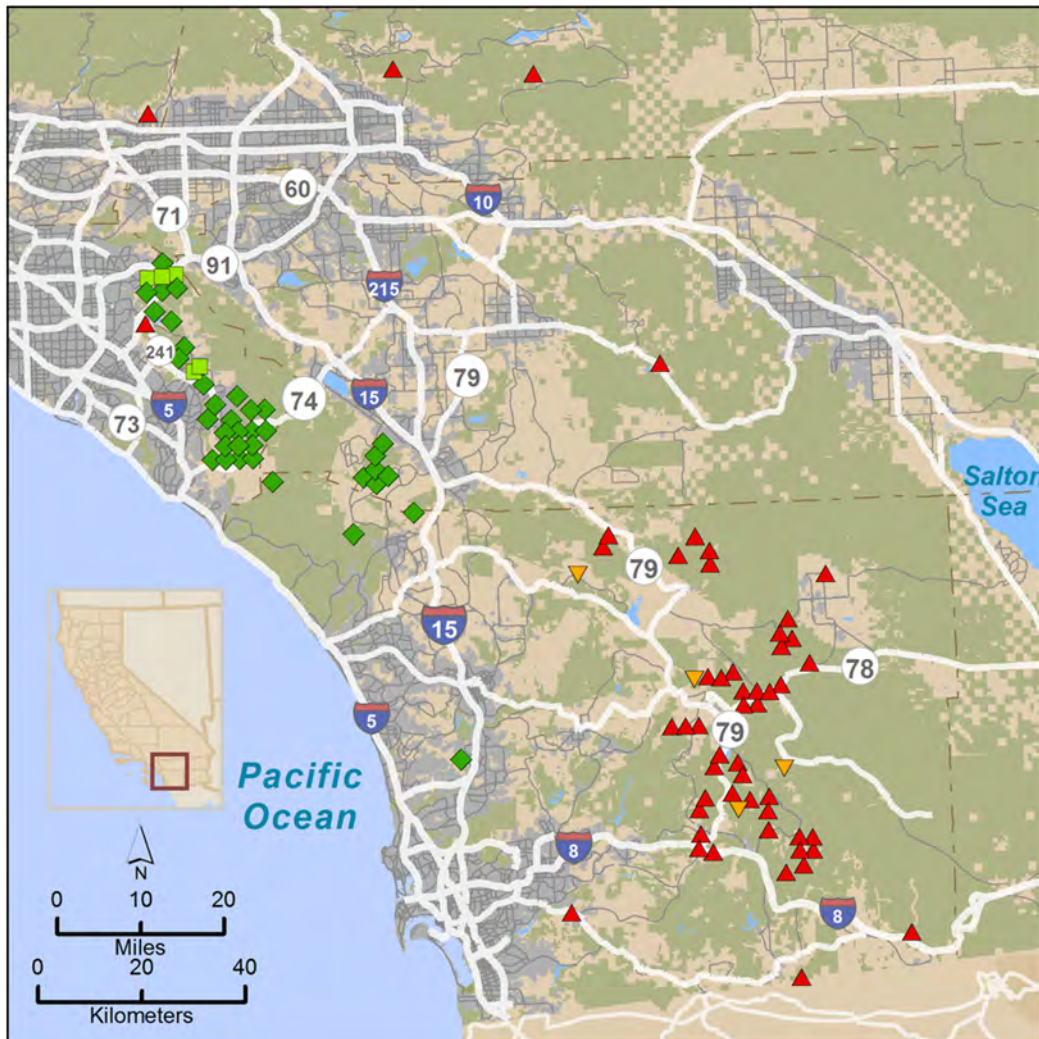
Animal handling was carried out in strict accordance with the recommendations and approved Protocol 10950/PHS, Animal

**Table 1.** Genetic diversity summary statistics for southern California pumas (n = 97) relative to other populations in California (n = 257).

Sampling Region	Abbrev.	N	Na	AR	Ho	He	I	%P
North Coast	NC	Mean	3.6	2.0	0.41	0.44	0.80	98%
		SE	0.2	0.1	0.03	0.03	0.05	
Modoc Plateau & Eastern Sierra Nevada	MP-ESN	Mean	4.2	2.4	0.52	0.54	0.98	100%
		SE	0.3	0.1	0.03	0.03	0.05	
Western Sierra Nevada	WSN	Mean	4.2	2.4	0.47	0.51	0.95	98%
		SE	0.2	0.2	0.03	0.03	0.06	
Central Coast: north	CC-N	Mean	3.2	1.9	0.41	0.41	0.70	98%
		SE	0.2	0.1	0.03	0.03	0.06	
Central Coast: central	CC-C	Mean	3.4	2.1	0.43	0.46	0.81	96%
		SE	0.2	0.1	0.03	0.03	0.05	
Santa Monica Mountains	CC-S	Mean	2.2	1.7	0.38	0.33	0.53	76%
		SE	0.1	0.1	0.04	0.03	0.05	
Peninsular Range-East	PR-E	Mean	3.1	2.0	0.43	0.41	0.74	87%
		SE	0.2	0.2	0.04	0.04	0.07	
Santa Ana Mountains	SAM	Mean	2.3	1.6	0.33	0.32	0.54	80%
		SE	0.2	0.1	0.03	0.03	0.05	

Abbrev. = region abbreviations used in Tables and Figures. Mean with standard error (SE). N = sample size. Na = average number of different alleles per locus. AR = allelic richness, standardized to sample size. Ho = observed heterozygosity. He = expected heterozygosity. I = Shannon's information index (Sherwin et al 2006). %P = percent of polymorphic loci. Regions are detailed further in text and generally follow California Bioregions designations. (<http://biodiversity.ca.gov/bioregions.html>).  
doi:10.1371/journal.pone.0107985.t001





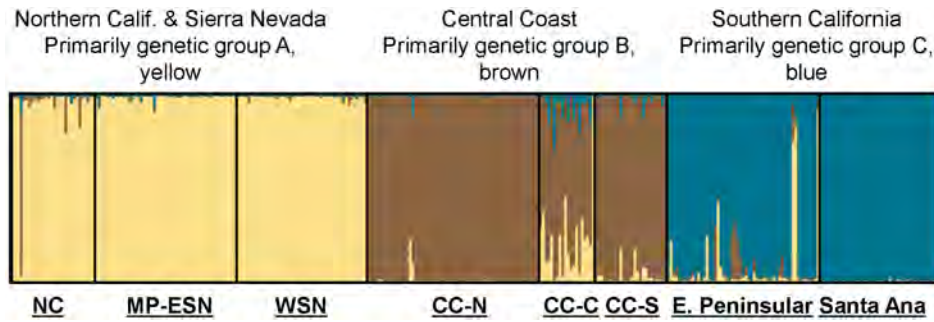
**Figure 2. Map of puma capture locations in the Santa Ana Mountains and eastern Peninsular Ranges of southern California.** Colors of symbols represent genetic group assignment inferred from Bayesian clustering analysis (STRUCTURE analysis, see Figure 4). Genetic group A-1 = green diamonds; A-2 = red triangles (apex at top). One male puma (M86) captured in the Santa Ana Mountains had predominant genetic assignment to the A-2 (red) genetic group. Five individuals (light green squares) captured in the Santa Ana Mountains had partial assignment to the A-2 group (M91, F92, M93, M97 and F102). Molecular kinship analysis showed that M86 and a female (F89) captured in the Santa Ana Mountains were parents of pumas M91, F92, and M93 (captured in the Santa Ana Mountains). Puma M97 assigned in parentage to M86 and F61, while F102 had unknown parentage (no parentage assignments; due possibly to her death early in project prior to collection of most of the samples). Three individuals (orange triangles, apex at bottom), had partial assignment (however, less than 20%) to A-1. doi:10.1371/journal.pone.0107985.g002

Welfare Assurance number A3433-01, with capture and sampling procedures approved by the Animal Care and Use Committee at the University of California, Davis (Protocol #17233), and Memoranda of Understanding and Scientific Collecting Permits from the California Department of Fish and Wildlife (CDFW). Permits and permissions for access to conserved lands at puma capture and sampling sites were obtained from CDFW, California Department of Parks and Recreation, The Nature Conservancy, United States (US) Fish and Wildlife Service, US Forest Service, US Bureau of Land Management, US Navy/Marine Corps, Orange County Parks Department, San Diego County Parks Department, San Diego State University, Vista Irrigation District, Rancho Mission Viejo/San Juan Company, Sweetwater Authority, California Department of Transportation (CalTrans), and the City of San Diego Water Department.

#### DNA Extraction and Microsatellite DNA data collection

Whole genomic DNA was extracted using the DNeasy Blood & Tissue Kit (QIAGEN, Valencia, CA, USA). Fifty microsatellite DNA primers were initially screened for this project. Forty-six loci that performed well in multiplex PCR (using the QIAGEN Multiplex PCR kit; QIAGEN) and conformed to expectations for Hardy-Weinberg and linkage equilibria were selected for ultimate analysis [11,12,13]. One sex-identification locus (Amelogenin) was used to confirm sex in samples from degraded puma carcasses [14].

PCR products were separated with an ABI PRISM 3730 DNA Analyzer (Applied Biosystems Inc., Foster City, CA, USA) with each capillary containing 1  $\mu$ L of a 1:10 dilution of PCR product and deionized water, 0.05  $\mu$ L GeneScan-500 LIZ Size Standard and 9.95  $\mu$ L of HiDi formamide (both products Applied Biosystems Inc.) that was denatured at 95°C for 3 min. Products



**Figure 3. California puma population genetic structure.** STRUCTURE bar plot displaying the genetic clustering relationship of southern California pumas relative to others in California. Three major genetic groups, A (blue, on right), B (brown, in center), and C (yellow, on left), are evident for analysis of 354 individuals sampled throughout California. Abbreviations: NC=North Coast, MP-ESN=Modoc Plateau & Eastern Sierra Nevada, WSN=Western Sierra Nevada, CC-N=Central Coast: north, CC-C=Central Coast: central, CC-S=Central Coast: South (Santa Monica Mountains), PR-E=Peninsular Range-East, SAM=Santa Ana Mountains. The plot is organized by grouping individuals in order of their geographic region sampling source. Proportional genetic assignment for each puma is represented by a vertical bar, most easily visualized for pumas that genetically assigned to a group different from most others sampled in its region (for example one individual with over 80% brown and 8% blue near far left of group A). Pumas primarily from the Sierra Nevada Range and northern California are represented by group A (yellow), group B (brown) includes primarily Central Coast pumas and group C (blue) represents primarily southern California pumas (Santa Ana Mountains and eastern Peninsular Ranges). doi:10.1371/journal.pone.0107985.g003

were visualized with STRand version 2.3.69 [15]. Negative controls (all reagents except DNA) and positive controls (well-characterized puma DNA) were included with each PCR run. Samples were run in PCR at each locus at least twice to assure accuracy of genotype reads and minimize risk of non-amplifying alleles. For >90% samples, loci that were heterozygous were run at least twice and homozygous loci were run at least three times.

#### Genetic diversity

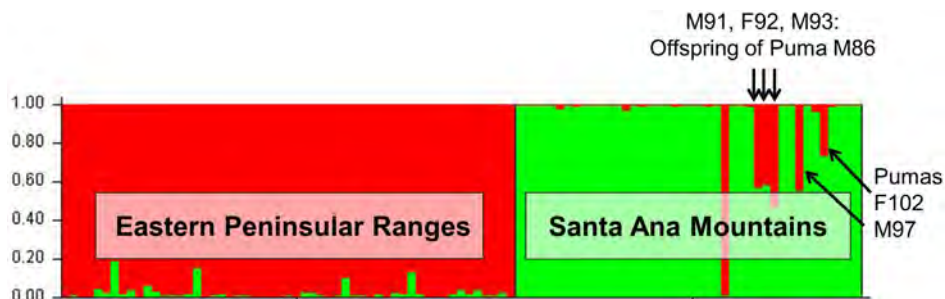
The number of alleles ( $N_a$ ), allelic richness (AR; incorporates correction for sample size), observed heterozygosity ( $H_o$ ), expected heterozygosity ( $H_e$ ), Shannon's information index [16], and tests for deviations from Hardy-Weinberg equilibrium were calculated using software GenAlEx version 6.5 [17,18]. Shannon's information index provides an alternative method of quantifying genetic diversity and incorporates allele numbers and frequencies. Testing for deviations from expectations of linkage equilibrium was conducted using Genepop 4.2.1 [19], and we tested for the presence of null alleles using the program ML RELATE [20]. We assessed significance for calculations at  $\alpha = 0.05$  and used

sequential Bonferroni corrections for multiple tests [21] in tests for Hardy-Weinberg and linkage equilibria.

The average probability of identity (PID) was calculated two ways using GenAlEx: 1) assuming random mating ( $PID_{RM}$ ) without close relatives in a population [22], and 2) assuming that siblings with similar genotypes occur in a population ( $PID_{SIBS}$ ) [23]. Probability of identity is the likelihood that two individuals will have the same genetic profile (genotype) for the DNA markers used.  $PID_{SIBS}$  is considered conservative since it probably conveys a higher likelihood; however, we recognized that siblings occurred in these populations.

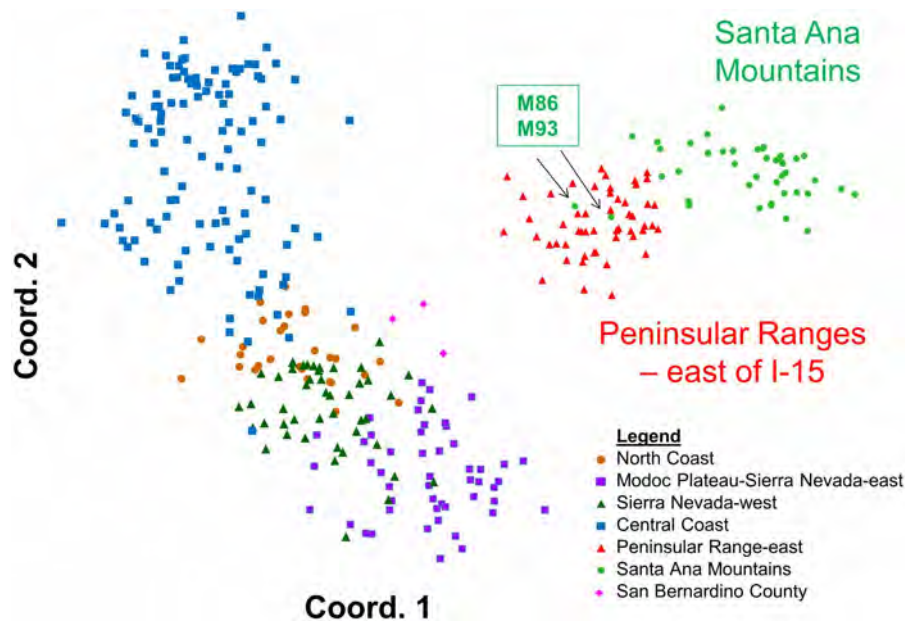
#### Assessing population structure and genetic isolation

We used a Bayesian genetic clustering algorithm (STRUCTURE version 2.3.4 [24,25]) to determine the likely number of population groups ( $K$ ; genetic clusters) and to probabilistically group individuals without using the known geographic location of sample collection. We used the population admixture model with a flat prior and assumed that allele frequencies were correlated among populations, and ran 50,000 Markov chain Monte Carlo repetitions following a burnin period of 10,000 repetitions. First,



**Figure 4. Southern California puma population genetic structure.** Bar Plot displaying results of STRUCTURE analysis focused on genotypic data from 97 southern California pumas (the blue block from Figure 3). With removal of the strong genetic signal from northern California and Central Coast samples (see Figure 3), two distinct southern California groupings were inferred, C-1 (green, on right) and C-2 (red, on left). These reflect the two regions: Santa Ana Mountains to the west of I-15 (predominantly genetic group C-1) and eastern Peninsular Ranges to the east of I-15 (predominantly genetic group C-2). Genetic clustering is dependent on genetic variance among samples included in the analysis. One male puma (M86) captured in the Santa Ana Mountains has predominant genetic assignment to the C-2 (red) genetic group (the predominant genetic cluster for PR-E), and five others had partial assignment to the C-2 group (M91, F92, M93, M97 and F102). Molecular kinship analysis showed that M86 and a female (F89) assigning to the C-1 genetic group were parents of pumas M91, F92, and M93 (all were captured in the Santa Ana Mountains). doi:10.1371/journal.pone.0107985.g004

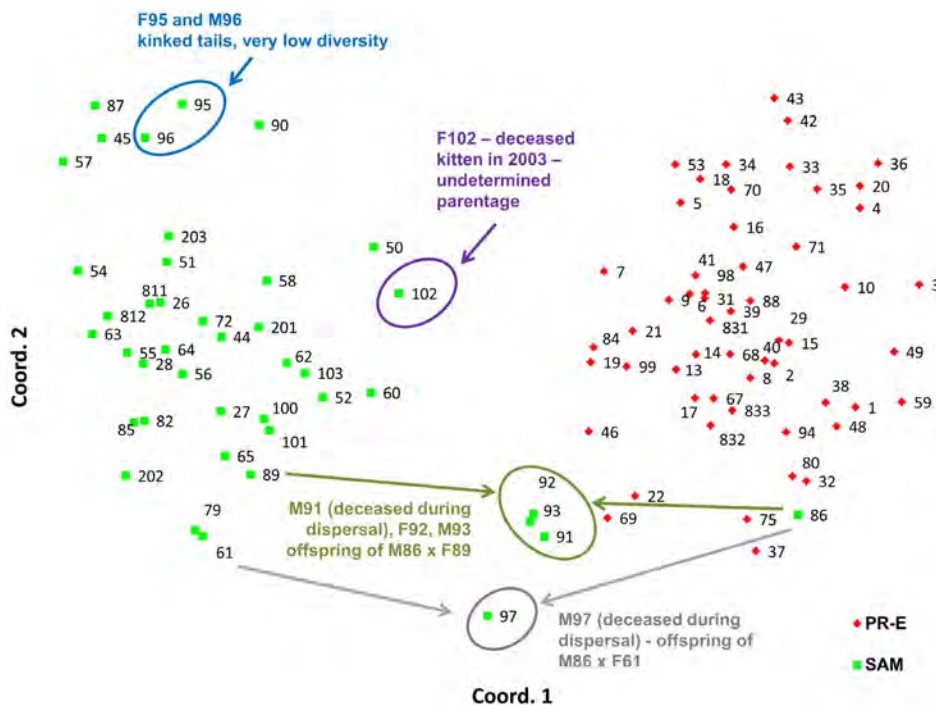




**Figure 5. Principal Coordinates analyses (PCoA) constructed using genetic covariance matrices (GenAlEx) for 354 California puma genetic profiles including 97 from southern California.** Patterns displayed for first two axes of variation within the genetic data set. Each point, color-coded to its sampling region, represents an individual puma. Note that colors in PCoA diagrams reflect geographic source of samples and not STRUCTURE genetic cluster assignment. Abbreviations and sample sizes per Table 1. Arrows denote pumas described in Figure 4. doi:10.1371/journal.pone.0107985.g005

an analysis including 354 statewide puma genotypes (97 from southern California and 257 from other regions) was run to estimate the probability of one through 10 genetic clusters (K), with each run iterated three times. Second, given the output of the

statewide run, we ran an analysis using only the 97 southern California puma genotypes to estimate the probability of one through five K, with each run iterated three times. Employing STRUCTURE HARVESTER [26] we averaged log probability



**Figure 6. Principal Coordinates analyses (PCoA) via covariance matrices for 97 southern California puma genetic profiles as conducted in GenAlEx.** Patterns displayed for first two axes of variation within the genetic data set. Each point represents an individual puma, and has sample identification number and color-coding to sampling region. Note that colors in PCoA diagrams reflect geographic source of samples and not STRUCTURE genetic cluster assignment. Abbreviations and sample sizes per Table 1. doi:10.1371/journal.pone.0107985.g006

**Table 2.** Wright's  $F_{ST}$  values indicate that southern California mountain lion populations are genetically distinct from other populations in California.

	NC	MP-ESN	WSN	CC-N	CC-C	CC-S	PR-E	SAM
North Coast (NC)	0							
Modoc Plateau & Eastern Sierra Nevada (MP-ESN)	0.09	0						
Western Sierra Nevada (WSN)	0.05	0.03	0					
Central Coast: north (CC-N)	0.13	0.14	0.12	0				
Central Coast: central (CC-C)	0.08	0.09	0.06	0.07	0			
Santa Monica Mountains (CC-S)	0.17	0.15	0.12	0.14	0.10	0		
Peninsular Range-East (PR-E)	0.13	0.08	0.09	0.12	0.09	0.16	0	
Santa Ana Mountains (SAM)	0.18	0.16	0.17	0.19	0.17	0.27	0.07	0

Note that one of the geographically closest puma populations, Santa Monica Mountains, has highest  $F_{ST}$  with the Santa Ana population, evidence of high genetic isolation for both regions. Probability,  $P(\text{random} > \text{data})$  based on 9999 permutations for all values are  $< 0.001$ . Abbreviation definitions and sample sizes are included in Table 1.  
doi:10.1371/journal.pone.0107985.t002

of the data given  $K$ ,  $\log \Pr(X|K)$ , statistics across the multiple runs for each of the  $K$  estimates. In each case (statewide and southern California), we selected the  $K$  value of highest probability by identifying the set of values where the  $\log \Pr(X|K)$  value was maximized and subsequently selected the minimum value for  $K$  that did not sacrifice explanatory ability [27,28,29]. We defined membership to a cluster based upon the highest proportion of ancestry to each inferred cluster.

To further assess and visualize genetic relationships among regions and individuals, we performed principal coordinates analyses (PCoA) via covariance matrices with data standardization [30] using GenAlEx. This is a technique that allowed us to explore and plot the major patterns within the data sets. The PCoA process located major axes of variation within our multidimensional genotype data set. Because each successive axis explains proportionately less of the total genetic variation, the first two axes were used to reveal the major separation among individuals. Employing Genalex software, a pairwise, individual-by-individual genetic distance matrix was generated and then used to create the PCoA.

Wright's  $F_{ST}$ , was calculated to appraise how genetic diversity was partitioned between populations. As implemented in GenAlEx, we used Nei's [31] formula, with statistical testing options offered through 9999 random permutations and bootstraps.

### Detecting migrants

We used GENECLASS2 version 2.0.h [32] to identify first-generation migrants, i.e. individuals born in a population other than the one in which they were sampled. Genetic clusters identified during STRUCTURE analysis were treated as putative populations. GENECLASS2 provides different likelihood-based test statistics to identify migrant individuals, the efficacy of which depends on whether all potential source populations have been sampled. We first calculated the likelihood of finding a given individual in the population in which it was sampled,  $L_h$ , assuming all populations had not been sampled. We then calculated  $L_h/L_{max}$ , the ratio of  $L_h$  to the greatest likelihood among the populations [33], which has greater power when all potential source populations have been sampled. The critical value of the test statistic ( $L_h$  or  $L_h/L_{max}$ ) was determined using the Bayesian approach of Rannala and Mountain [34] in combination with the resampling method of Paetkau et al. [33]; i.e., Monte Carlo simulations carried out on 10,000 individuals with the significance level set to 0.01.

### Testing for bottlenecks and inferring effective population size

We tested for evidence of recent population size reductions in Santa Ana Mountains and eastern Peninsular Range regions with one-tailed Wilcoxon sign-rank tests for heterozygote excess in the program BOTTLENECK version 1.2.02 [35]. The program evaluates whether the reduction of allele numbers occurred at a rate faster than reduction of heterozygosity, a characteristic of populations which have experienced a recent reduction of their effective population size ( $N_e$ ) [35,36]. This bottleneck genetic signature is detectable by this test for a finite time, estimated to be less than 4 times  $N_e$  generations [37]. These tests were performed using the two-phase (TPM, 70% step-wise mutation model and 30% IAM) model of microsatellite evolution and 10,000 iterations.

We then estimated contemporary  $N_e$  for each of the two regions based on gametic disequilibrium with sampling bias correction [38] using LDNE version 1.31 [39].  $N_e$  is formally defined as the size of the ideal population that would experience the same

**Table 3.** Effective population size estimations and indications of recent genetic bottlenecks in southern California pumas.

	<b>Mode</b>	<b>TPM</b>	<b>Ne (P-CI; JK-CI)</b>
Santa Ana Mtns	Shifted mode	0.009	5.1 (3.3–6.7; 3.3–6.6)
Peninsular Range, East	Normal L	0.19	24.3 (21.7–27.3; 20.6–28.8)

Listed by column are p-values for population bottleneck tests (Wilcoxon sign-rank test; BOTTLENECK) assuming the two-phase (TPM) model of microsatellite evolution. Effective size ( $N_e$ ) estimations (95% CI) based on data from 42 microsatellite loci. The Santa Ana Mountains population exhibited clear evidence of a population bottleneck. Effective population size estimate using the point estimate linkage disequilibrium method of (LDNE, Waples 2006) with 95% confidence intervals (CI) for both parametric (P) and jackknifed (JK) estimates.

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amount of genetic drift as the observed population [40]. These analyses excluded alleles occurring at frequencies  $\leq 0.05$ , and we used the jackknife method to determine 95% confidence intervals [38].

### Relatedness analyses: pairwise coefficient and internal

Molecular kinship analysis was conducted using a number of software packages. Pairwise relatedness among individuals was evaluated using the algorithm of Lynch and Ritland [41], with reference allele frequencies calculated and relatedness values averaged within each southern California population, as implemented in GenAlEx. Partial molecular kinship reconstruction was conducted using a consensus of outputs from the GenAlEx pairwise relatedness calculator, ML Relate [20], CERVUS version 3.0.3 [42], and Colony version 2.0.3.1 [43,44]. Individual genetic diversity (also called internal relatedness) was assessed using R<sub>hh</sub> [45] as implemented in R statistical software [46]. This is a measure of genetic diversity within each individual (an estimate of parental relatedness [47]), and we averaged over individuals for each of the two regions of southern California. Significance of differences between means was evaluated using t tests.

## Results

Forty-two of the 46 loci that we employed were polymorphic in southern California and selected for the subsequent analyses. The average probabilities of identity with assumptions of either random mating ( $PID_{RM}$ ) or mating among sibs ( $PID_{SIBS}$ ) across the 42 loci for the eastern Peninsular Ranges were ( $PID_{RM}$ )  $6.3 \times 10^{-22}$  and ( $PID_{SIBS}$ )  $3.1 \times 10^{-10}$ , and for the Santa Ana Mountains were ( $PID_{RM}$ )  $2.8 \times 10^{-15}$  and ( $PID_{SIBS}$ )  $1.1 \times 10^{-7}$  respectively. These very small values indicate that the panel of genetic markers provided very high resolution to distinguish individuals. For

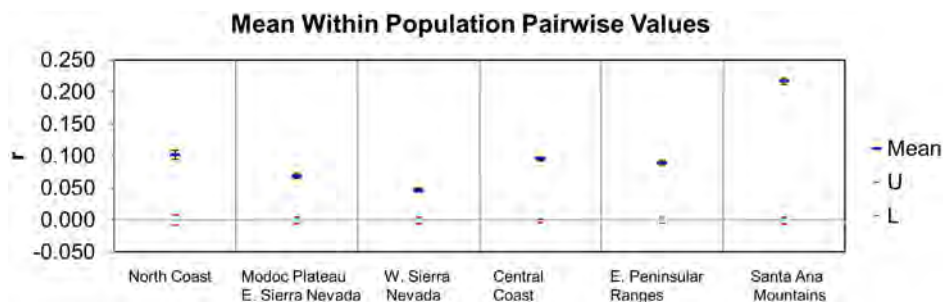
example, given this data the probability of seeing the same multi-locus genotype in more than one puma was less than one in nine million for Santa Ana Mountains pumas.

### Genetic diversity

Measures of genetic variation including allelic diversity, heterozygosity, Shannon's information index, and polymorphism, were lower for Santa Ana pumas than most of those tested from other regions of California (Table 1). Such low genetic diversity indicators were approached only by pumas in the Santa Monica Mountains (Ventura and Los Angeles Counties), a neighboring remnant puma population in the north Los Angeles basin (Figure 1).

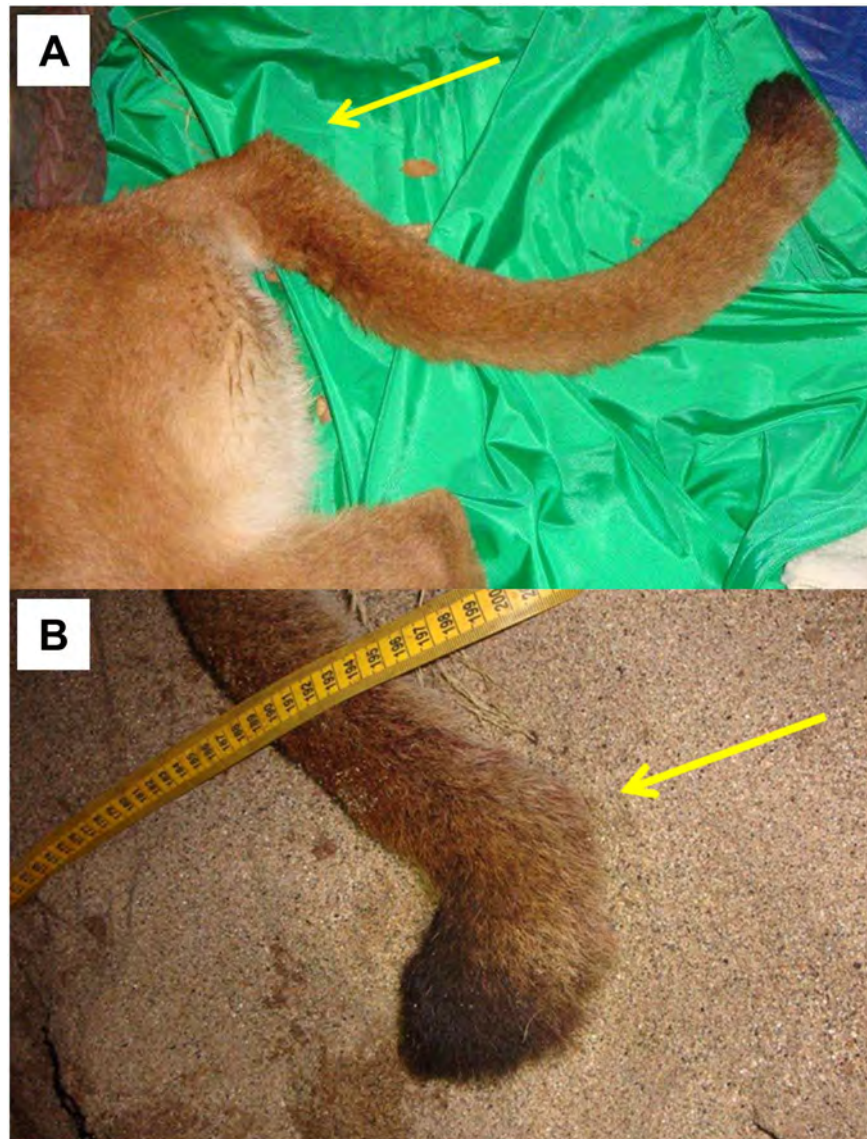
### Population Structure

Bayesian clustering analysis (STRUCTURE; Figure 3 of statewide puma genetic profiles ( $n = 354$ ), including 97 from southern California, also support genetic distinctiveness of Santa Ana Mountains and eastern Peninsular Range pumas from other populations in the state. Three main genetic groups (A, B, and C) were evident in the analysis (Figure 3) The 97 pumas sampled in southern California (right-hand set of bars in Figure 3, with samples from Santa Ana and eastern Peninsular Range pumas labeled) predominantly cluster within genetic group C. The Santa Ana pumas assign very tightly to group C (0.996 average probability assignment), while pumas of the eastern Peninsular Ranges showed more variable assignment (0.93 average probability assignment), with 9 individuals (16%) having less than 0.90 assignment. Pumas sampled in the Central Coast of California (which included Santa Monica Mountains pumas) make up the central set of bands, and those individuals predominantly assign to the genetic group B. Pumas sampled in the other regions of California (North Coast Ranges, Modoc Plateau, western Sierra



**Figure 7. Average pairwise relatedness ( $r$ ; blue bars with confidence intervals) for pumas sampled in southern California relative to other regions in California. Algorithm of Lynch and Ritland (1999) as implemented in GenAlEx.** Expected range for “unrelated” is shown as red bars with confidence intervals. The average relatedness of Santa Ana Mountain pumas is higher than those sampled in Peninsular Ranges east of I-15 and for any other region tested in California. Relatedness in the Santa Ana Mountains pumas approaches second order family relationship (half sibs, niece-aunt, grandparent-grandchild, etc.). Abbreviations listed in Table 1. doi:10.1371/journal.pone.0107985.g007





**Figure 8. Photographs of kinked tails of pumas F95 (a) and M96 (b).** Arrows indicate kink sites. Puma F95 had tail kink at base of tail and Puma M96 had tail kink near distal tip of tail. These two pumas had among the lowest genetic diversity measured in this study. doi:10.1371/journal.pone.0107985.g008

Nevada, and eastern Sierra Nevada) predominantly cluster with the genetic group A. Notably, there are individuals sampled in each geographic area which cluster with a genetic group that is not the dominant one in that area, suggesting dispersal events and/or genetic exchange that have occurred to varying degrees in each region.

A STRUCTURE analysis focused only on genetic data from the 97 southern California pumas indicated two distinct genetic groups (C-1 and C-2 shown in Figure 4). Pumas sampled in the eastern Peninsular Range region east of I-15 group primarily with C-2 and those of the Santa Ana Mountain region on the west side of I-15 group with C-1. An exception to the consistent genetic clustering was an adult male (M) puma (M86), that was captured in the Santa Ana Mountains but clustered with pumas from the eastern Peninsular Ranges (primarily genetic group C-2). Five other pumas captured in the Santa Ana Mountains had a 30–50% assignment to the C-2 group (M91, F92, M93, M97 and F102). Molecular kinship analysis showed that M86 and a female (F89)

captured in the Santa Ana Mountains and assigned to the C-1 genetic group were the likely parents of three of these pumas (M91, F92, and M93) (results of relatedness and kinship analyses). M86 also was the likely parent of another puma in the group (M97), an offspring of another female (F61) that was sampled in Santa Ana Mountains and clustered with the C-1 genetic group. F102 was a <1 year old female killed by a vehicle in 2003 prior to collection of the majority of samples from adults in the Santa Ana Mountains.

Principal coordinates analysis of statewide puma genetic profiles ( $n = 354$ ) (PCoA; Figure 5) allowed graphical examination of the first two major axes of multivariate genetic variation, and confirmed and added detail to the genetic distinctiveness of southern California pumas relative to others in California. The PCoA also reinforced the distinctiveness of pumas sampled in the Santa Ana Mountains from those sampled in the eastern Peninsular Ranges. Most pumas sampled in the Santa Ana Mountains align in a cloud of data points distinct from the eastern

Peninsular Range pumas, and were the most genetically distant from all other pumas tested in California (Figure 5). The analysis also confirms the STRUCTURE findings that M86 who was sampled in the Santa Ana Mountains genetically aligns with the pumas sampled in the Peninsular Ranges, as does one of his offspring, M93 (see Figure 6 for additional detail). The PCoA position of data points for three pumas sampled in the San Bernardino Mountains north of Peninsular Ranges (pink diamonds in Figure 5) illustrates an intermediate genetic relationship between pumas from the rest of California and pumas sampled in the eastern Peninsular Ranges and Santa Ana Mountains, and suggests that they may represent transitional gene flow signature between southern California and regions to the north and east.

PCoA analysis of only the samples collected in the Santa Ana and Peninsular Ranges (Figure 6) confirms the findings from the STRUCTURE analysis indicating genetic distinctiveness of these two populations despite geographic proximity. Siblings M91, F92, and M93 (offspring of F89 and M86 according to our kinship reconstructions) as well as M97 (likely offspring of a female puma captured in the Santa Ana Mountains, F61, and M86, according to kinship reconstructions) are located graphically midway between their parents' PCoA locations.

### Genetic isolation

Wright's  $F_{ST}$  calculations (Table 2) indicate that Santa Ana Mountains pumas are the most isolated of those tested throughout California ( $p = 0.0001$ ). Despite the short distance (as short as the distance across the I-15 Freeway) between the Santa Ana Mountains and the eastern Peninsular Range region,  $F_{ST}$  was surprisingly high (0.07) given the very close proximity of the two regions (separated only by an interstate highway). The Santa Monica Mountains pumas and Santa Ana Mountains pumas had the highest  $F_{ST}$  (0.27; lowest gene flow) of all pairwise comparisons in the state, demonstrating a high level of genetic isolation between these regions. The Santa Monica Mountains and Santa Ana Mountains are less than 100 km direct distance apart, through the center of Los Angeles. However the more likely distance for puma travel between these two mountain ranges, avoiding urban areas and maximizing upland habitat, would likely exceed 300 km (estimated using coarse measurements on Google Earth, Google, Inc.).

### Detection of migrants

GENECLASS2 identified four individuals as first-generation migrants ( $P < 0.01$ ), four with the  $L_h$  method (pumas F75, M80, M86, and M99), and one with the  $L_h/L_{max}$  ratio (M86, which was detected using both likelihood methods). Pumas F75, M80, and M99 were all captured from the San Bernardino Mountains (Figure 2) at the northern extent of the study region, yet clustered with individuals from the Eastern Peninsular Range during STRUCTURE analysis. Their migrant designation may suggest immigration from populations north of Los Angeles and/or a distinct genetic population within the San Bernardino region. Puma M86 was captured in the Santa Ana Mountains, but assigned strongly to the eastern Peninsular Range genetic cluster, indicating a seemingly clear population of origin. This individual assignment is in accord with the clustering results from STRUCTURE (Figure 4).

### Evidence of genetic bottlenecks

The Santa Ana Mountains population exhibited clear evidence of a population bottleneck (Table 3; Wilcoxon sign-rank test for heterozygote excess, and detection of a shift in the allele frequency distribution mode [36]; BOTTLENECK software). The eastern

Peninsular Range mountain lions did not show a strong signature of a bottleneck.

### Effective population size

Effective population size ( $N_e$ ) estimations using the linkage disequilibrium method (LDNe program) were 5.1 for the Santa Ana Mountains population and 24.3 for mountain lions in the eastern Peninsular Ranges. Statistical confidence intervals for both regions, given the genetic data, were tight (Table 3).

### Relatedness: pairwise coefficient and internal

The average pairwise coefficient of relatedness ( $r$ , Figure 7) was highest in Santa Ana Mountains pumas relative to all others tested in California (0.22; 95% confidence interval of 0.22–0.23), a level that approaches second order kinship relatedness (half-sibs, grandparent/grandchild, aunt-niece, etc.). The value for the eastern Peninsular Ranges was 0.10 (confidence interval of 0.09–0.10), less than that of third order relatives (first cousins, great-grandparent/great grandchild). Other regions of California averaged similar or lower values to those of eastern Peninsular Ranges (Figure 7).

Among pumas sampled in the Santa Ana Mountains, the population average (0.14) for internal relatedness as implemented in rHH software was significantly higher ( $t$  test;  $p = 5.8 \times 10^{-6}$ ) than for those sampled in the eastern Peninsular Ranges (0.001). Of a group of six pumas which clustered near one another in PCoA (Figure 6), five have among the lowest individual genetic diversity measured in southern California (Puma ID [Internal Relatedness value: F45 [0.37], F51 [0.37], M87 [0.28], F90 [0.21], F95 [0.38], and M96 [0.33]). Notably, pumas F95 and M96 (highest internal relatedness) were observed with kinked tails at capture in the Santa Ana Mountains (Figure 8).

### Discussion

Pumas of the Santa Ana Mountains are genetically depauperate, isolated, and display signs of a recent and significant bottleneck. In general, coastal California puma populations have less genetic diversity and less gene flow from other populations than those farther inland [9] (Table 1). This study showed that two coastal populations (Santa Ana Mountains and Santa Monica Mountains) had particularly low genetic variation and gene flow from other regions. Lack of gene flow is likely due in part to natural barriers to puma movement: geography and habitat (Pacific Ocean to the west; less hospitable desert habitat bounding certain regions, etc.). However, our data suggest that anthropogenic developments on the landscape are playing a large role in genetic decay in the Santa Ana Mountains puma population. As large solitary carnivores with sizable habitat requirements, pumas are extremely sensitive to habitat loss and fragmentation [48,49].

The genetic bottleneck in the Santa Ana Mountains pumas is estimated at less than about 80 years, depending on definitions of effective population size ( $N_e$ ) and puma generation time. Luikhart and Cornuet [37] state that the bottleneck signatures decay after "4 times  $N_e$  [here estimated to be 5.1] generations". Logan and Sweaner [50] estimated generation time for their New Mexico population of pumas to be 29 months (2.4 years) for females. If an allowance of 2.4–4.0 years is made for generation times (unknown) in the Santa Ana Mountains population, the maximum estimated time since a bottleneck would be about 40–80 years. This was a period of tremendous urban development and multi-lane highway construction in southern California, particularly I-15 [51]. It is likely that the potential for connectivity between the Santa Ana Mountains and the Peninsular Range-East region will continue to be eroded by ongoing increases in traffic volumes on I-15, and



conversion of unconserved lands along the I-15 corridor by development and agriculture [8,48,52].

An isolated population of pumas in the Santa Monica Mountains to the north of the Santa Ana Mountains also exhibit low values relative to other western North American populations (see Table 2 in [53]). Santa Monica pumas are isolated by urbanization of a megacity and busy wide freeways (Ventura county, including greater Los Angeles region [53]). Multiple instances of intraspecific predation, multiple consanguineous matings (father to daughter, etc.), and lack of successful dispersal highlight a suite of anthropogenic processes also occurring in the Santa Ana Mountains. Our collective findings of kinked tails *and* very low genetic diversity in Santa Ana pumas F95 and M96 may portend manifestations of genetic inbreeding depression similar to those seen in Florida panthers [54,55]; however recognizing that kinked tails can have non-genetic etiologies.

Our analyses suggest that the Santa Ana Mountains puma population is highly challenged in terms of genetic connectivity and genetic diversity, a result hinted at in Ernest et al. [9] and now confirmed to be an ongoing negative process for this population. This compounds the demographic challenges of low survival rates and scant evidence of physical connectivity to the Peninsular Ranges east of I-15 (unpublished data). Beier [6] documented these same challenges during the 1990's, and data from the ongoing UCD study suggest the trends have accelerated. Substantial habitat loss and fragmentation has occurred and is continuing to occur; Burdett et al. [10] estimated that by 2030, approximately 17% of puma habitat that was still available in 1970 in southern California will have been lost to development, and fragmentation will have rendered the remainder more hazardous for pumas to utilize. Riley et al [53] document a natural "genetic rescue" event: the 2009 immigration and subsequent breeding success of a single male to the Santa Monica Mountains. This introduction of new genetic material into the population was paramount to raising the critically low level of genetic diversity, as also exemplified by the human-mediated genetic augmentation of Florida Panthers with Texas puma stock [56].

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# Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore

Mourad W. Gabriel<sup>1,2\*</sup>, Leslie W. Woods<sup>3</sup>, Robert Poppenga<sup>3</sup>, Rick A. Sweitzer<sup>4</sup>, Craig Thompson<sup>5</sup>, Sean M. Matthews<sup>6</sup>, J. Mark Higley<sup>7</sup>, Stefan M. Keller<sup>8</sup>, Kathryn Purcell<sup>5</sup>, Reginald H. Barrett<sup>4</sup>, Greta M. Wengert<sup>1</sup>, Benjamin N. Sacks<sup>2</sup>, Deana L. Clifford<sup>9</sup>

**1** Integral Ecology Research Center, Blue Lake, California, United States of America, **2** Veterinary Genetics Laboratory, University of California Davis, Davis, California, United States of America, **3** California Animal Health and Food Safety Laboratory System, University of California Davis, Davis, California, United States of America, **4** Sierra Nevada Adaptive Management Project, University of California, Berkeley, California, United States of America, **5** Pacific Southwest Research Station-Sierra Nevada Research Center, United States Forest Service, Fresno California, United States of America, **6** Wildlife Conservation Society, Hoopa, California, United States of America, **7** Wildlife Department, Hoopa Tribal Forestry, Hoopa, California, United States of America, **8** Department of Pathology, Microbiology and Immunology, University of California Davis, Davis, California, United States of America, **9** Wildlife Investigations Laboratory, California Department of Fish and Game, Rancho Cordova, California, United States of America

## Abstract

Anticoagulant rodenticide (AR) poisoning has emerged as a significant concern for conservation and management of non-target wildlife. The purpose for these toxicants is to suppress pest populations in agricultural or urban settings. The potential of direct and indirect exposures and illicit use of ARs on public and community forest lands have recently raised concern for fishers (*Martes pennanti*), a candidate for listing under the federal Endangered Species Act in the Pacific states. In an investigation of threats to fisher population persistence in the two isolated California populations, we investigate the magnitude of this previously undocumented threat to fishers, we tested 58 carcasses for the presence and quantification of ARs, conducted spatial analysis of exposed fishers in an effort to identify potential point sources of AR, and identified fishers that died directly due to AR poisoning. We found 46 of 58 (79%) fishers exposed to an AR with 96% of those individuals having been exposed to one or more second-generation AR compounds. No spatial clustering of AR exposure was detected and the spatial distribution of exposure suggests that AR contamination is widespread within the fisher's range in California, which encompasses mostly public forest and park lands. Additionally, we diagnosed four fisher deaths, including a lactating female, that were directly attributed to AR toxicosis and documented the first neonatal or milk transfer of an AR to an altricial fisher kit. These ARs, which some are acutely toxic, pose both a direct mortality or fitness risk to fishers, and a significant indirect risk to these isolated populations. Future research should be directed towards investigating risks to prey populations fishers are dependent on, exposure in other rare forest carnivores, and potential AR point sources such as illegal marijuana cultivation in the range of fishers on California public lands.

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\* E-mail: mwgabriel@ucdavis.edu

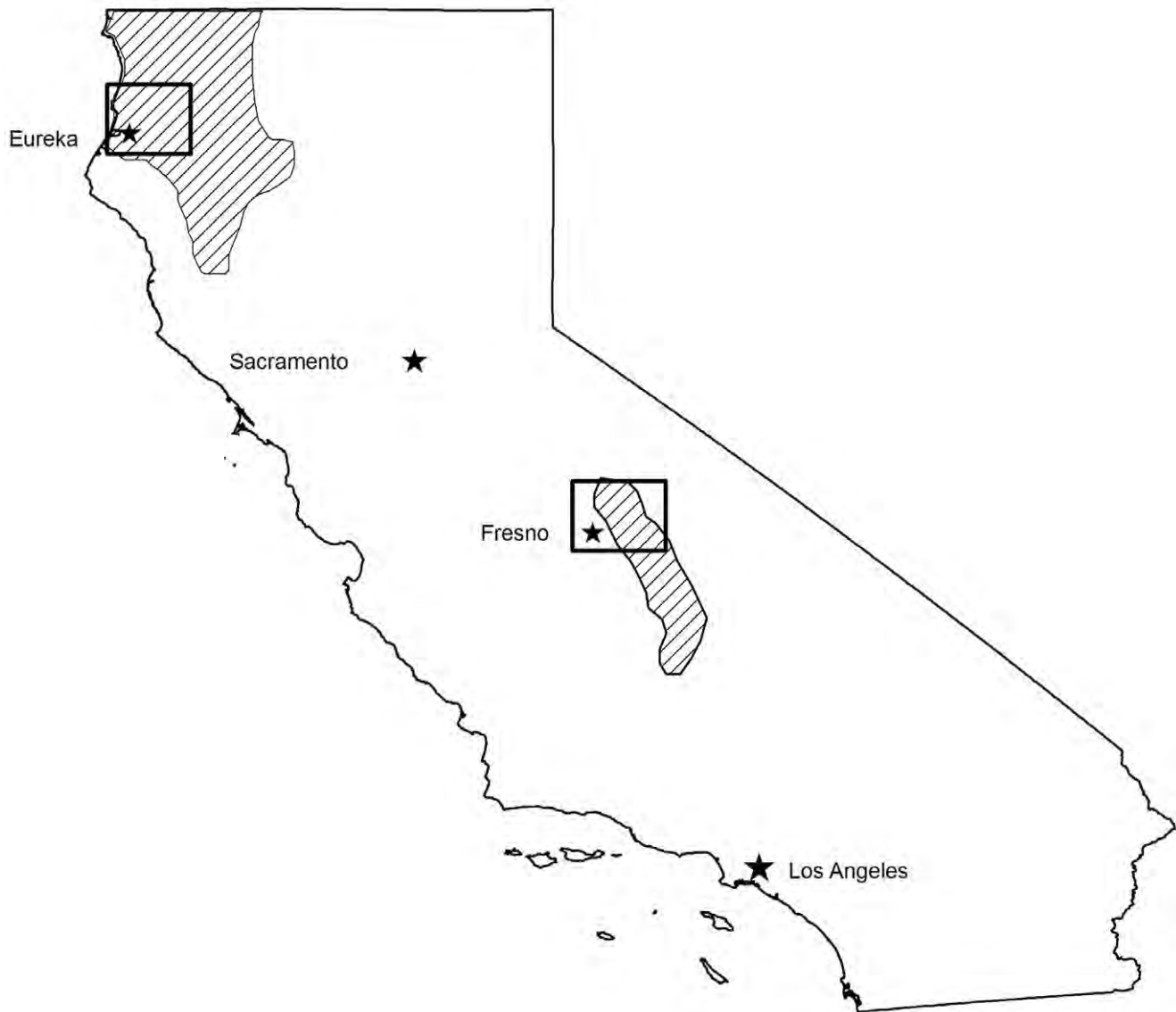
## Introduction

Anticoagulant rodenticide (AR) exposure and poisoning has emerged as a conservation concern for non-target wildlife [1,2,3]. These toxicants are used to eradicate or suppress rodent pest populations in agricultural or urban settings to minimize economic losses [1,4]. Generally, the mechanism of AR function is to bind and inhibit enzyme complexes responsible for the recycling of vitamin K<sub>1</sub>, thus creating a series of deleterious clotting and coagulation impairments [4,5]. The ARs are grouped into two classes: first-generation compounds, which require several doses to cause intoxication, and second-generation ARs, which are more acutely toxic often requiring only a single dose to cause intoxication and persist in tissues and in the environment [1,4,6,7]. Rodents have started to develop resistance to both first-generation and second-generation ARs, prompting increas-

ingly greater reliance on more acutely toxic compounds and increased distribution by AR users [1,7,8].

Primary exposure by ingestion of bait or secondary exposure through consumption of exposed prey has been documented in numerous species of endangered and common non-target wildlife [1,3,9,10,11,12,13]. Wildlife are thought to be at greatest risk of exposure to ARs in agricultural, urban or peri-urban settings, where large quantities of these compounds are often used [12,14,15]. However, little is known about the risks to wildlife in settings with little or no anthropogenic influences.

Fishers (*Martes pennanti*), a large mustelid and the largest member in the genus *Martes*, were once widely distributed throughout west coast of North America, but have experienced significant population declines, including extirpation from some regions and contractions of historic ranges [16,17,18]. Populations of fishers inhabiting California, Oregon and Washington have been



**Figure 1. Fisher (*Martes pennanti*) current range in California and project areas.** Current range (shaded areas) of the two isolated California populations of fishers (*Martes pennanti*). Areas of fisher projects that generated data for exposure and mortality to anticoagulant rodenticides are outlined within the two isolated populations.  
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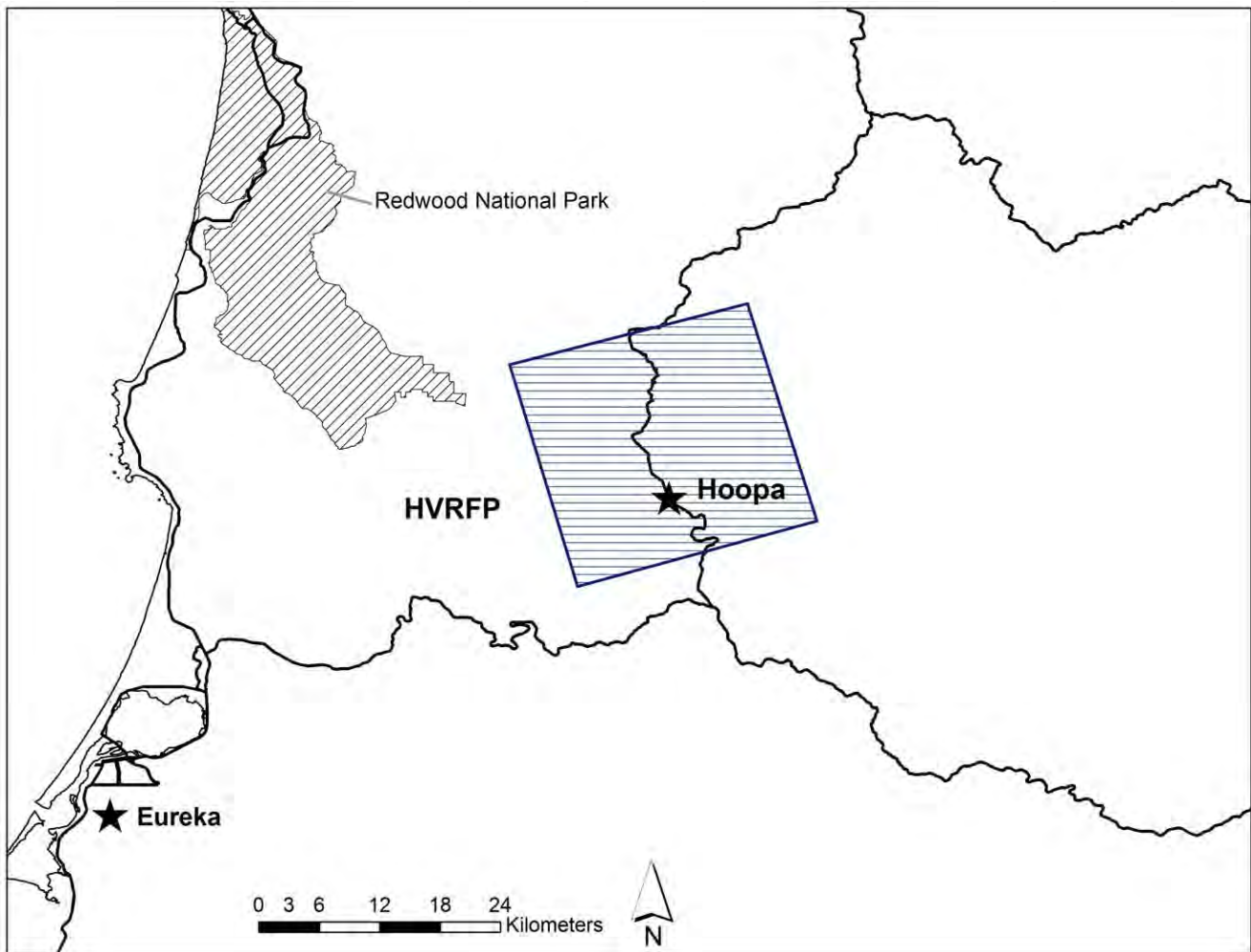
designated as a Distinct Population Segment (DPS) and declared a candidate species for listing under the federal Endangered Species Act [17,19]. The west coast DPS encompasses areas where fishers were extirpated from Washington and central and northern Oregon, a reintroduced population in the Cascade mountains of southern Oregon, and two extant and isolated populations, one spanning southern Oregon and northern California and another in the southern Sierra Nevada mountains of California [17,19]. The population status of fishers in the southern Oregon/northern California is unknown; however population estimates for the isolated fisher population in the southern Sierra Nevada range from 150–300 fishers, with 120–250 in the adult age class [17,20,21]. Because fishers in the DPS occur in and are dependent on mid to late-seral stage coniferous and hardwood forests and are not associated with agricultural or urban settings, toxicants have not been previously considered a likely threat to fisher populations [17,22,23].

We assessed the magnitude of AR exposure and poisoning among fisher carcasses submitted for necropsy from 2006 to 2011 as part of a collaborative effort studying threats to population persistence of fishers in California. Additionally, spatial analysis of telemetry data from sampled fishers was conducted in an effort to identify potential sources of AR in the environment. We hypothesized that due to fishers being a forest-dependent carnivore, exposure to ARs will be rare.

## Methods

### Ethics Statement

All procedures involving animals were reviewed and approved by the University of California, Davis, Animal Care and Use Committee (Protocol No. 16551).



**Figure 2. Enlarged map of fisher (*Martes pennanti*) project area for the northern California population at the Hoopa Valley Reservation Fisher project (HVRFP).**

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### Study Area

Fishers were captured in box traps modified with a plywood cubby box (model 207, Tomahawk Live Trap Company, Tomahawk, Wisconsin, USA), sampled, and fitted with a VHF radio-collar and monitored via telemetry. Fisher carcasses were submitted from the two isolated California populations by three fisher monitoring projects (Figure 1). Carcasses from the northern California population were submitted by the Hoopa Valley Reservation Fisher Project (HVRFP), conducted in northwestern California within tribal, private and public lands, and non-monitored fishers on public and private lands throughout the northern Sierra Nevada/southern Cascade Mountain borderlands of north central California (Figure 2). Carcasses from the southern Sierra Nevada California population were submitted by the Sierra Nevada Adaptive Management Project (SNAMP) and the USDA Forest Service Kings River Fisher Project (KRFP); both projects were conducted on the Sierra National Forest in the northern and central portions of this population's extent (Figure 3).

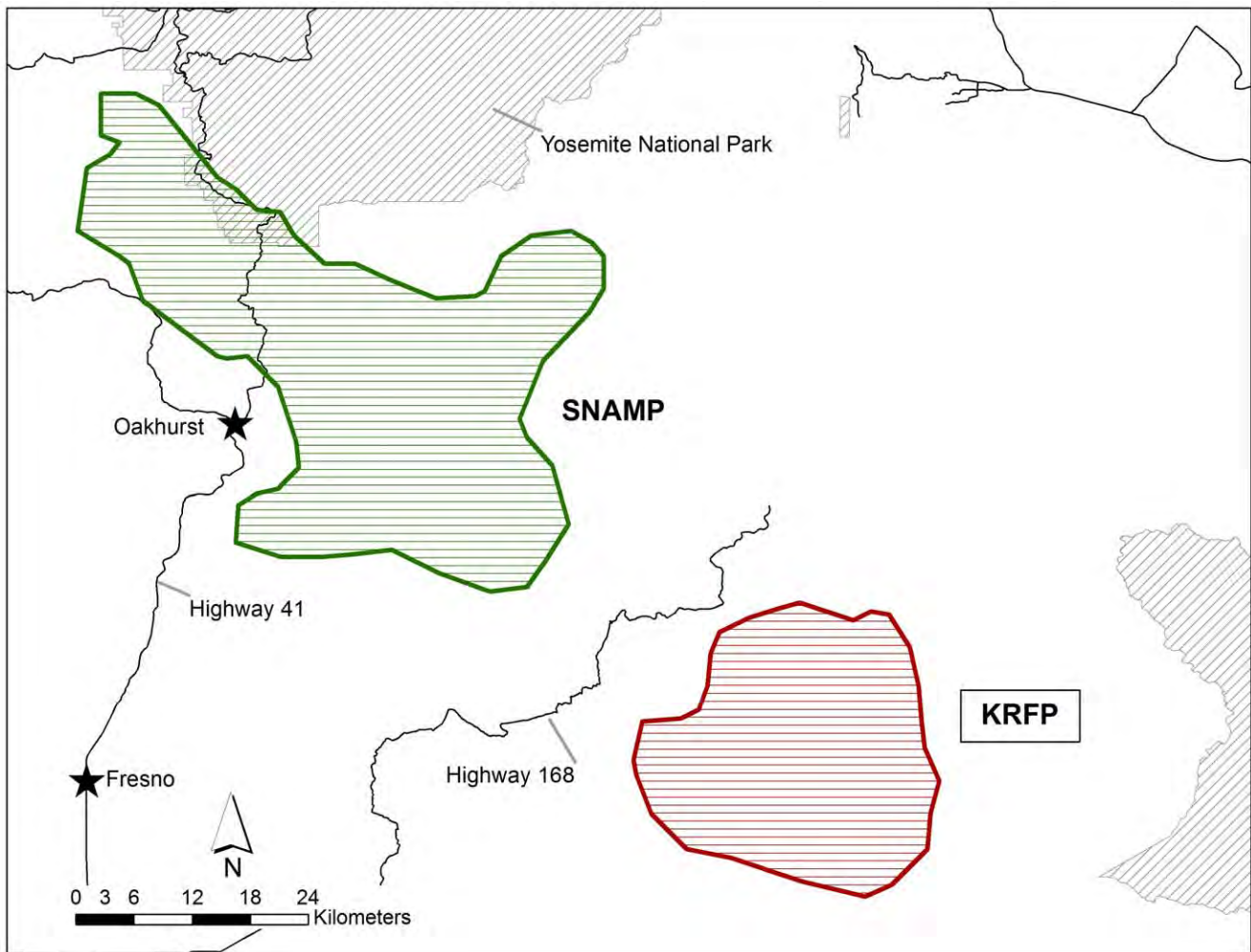
### Sample Collection

Deceased fishers were collected by project personnel whenever a fisher was determined to be inactive for >24 hours, a mortality signal from the VHF collar was detected or when unmarked fisher

carcasses were opportunistically observed at the project sites or adjacent areas. Fisher carcasses were stored in a  $-20^{\circ}\text{C}$  freezer until a complete necropsy to determine causes of mortality was performed by a board-certified pathologist specializing in wildlife at the California Animal Health and Food Safety Laboratory System (CAHFS) or the University of California Davis Veterinary Medical Teaching Hospital in Davis, CA, USA. Liver samples were collected during necropsy and submitted for screening and quantification of seven ARs at CAHFS by liquid chromatography-tandem mass spectrometry for screening presence of ARs and high-performance liquid chromatography to quantitate positive samples. The AR compounds tested for included first-generation ARs, warfarin (WAF), diphacinone (DIP), chlorophacinone (CHL), and coumachlor (COM); and second-generation ARs, brodifacoum (BRD), bromodiolone (BRM), and difethialone (DIF). The reporting limits were 0.01 ppm for BRD, 0.05 for WAF, BRM, and COM, and 0.25 ppm for DIP, CHL, and DIF. Detectable compound concentrations that were below quantitate limits were labeled as "trace" concentrations. All results were reported on a tissue wet weight basis and reviewed by a board-certified toxicologist [12,24].

Age classification was determined by tooth wear, sagittal crest or testicular/teat development, field and laboratory observation, and





**Figure 3. Enlarged map of fisher (*Martes pennanti*) project areas for the southern Sierra Nevada population: the Sierra Nevada Adaptive Management Project (SNAMP) and Kings River Fisher Project (KRFP).**

doi:10.1371/journal.pone.0040163.g003

monitoring of individual animals [17,18,25]. Fishers were classified as kits when fully or semi-altricial and dependent on milk for nourishment (roughly  $\leq 10$  weeks), juveniles if weaned and  $< 12$  months of age, sub-adults when between 13–24 months of age, and adults  $\geq 24$  months of age [17,18,25].

### Statistical Analysis

Prevalence of AR exposure among fishers was calculated for the total sample, each sex and each age class. We compared the AR exposure prevalence between sexes within and between the two California populations using two-tailed heterogeneity chi-square tests of association [26]. The effects of sex and population on the number of anticoagulant rodenticides found per individual were analyzed with a two-way ANOVA [27]. All tests were conducted using the program NCSS (Number Cruncher Statistical Software, Kaysville, UT, USA) with an alpha level  $p = 0.05$ .

### Spatial Analysis

For monitored fishers, telemetry locations were used to generate 95% minimum convex polygon (MCP) home-range centroids to represent a centralized point within the core area of movement within each individual fisher home-range within each project area [28]. For each fisher, three centroids representing three sampling

timeframes were calculated using ArcView 9.1 home range extensions (ESRI Inc., Redlands CA., USA) [29]. The first centroid incorporated all fisher locations from initial capture until death, irrespective of the monitoring time; the second centroid incorporated fisher locations collected six months prior to death; and the third centroid incorporated only the fisher locations collected three months prior to death. These two latter centroids containing locations collected over a shorter time period prior to death were calculated because some ARs have relatively short half-lives and any spatial clustering in these MCP centroids might suggest the locale of recent sources of AR exposure. Only fishers with  $\geq 3$  months of monitoring were used for spatial analysis, individuals that had less than or were opportunistically collected were excluded.

Centroids were analyzed by spatial scan statistics to determine whether exposure to ARs, exposure to different generation classes (1<sup>st</sup> and 2<sup>nd</sup>) of ARs, or exposure to individual compounds of ARs were distributed uniformly or spatially clustered in each of the two California populations [30]. SaTScan version 9.1.1 (M. Kulldorff, Harvard Medical School, Boston, MA, USA) was used to evaluate two separate models. First, a Bernoulli model utilizing count data was used to determine if spatial clustering occurred in exposed and non-exposed fishers, or in first or second-generation class AR

**Table 1.** Exposure and mortality due to anticoagulant rodenticides (AR) fishers (*Martes pennanti*) within the two isolated populations, northern California and southern Sierra Nevada.

Fisher population	Number of fishers tested (F:M)	Number of AR exposed fishers (F:M)	Number of AR mortalities	$\bar{x}$ , SD and range in all, female (F) and male (M) exposed fishers	Chi-square	Probability Level	DF
Northern California	18 (11:7)	13 (72%) (8:5)	2	1.38 (SD = 0.84; range 1–3) (F) 1.13 (SD = 0.35; range 1–3) (M) 1.8 (SD = 0.84; range 1–3)	0.004	0.952	1
Sierra Nevada	40 (18:22)	33 (83%) (16:17)	2	1.70 (SD = 0.88; range 1–4) (F) 1.47 (SD = 0.87; range 1–4) (M) 2.00 (SD = 0.85; range 1–4)	0.925	0.336	1
All California	58 (31:27)	46 (79%) (26:20)	4	1.61 (SD = 0.83; range 1–4) (F) 1.33 (SD = 0.73; range 1–4) (M) 2.00 (SD = 0.82; range 1–4)	0.844	0.358	1
Heterogeneity chi-square					0.085	0.77	1

Mean number ( $\bar{x}$ ) of AR compounds detected per individual, range of numbers of AR per individual and standard deviation (SD) are given for all, female (F) and male (M) fishers for each population. Chi-square and heterogeneity Chi-square test analyzing exposure between the sexes both within and between the populations. doi:10.1371/journal.pone.0040163.t001

exposure. The second model, a multinomial model using categorical data, was used to assign each fisher to a group based on the number of AR compounds detected and to examine possible clustering of individuals with high numbers of AR compounds [31]. SatScan uses these models to scan the geographic area encompassing the MCP centroids to detect spatial clusters encompassing not more than 50% of the centroids [32]. The elliptical scanning window option was chosen for both models because it utilizes both circular and elliptical shapes to allow for a better fit to linear geographic features (i.e. drainages or ridgelines) that occur within the fisher's habitat [32,33]. All statistical values from the models were generated by Monte Carlo simulations of 999 iterations and clusters evaluated for significance with  $\alpha = 0.05$ .

## Results

### Population-level Exposure to AR

Forty-six of the 58 fisher carcasses tested (79%) were exposed to one or more compound of AR (Table 1). Frequency of exposure ( $p > 0.05$ ) and the number of ARs per fisher ( $p > 0.05$ ) were similar between populations and sexes (Table S1). The number of AR compounds detected per individual ranged from 1–4 (Table 1). Exposure to at least one AR among age classes ranged with one of 4 pre-weaned kits (25%), 4 of 4 (100%) juveniles, 12 of 17 (70%) sub-adults, and 29 of 33 (88%) adults. Both first and second generation ARs were detected, with BRD being most common and detected in 44 of the 46 (96%) exposed fishers, followed by BRM (16 of 46; 35%), DIP (8 of 46; 17%), CHL (four of 46; 9%), DIF (one of 46; 2%), and WAF (one of 46; 2%). Quantifiable levels of BRD ( $\bar{x} = 0.22$  ppm; range trace –3.4 ppm) and BRM ( $\bar{x} = 0.12$  ppm; range trace –0.54 ppm) were detected while only trace levels of other ARs were detected (Figure 4). No samples had detectable levels of COM and no indicator dye or AR bait was detected in either stomach or the GI contents of any fisher.

### Northern California Fishers

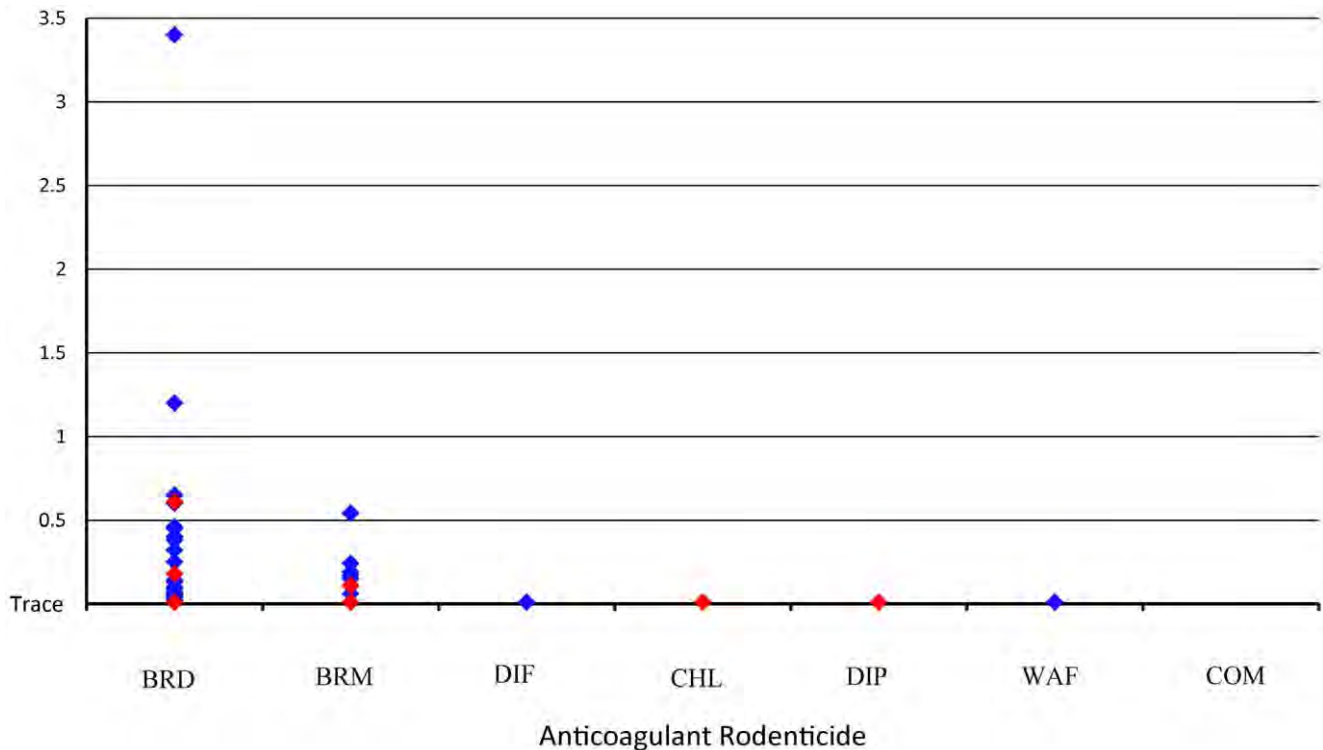
Thirteen of 18 (72%) fishers from the northern California population were exposed to an AR compound (Table 1). Brodifacoum was detected in 12 (92%), BRM in two (15%), DIP in two (15%), CHL in one (8%), and WAF in one (8%) of the 13 exposed individuals.

### Sierra Nevada Fishers

Thirty-three of 40 (83%) fishers from the southern Sierra Nevada were exposed to an AR compound (Table 1). Brodifacoum was detected in 32 (97%), BRM in 14 (42%), DIP in six (18%), CHL in three (9%), and DIF in one (3%) of the 33 exposed individuals.

### Spatial Distribution of AR Exposure

Complete centroids were generated for 42 monitored fishers, 12 fishers from the northwestern California population (all 12 from HVRFP) and 30 from the southern Sierra Nevada population (19 from SNAMP, 11 from KRFP). Of these fishers, 3-month MCP centroids were generated for 39 fishers, and 6-month centroids for 27 (Table S2). Spatial analysis for 6-month centroids from the KRFP could not be conducted because all fishers in the data set were AR exposed. Sixteen fishers were excluded from the analysis due to lack of monitoring data. No spatial clustering of AR exposure was detected for any of the temporal periods, specific AR compounds, generation class of AR, or distribution of numbers of ARs per fisher in any of the study areas (Table S2; Figure 5, Figure 6).



**Figure 4. Quantification levels of anticoagulant rodenticides detected in California fishers.** Anticoagulant rodenticides (AR) brodifacoum (BRD), bromodiolone (BRM), difethialone (DIF), chlorophacinone (CHL), diphacinone (DIP), warfarin (WAF) and coumachlor (COM) parts per million (PPM) levels detected in positive fishers (*Martes pennanti*) in California. Blue diamonds represent AR quantification levels (ppm). Red diamonds represent levels in fishers that died due to AR ingestion. doi:10.1371/journal.pone.0040163.g004

### AR-Mortalities

Cause-specific mortality factors for all 58 fishers sampled ranged widely and included predation, infectious and non-infectious disease processes and vehicular strikes (M.W. Gabriel unpublished data). The cause of death for four of these fishers was attributed to lethal toxicosis, indicated by AR exposure with simultaneous coagulopathy and bleeding into tissues or cavities and ruling out any concurrent processes that might cause hemorrhaging [34]. Two of the four fishers killed by ARs were from the southern Sierra Nevada population, and two were from northern California (Table 1) and the case details are described below.

#### Southern Sierra Nevada

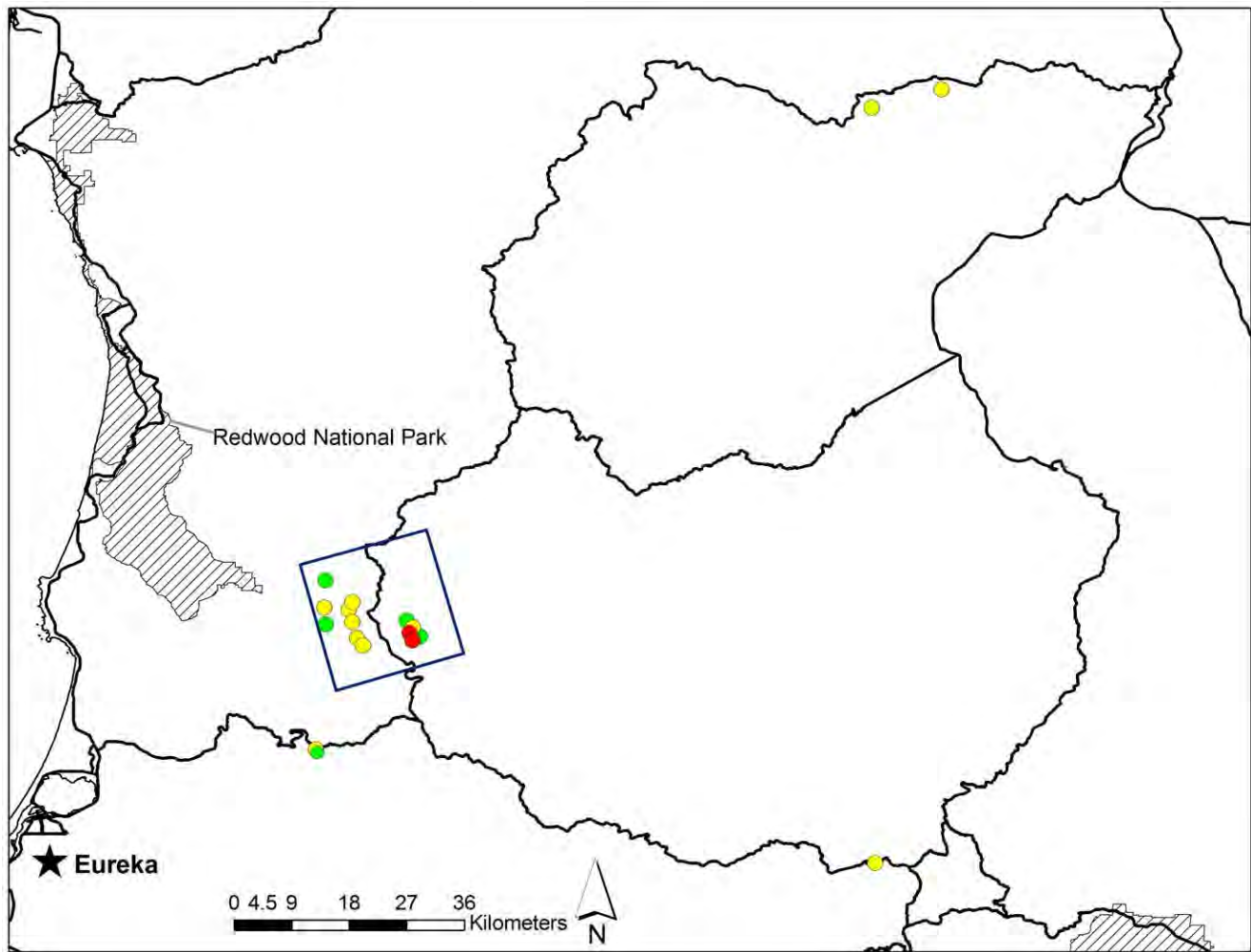
An adult male fisher was recovered on 15 April 2009, in the southern Sierra Nevada at the SNAMP project area. The fisher showed no signs of predation or scavenging (Figure 7). Gross necropsy determined that the fisher was in good nutritional (3.45 kg) and fair postmortem condition. Frank blood was observed in both the thoracic and abdominal cavities (150 ml and 100 ml respectively), and in the pericardial sac (7 ml) (Figure 8). The stomach and lower gastrointestinal tract contained some blood but no prey or formed feces, and no mucosal changes were noted. There were no other findings on gross examination. Histopathologically, no significant changes were observed in any tissues. Brodifacoum and BRM were detected and quantified in the liver sample at 0.38 ppm and 0.11 ppm, respectively, and CHL at trace levels (Figure 4).

The second fisher mortality was a lactating adult female recovered on 2 May 2010 in the center of a paved rural highway in the SNAMP project area approximately 3.7 km from Yosemite

National Park. Vehicular strike was initially suspected as the cause of mortality due to the location of the carcass but lacerations, abrasions and visual evidence of trauma were not seen on gross examination of the intact carcass. The post-mortem state of the carcass was good and the nutritional state was poor (2.54 kg). Shallow subcutaneous hemorrhage was noted over the hindquarters and spinal column with no associated fractures, punctures or abrasions. There was approximately 20 ml of frank blood within the thoracic cavity. There was no evidence of pneumothorax, vessel ruptures, or visceral tearing. No blood or visceral damage was seen in the abdominal cavity. Stomach contents contained various rodent parts with formed feces in the descending colon. Histopathologically, no significant changes were observed in any tissues. Brodifacoum and BRM were detected and quantified at 0.60 ppm and 0.17 ppm, while one first generation AR, DIP was detected at a trace level within the liver tissue (Figure 4). No evidence was present to suggest that this fisher died due to vehicular trauma, despite its location on the highway.

#### Northern California

A sub-adult male fisher was recovered on 4 May 2010 at the base of several riparian shrubs near a watercourse in northwestern California at the HVRFP. Severe ectoparasitism on the carcass was noted in the field with ticks in both replete and non-replete stages. Predation was not suspected due to absence of external wounds. The gross necropsy determined that this fisher (2.65 kg) was in poor nutritional condition with no subcutaneous or visceral fat. Frank blood was present in the right external ear canal, nasal and oral cavities, within the lumen of the trachea and within the periorbital tissue with no associated skull fractures or punctures.



**Figure 5. Exposure to and mortality from anticoagulant rodenticides (AR) in fishers (*Martes pennanti*) from the isolated northern California population.** Green circles represent negative fishers, yellow circles represent exposed fishers, while red circles are fishers that died due to AR toxicosis.

doi:10.1371/journal.pone.0040163.g005

The stomach was devoid of prey. The colon only contained semi-formed feces. Ectoparasitism was severe with approximately 48 female and 10 male American dog ticks (*Dermacentor variabilis*) and 8 female and 2 male western black-legged ticks (*Ixodes pacificus*) removed from various regions of the fisher. The liver sample from this fisher had quantifiable levels of BRD at 0.04 ppm as well as a trace level of CHL (Figure 4).

The second northern California fisher AR death, was an adult male recovered on 26 May 2010 at the HVRFP. Field observations included no evidence of predation or scavenging. The nutritional state as well as the postmortem condition were poor. Gross necropsy determined that the fisher (2.89 kg) had no body fat present in any of the tissues. Frank blood was present in both thoracic and abdominal cavities. The stomach contained red and black fluid but no prey. Ectoparasitism was severe with 204 female and 27 male adult American dog ticks in both replete and non-replete stages on areas of the muzzle, chest, tops of fore-and hind-limbs as well as inguinal sections. Severe nematodiasis was seen in skeletal muscle throughout the body (trichinosis). Pulmonary nematodiasis (lungworm) was also noted in the marginal portions of the lungs. Histopathologically, no notable disease processes were seen but severe parasitism was noted. The

liver sample for this fisher had quantifiable levels of BRD at 0.61 ppm and trace levels of BRM (Figure 4).

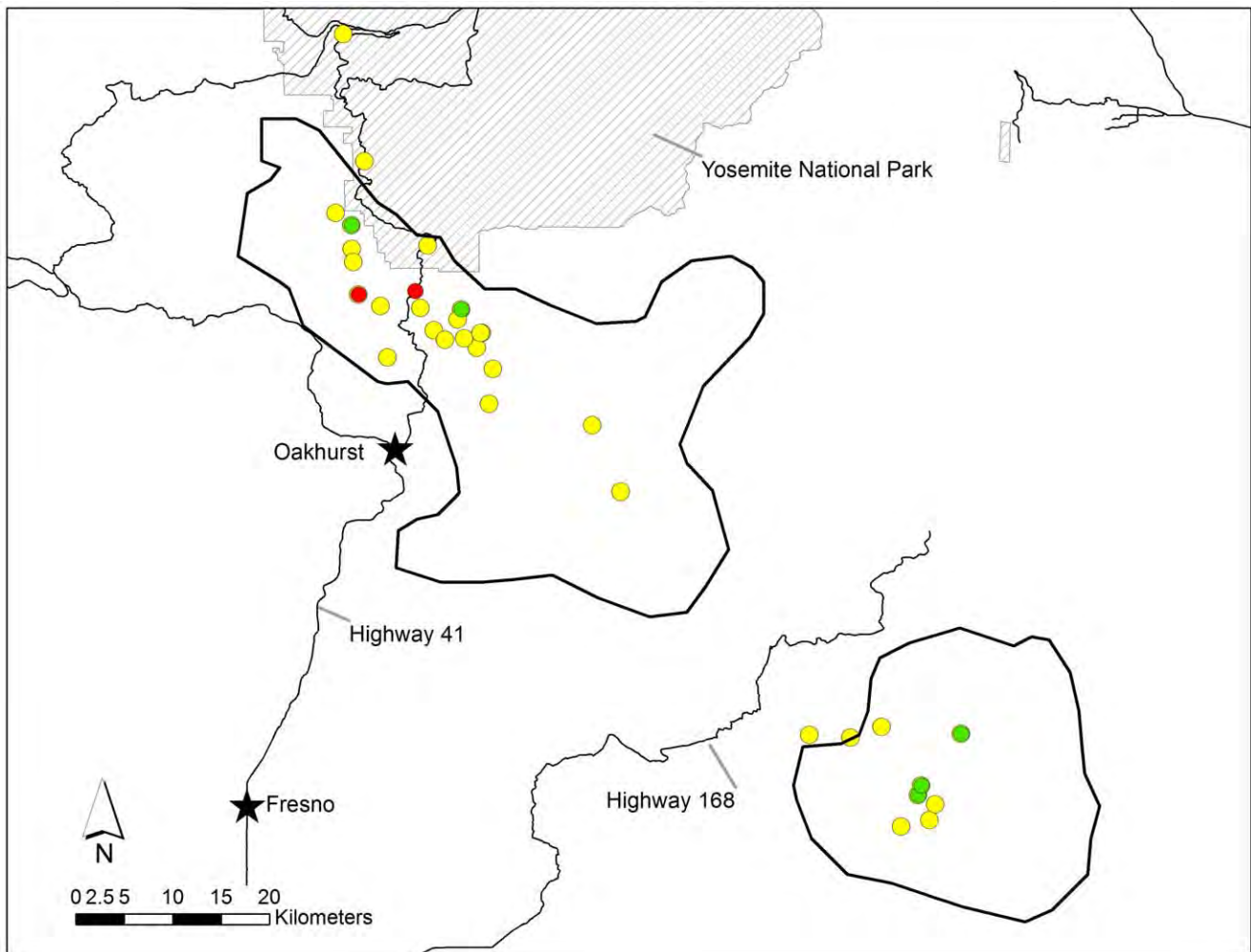
#### Neonatal Transfer of AR

Necropsies and AR testing was performed on four kits who were all still dependent on mother's milk when they died following maternal abandonment from their mothers death. One kit, a female fisher (0.32 kg) from KRFP tested positive for AR exposure. This kit was approximately six weeks of age and was recovered within a monitored maternal den tree shortly after maternal abandonment. Cause of death was determined to be acute starvation and dehydration. The liver tissue contained trace level of BRD but there was no associated hemorrhaging in any tissues, body cavities or lumina, suggesting that this finding was not clinically significant.

#### Discussion

Our findings demonstrate that anticoagulant rodenticides, which were not previously investigated in fishers or other remote forest carnivores, are a cause of mortality and may represent a conservation threat to these isolated California populations. This is





**Figure 6. Exposure to and mortality from anticoagulant rodenticides (AR) in fishers (*Martes pennanti*) from the isolated southern Sierra Nevada population.** Green circles represent negative fishers, yellow circles represent exposed fishers, while red circles are fishers that died due to AR toxicosis.

doi:10.1371/journal.pone.0040163.g006

the first documentation of exposure to ARs and of direct mortality from ARs in fishers anywhere in their geographic range. Earlier studies suggest ARs posed little or no additive mortality effects on non-target populations [7,35,36]. The shortfall of many of these studies was the utilization of common cosmopolitan species so they did not take in consideration that AR mortality may be additive in otherwise compromised populations. The spatially ubiquitous exposure observed within all post-weaning age classes and across the project areas in their contemporary range in California is of significant concern especially considering the recent work of Spencer et al. (2010), who demonstrated that even a small increase in human-caused mortality of 10–20% in the isolated Southern Sierra Nevada fisher population would be enough to prevent population expansion if other restrictive habitat elements were removed.

The high rate of exposure to second generation AR compounds (96% of exposed fishers) in these populations is surprising and cause for concern. This generation of ARs are not only more acutely toxic, but have long retention (>150 days half-life) through biphasic elimination in mammal tissues [1,37]. Second-generation ARs are more toxic because death can occur from a single primary ingestion by a rodent [1,5,37,38].

However, rodents can receive a lethal dose of second-generation ARs in one feeding bout and it can take up to 7 days before clinical signs manifest [1,39]. Therefore, prey that have consumed a “super-lethal” dose of AR can pose a substantial risk to predators for several days prior to death [39]. In one study, a group of Norway rats (*Rattus norvegicus*) was given a choice between BRD bait and untreated food and another group had access only to the BRD bait [1]. Both groups consumed 10 and 20 median lethal doses ( $LD_{50}$ ) on the first day and 40 to 80  $LD_{50}$  doses by day 6.5, respectively [1]. If sources for these toxicants are maintained for even short periods, exposed rodents, the main prey source for fishers in these populations [17] can pose significant threats to their predators.

Many manufactures use “flavorizers” since the AR compound may be bitter and unpalatable to rodent pests [1,39]. Emulsions used to increase palatability include sucrose, bacon, cheese, peanut butter, and apple flavors (Sure-Gro Inc., Brantford, Ontario, Canada and J.T. Eaton, Twinsburg, Ohio, USA), and thus could be palatable to generalist carnivores like fishers. Although we did not visually detect AR bait in the stomach or GI tracts of any fishers that died, primary poisoning cannot be completely ruled out.





**Figure 7. Condition of the undisturbed mortality site in which a fisher (*Martes pennanti*) mortality due to anticoagulant rodenticide from the southern Sierra Nevada population was found.**

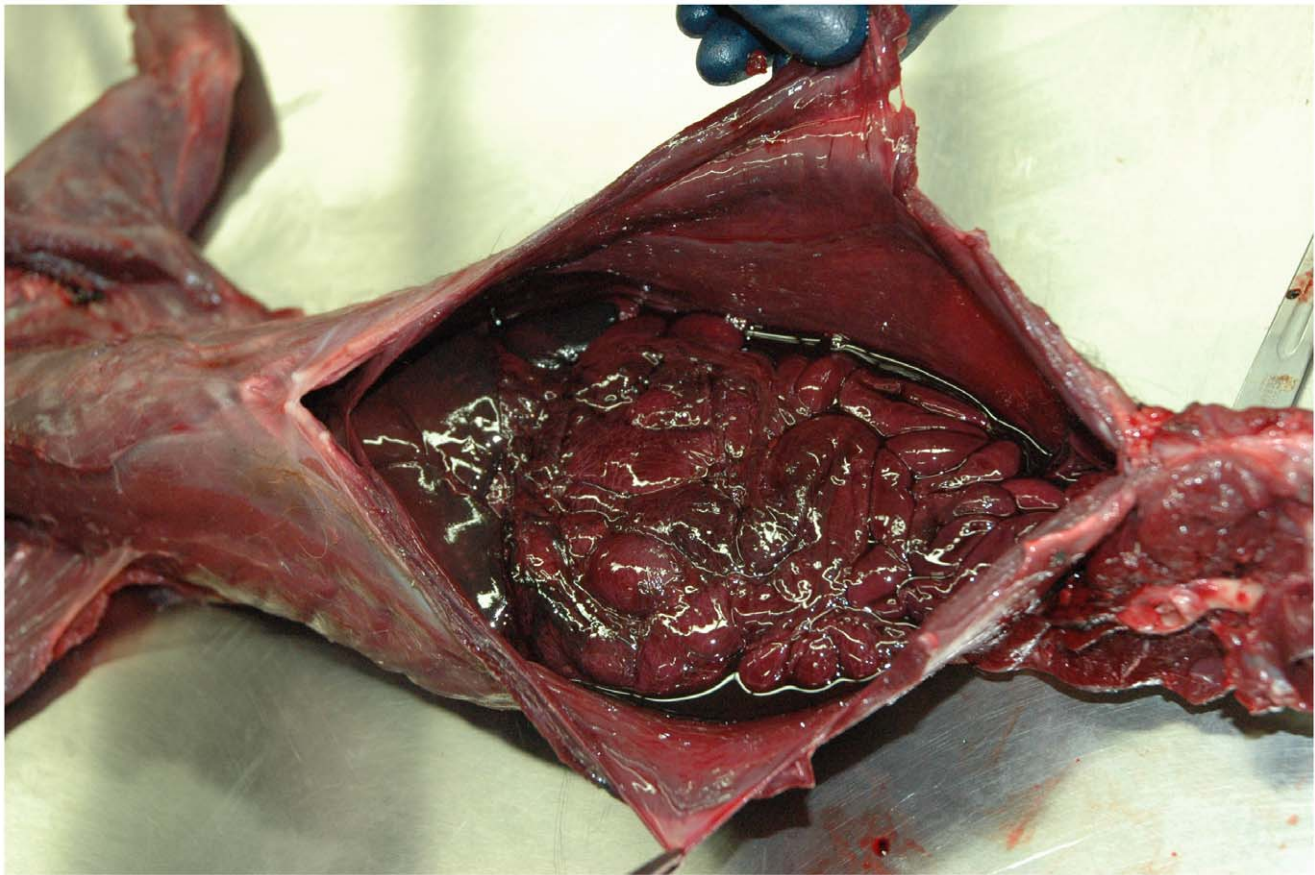
doi:10.1371/journal.pone.0040163.g007

#### Sub-lethal AR Exposure

In addition to the risk from lethal toxicosis, sub-lethal AR exposure may compromise fishers through a reduction in the function of normal clotting [5,37,40,41]. The occurrence of AR-exposed wildlife dying from minor wounds that otherwise might have easily resolved themselves if ARs were not present suggests contributory lethal effects [1]. Several cases describe raptors receiving minor defensive lacerations or trauma from

prey that lead to the raptor's death by exsanguination or hemorrhaging [1,42]. Fishers actively pursue a wide array of terrestrial and arboreal prey [17,18]. Hence, it is conceivable that a fisher could receive similar wounds or trauma from prey, or during the pursuit of prey. Consequently, if clotting mechanisms were compromised due to ARs, benign injuries could lead to serious complications [1,42,43,44]. The leading causes of mortality within the USFWS DPS is intraguild





**Figure 8. Thoracic cavity hemorrhaging containing 150 ml of frank blood due to coagulopathy after lethal exposure to anticoagulant rodenticides in a fisher (*Martes pennanti*) from the southern Sierra Nevada population.**  
doi:10.1371/journal.pone.0040163.g008

predation (G.M.Wengert, unpublished data). It is possible that some of these cases, AR exposure could have compromised clotting mechanisms at the predation attempt and this deserves further study.

High levels of tick infestations were noted in two of the AR mortalities when compared to other sympatric species within the same project area [45]. In addition, locations of these replete ticks were in infrequent regions in other captures, most likely due to a lack of regular grooming. Whether ARs played a role by allowing more ticks to obtain a blood meal due to immobilization due to compromised clotting factors is unknown.

Furthermore, sublethal AR exposure may decrease an animal's resilience to environmental stressors. In a study on rabbits and rats subjected to stressors such as severe decreases in ambient temperature (i.e. frostbite), approximately 10% of test animals died; however when animals were exposed to low non-lethal doses of anticoagulants and subjected to the same stressors, mortality rates increased to 40–70% [46]. It is unknown if stressors or injuries from environmental, physiological or even pathogenic factors could predispose fishers to elevated mortality rates when coupled with AR exposure.

#### Neonatal Transfer of AR

The documentation of neonatal or lactational transfer of AR to a dependent fisher kit was unexpected, and the effects of AR exposure to a kit during fetal development or shortly after birth are unstudied. AR exposure in pregnant or whelping domestic

canids varied, causing no clinical signs in some cases [47] but death due to coagulopathy immediately after delivery in other cases [48]. The female fisher who gave birth to this kit did not exhibit clinical signs at pre- or postpartum captures and monitoring of her maternal den site verified that one kit survived from that litter (Rebecca Green, United States Forest Service, personal communication). Nevertheless, clinical signs including hemorrhaging, inappetence and lethargy have been seen in domestic canid puppies of AR-exposed mothers [47,48]. Mild to severe manifestations such as low birth weight, stillbirth or eventually neonatal death has been documented in several cases [47,48,49]. In one human study where pregnant women received low doses of warfarin due to severe risk of thromboembolic events, 33% of them had stillbirths, 28% had abortions, and 11% of the neonates died shortly after birth [50]. The range for congenital anomalies and miscarriages in pregnant females for prescribed doses of warfarin varied from 15 to 56% and long-term neurological symptoms have been reported in children that were exposed in-utero [51]. The fetotoxic effects of AR in pregnant fishers and their fetuses are unknown. In addition, because fishers exhibit delayed implantation of the blastocyst, whether ARs may cause pregnant females to abort or reabsorb the fetus merits further research [52,53,54]. The transfer of first generation ARs from mother to offspring in milk is not well-understood and there are no data on lactational transfer of second-generation ARs [49].





**Figure 9. One of several nine-pound buckets of anticoagulant rodenticide removed from an illegal northern California marijuana operation within the northwestern California fisher (*Martes pennanti*) project boundary.**  
doi:10.1371/journal.pone.0040163.g009

### Quantification Levels

The quantity (ppm) of AR we observed in fisher liver tissues varied and overlapped extensively in both sublethal and lethal cases with no clear indication of a numeric threshold that might indicate an amount leading to morbidity or mortality. This lack of predictive ability has been shown in numerous wildlife cases [1,12,55]. For example, Brodifacoum, the most prominent AR compound detected in fishers in this study ranged considerably in lethal cases among individual mustelid species, with 0.32–1.72 ppm in stoats (*Mustela ermine*) [55,56,57], 0.7 ppm in least weasels (*Mustela nivalis*) [56], 1.47–1.97 in ferrets (*Mustela furo*) [57] and 9.2 ppm in American mink (*Mustela vison*) [3,36]. In addition, there are stark differences for acute LD<sub>50</sub> doses among genera, where minute amounts of brodifacoum bait caused death in domestic canids but domestic felids required doses 5 to 40 times higher [38]. The same variability seen in both mustelids and other carnivores suggests that predicting clinical thresholds for fishers would be pre-mature [1,58]. Furthermore, AR exposed fishers had an average of 1.6 AR types within their systems, and possible interaction effects from a combination of 2 or more AR compounds within a fisher and other species are entirely unknown [1,37].

### Potential Sources of AR

Spatial analyses did not reveal any obvious point sources of AR exposure. Instead, these analyses suggested that exposure is widespread across the landscape. Previous studies expected that exposure to AR compounds would be clustered near areas of human activity or inhabitations and that exposure would not be common outside of these areas [1,12,14,24]. Incongruously, data from this study refuted this hypothesis thus making the finding even more significant. Furthermore, these exposures occurred within a species that is not closely affiliated with urban, peri-urban or agricultural settings in which second-generation ARs typically are [1,12,14,24]. Federal and state regulations for anticoagulant rodenticide usage are specific for both generations. Before the June 2011 Environmental Protection Agency (EPA) regulations [39], second generation class ARs could be purchased at local retailers, with recommendations for placement in weather- and tamper-resistant bait containers no more than 50 feet from any building [39]. However, since June 2011, second generation ARs have not been available to consumers at retail, but only at agricultural stores (farm, tractor or feed stores) with additional form and weight restrictions [39]. These newly passed regulations are aimed at further restriction of irresponsible and illegal use of ARs [39]. However, we would have expected that with either pre- or post-





**Figure 10. Multiple packets of anticoagulant rodenticides found surrounding an illegal marijuana grow site within the southern Sierra Nevada fisher (*Martes pennanti*) project.**  
doi:10.1371/journal.pone.0040163.g010

June 2011 regulations, second generation AR exposed fishers would have overlapped with urban, peri-urban, or agricultural environments. This pattern is acknowledged in several studies, such as Riley et al. (2007) where bobcat (*Lynx rufus*) and mountain lion (*Felis concolor*) total quantification levels of AR exposure were associated with human-developed areas. Numerous studies have documented that secondary poisoning cases are closely associated with recent agricultural or urban pest eradication efforts [1,13,14,24].

The majority of habitat that fishers in California and fishers throughout the DPS currently and historically occupied is not within or near agricultural or urban settings [17]. Several fishers that were exposed had been monitored their entire lives and inhabited public or community lands where human structures are rare or non-existent (M. Higley, R. Sweitzer, C. Thompson unpublished data). Therefore, exposure from first or second-generation AR use at or within 50 feet of residential or agricultural structures and settings were considered unlikely due to fisher habitat requirements and general lack of association with humans. This suggests that wide-spread non-regulated use of second

generation second generation ARs is occurring within the range of fishers in California, especially on public lands.

A likely source of AR exposure to fishers is the emerging spread of illegal marijuana cultivation within California public and private lands [59,60]. In 2008 in California alone, over 3.6 million outdoor marijuana plants were removed from federal and state public lands, including state and national parks, with thousands of pounds of both pesticides and insecticides found at grow sites [59,60,61]. In 2011, a three week eradication operation of marijuana cultivation removed over 630,000 plants and 23,316 kg of trash including 68 kg of pesticides within the Mendocino National Forest in the northern California fisher populations range [17,62]. Anticoagulant rodenticides and pesticides are typically dispersed around young marijuana plants to deter herbivory, [60,62,63] but significant amounts of AR compounds are also placed along plastic irrigation lines used to draw water from in order to deter rodent chewing [60,62,63] (M.W. Gabriel, personal observation). A recent example in which over 2,000 marijuana plants were removed less than 12 km from one of the project areas revealed that plants on the peripheral





**Figure 11. Anticoagulant rodenticide bait pellets (bright green) with plant fertilizer freely dispersed around 2,000 plants from northern California marijuana grow site within the northwestern California fisher (*Martes pennanti*) project boundary.**  
doi:10.1371/journal.pone.0040163.g011

edges as well as nearby irrigation had large amounts of second generation AR placed (Figure 9, Figure 10, Figure 11). Finally, just within a single eradication effort, multiple kilometers (>40 km) of irrigation line within National Parks and Forests in California were removed [60,62]. Placement of ARs at the grow sites and along irrigation lines which jut out great distances from the grow site itself may explain why there are no defined clusters of AR exposure.

It is noteworthy that the AR fisher mortalities we documented occurred in different areas of their California range but within a relatively short seasonal period between mid-April to mid-May. We cannot specify the exact explanation or source contributing to all AR mortalities that occurred within this short temporal period. This period is when females are providing for offspring as well as males searching for mates; however, preliminary spatial data for fishers in California document that females have more confined home-ranges during this period, while males have slightly larger home-ranges (S. Matthews, R. Sweitzer, unpublished data).

Additionally, several books available to the general public identify the optimal time for planting marijuana outdoors is during mid to late spring, and seedlings are especially vulnerable to rodent pests [64,65,66]. Of additional concern is that April to May is the

denning period for female fishers and a time when fisher kits are entirely dependent on their mothers [17,18]. The documentation of a lactating female mortality attributed to AR toxicosis during this period suggests that most likely kits would be abandoned and die from female mortalities during this time.

In conclusion, this study has demonstrated that fishers in the western DPS, which are of conservation concern and a candidate for protection under the Endangered Species Act, are not only being exposed to ARs, but ARs are a direct cause of mortality and indirect mortality (i.e. kit abandonment) in both of California's isolated populations. Consequently, these toxicants may not only pose a mortality risk to fishers but could also pose significant indirect risks by depleting rodent prey populations upon which fishers depend. The lack of spatial clustering of exposed individuals suggests that AR contamination is widespread within this species' range and illegal or irresponsible use of ARs continues despite recent regulatory changes regarding their use. Because we do not know the long-term ecological ramifications of these toxicants left on site long after marijuana grows are dismantled, heightened efforts should be focused on the removal of these toxicants at these and adjacent areas at the time of dismantling. Further regulation restricting the use of ARs to only pest management professionals



as well as continued public outreach through state wide Integrated Pest Management programs may be warranted. In addition, promotion of compounds that do not possess the propensity for secondary poisoning (i.e. zinc phosphide) should be considered in non-professional use settings. Furthermore, ARs in these habitats may pose equally grave risks to other rare and isolated California carnivores such as the Sierra Nevada red fox (*Vulpes vulpes nector*), American marten (*Martes americana*), wolverine (*Gulo gulo*), gray wolf (*Canis lupus*) or raptors such as northern spotted owls (*Strix occidentalis caurina*), California spotted owls (*S.o. occidentalis*) and great gray owls (*Strix nebulosa*). Future research should be directed to investigating potential risks to prey populations as well as other sympatric species that may allow a better understanding of the potential AR sources contributing to these exposure and mortality rates from anticoagulant rodenticides.

## Supporting Information

**Table S1 A two-way ANOVA analyzing the effects of California fisher (*Martes pennanti*) populations and sex on the number of anticoagulant rodenticides found per individual.**

(DOCX)

**Table S2 Results of spatial scan statistics to detect clusters of anticoagulant rodenticide (AR) exposed fishers within each California fisher project.** Number of individual fisher minimum convex polygon (MCP) centroids used for each temporal period, specific AR types, generation class of

AR and distribution of numbers of ARs per fisher (number of AR positive fishers per test in parentheses) are shown. (DOCX)

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## Author Contributions

Conceived and designed the experiments: MWG LWW RHP RAS CT SMM JMH SMK KP RHB GMW DLC. Performed the experiments: MWG LWW RHP RAS CT SMM JMH SMK KP RHB GMW DLC. Analyzed the data: MWG LWW RHP RAS CT SMM JMH SMK KP RHB GMW BNS DLC. Contributed reagents/materials/analysis tools: MWG LWW RHP RAS CT SMM JMH SMK KP RHB GMW DLC. Wrote the paper: MWG LWW RHP GMW BNS DLC. Acquisition of funding: MWG RAS CT SMM JMH KP RHB GMW.

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# Small-scale habitat fragmentation effects on pollinator behaviour: experimental evidence from the bumblebee *Bombus veteranus* on calcareous grasslands

M. Goverde\*, K. Schweizer, B. Baur, A. Erhardt

Department of Integrative Biology, Section of Conservation Biology, University of Basel, St. Johannis-Vorstadt 10, CH-4056 Basel, Switzerland

## Abstract

We examined visiting patterns of pollinators of *Betonica officinalis* L. (Lamiaceae) in experimentally fragmented calcareous grasslands and corresponding control plots at two study sites (Movelier and Nenzlingen) in the north-western Swiss Jura mountains. Fragments (1.5 × 1.5 m) were isolated by a 5-m wide strip of frequently mown vegetation while the control plots were situated in the adjacent undisturbed vegetation. The most common pollinator, the bumblebee *Bombus veteranus* (Apidae), visited fragments 53.7% less frequently than control plots. Furthermore, a change in foraging behaviour of *Bombus veteranus* was observed. In fragments the bumblebees visited more inflorescences, flew longer total visiting distances and the visiting time per patch tended to be higher than in control plots. The distribution of angles between arrival and departure direction (turning angles) differed from a uniform distribution in fragments but not in control plots. The increased directionality of bumblebee flight might be due to a decrease in floral rewards. Our results show that small-scale habitat fragmentation can affect plant pollination at two levels both relevant for plant fitness. First, lower visitation rates indicate a limitation of pollinators which might result in reduced seed set of the pollinated plant. Second, changes in pollinator behaviour might reduce pollen dispersal among flowers, increase inbreeding and hence reduce genetic variability in populations of this bumblebee pollinated plant. © 2002 Elsevier Science Ltd. All rights reserved.

**Keywords:** *Betonica officinalis*; *Bombus veteranus*; Bumblebee; Gene flow; Plant–pollination interaction

## 1. Introduction

Nutrient-poor, calcareous grasslands are among the habitats with the highest species richness in western Europe (Zoller, 1954; Ellenberg, 1982; Willems, 1982). However, industrialisation and changes in agricultural land use since the 1950s caused a dramatic decline of this once common type of grassland, and the remaining remnants are often small, fragmented and isolated (e.g. Willems, 1982; Zoller et al., 1986; Fischer and Stöcklin, 1997). Fragmentation of these natural habitats has especially negative biological consequences for ecosystem functions (Saunders et al., 1991; Kearns et al., 1998), such as plant–pollinator interactions, the subject of the present study.

The ecological importance of pollinators in their communities is crucial (Kearns et al., 1998). The entire structure of biotic communities will be dramatically changed when keystone plant species lose their pollinators. A

cascade of changes including a decline in biodiversity may follow (Allen-Wardell et al., 1998; Kearns et al., 1998). Habitat fragmentation can affect pollinator behaviour, population size of animals and plants, and even pollinator morphology (Phillips, 1997; Berwaerts et al., 1998; Thomas et al., 1998; VanDyck and Matthysen, 1999). These changes might in turn influence community structure, population dynamics, trophic levels and genetic diversity in natural ecosystems. Plants experience lower fitness if pollinators are missing or reduced in numbers (e.g. Jennersten, 1988; Pavlik et al., 1993; Fischer and Matthies, 1997; Robertson et al., 1999). Furthermore, habitat fragmentation can change the spatial distribution of plants, which in turn changes foraging patterns of pollinators (Cresswell, 1997). If the distance between plants to be pollinated is too large, pollination is limited (Schmitt, 1983; Klinkhamer et al., 1989) and plant fitness may be reduced due to inbreeding and/or outbreeding depression caused by increased genetic drift (Waser and Price, 1983; Van Teuren et al., 1991; Holsinger, 1993; Percy and Cronk, 1997; Gigord et al., 1999). Thus, a change in pollinator behaviour might strongly affect plant reproductive success and plant fitness.

\* Corresponding author. Tel.: +41-61-267-08-31; fax: +41-61-267-08-32.

E-mail address: goverde@mail.com (M. Goverde).

There is empirical evidence that habitat fragmentation can influence pollinator populations directly or indirectly, and may cause declines of pollinators (Allen-Wardell et al., 1998). However, little attention has been given to the effect of fragmentation on pollinator behaviour. The aim of this study was to investigate under natural conditions the influence of experimental small-scale fragmentation on the pollinator behaviour of *Bombus veteranus* (Apidae), the most common pollinator of *Betonica officinalis* L. (Lamiaceae), a typical perennial forb in calcareous grasslands of the Swiss Jura mountains.

## 2. Methods

### 2.1. Fragmentation experiment and sampling

The study was carried out from 22 July to 7 August 1998 in the experimental habitat fragmentation study site of the University of Basel in the Swiss Jura mountains (Baur and Erhardt, 1995; Baur et al., 1996). The original design, established in spring 1993, consists of three field sites with a total of 12 blocks (Fig. 1) on nutrient-poor, dry calcareous grasslands belonging to the Teucro-Mesobrometum type (Ellenberg, 1988). In the present study the medium-sized fragments (1.5×1.5 m) and control plots of equal size from six blocks at two sites were used (three blocks at Movelier and three blocks at Nenzlingen). These field sites are situated near Nenzlingen (10 km south of Basel) and near Movelier (5 km north of Delémont).

In each block, fragments were separated by a 5-m wide strip of frequently mown vegetation (6–12 times per year). Corresponding control plots of equal size were mirror-symmetrically arranged and surrounded by undisturbed vegetation (Fig. 1). Because the original control plots varied largely in occurrence of *Betonica officinalis*, we placed control plots in the undisturbed vegetation so as to contain approximately the same number of *Betonica officinalis* inflorescences as in the fragments. Thus, in the surroundings of the control plots numerous other *Betonica officinalis* inflorescences were present, whereas those in the fragments were separated by at least 5 m from other *Betonica officinalis* inflorescences.

In each patch (fragment or control plot) all *Betonica officinalis* inflorescences and open flowers were counted. The positions of all flowering *Betonica officinalis* inflorescences were mapped in 36 cells measuring 25×25 cm. Pollinators were observed in each patch for 20 min on three separate days. We recorded the visitation pattern of every flower visitor entering the plot during the survey. We measured for each insect the visiting distances between successively visited inflorescences, the total flying distance in the patch and the turning angles. Flower visitors that were already in the patch at the beginning

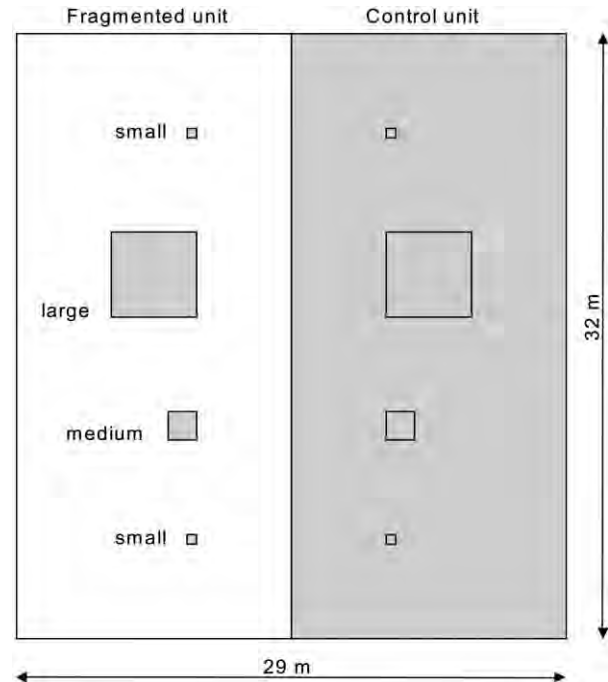


Fig. 1. Experimental layout for one of 12 experimental blocks of 29×32 m established in spring 1993. Each unit contained one large (4.5×4.5 m), one medium (1.5×1.5 m) and two small fragments (0.5×0.5 m), all of them separated by a 5-m wide strip of mown vegetation (white area), as well as the corresponding control plots, which were mirror-symmetrically arranged and surrounded by undisturbed vegetation (grey area).

of the survey were not considered. Additionally, the duration of the visit in the plot of each flower visitor was assessed using a DAT-recorder. Observations were performed between 10:00 and 16:00 in sunny and warm weather. To avoid any time effect the order of surveys in fragments and their control plots were randomised on each observation day. Fragments and control plots of each site were surveyed on three different days (Nenzlingen on 22 and 30 July and on 8 August 1998, Movelier on 24 July and on 6 and 7 August 1998).

The distance between nesting sites of *Bombus veteranus*, the most frequent visitor, and the experimental patches could potentially have affected our observations. However, the fact that bumblebees can forage several hundred metres away from their nesting sites (Osborne et al., 1999), and the design of our experiment (random distribution of fragments and control plots) suggest that positions of nesting sites do not affect the results of the present study.

### 2.2. Data analyses

To compare the number of visits between fragments and control plots a chi-square goodness of fit test with a hypothesised ratio of 1:1 was used for each site (Zar, 1999). We used pooled data from the three survey days for each fragment and control plot.

To prevent spatial pseudoreplication, data from visiting patterns were averaged per fragment or control plot, respectively, for each survey day. To prevent temporal pseudoreplication we used the average of the three survey days per site, thus, resulting in 12 independent replications (six fragments and six control plots). Three-way analyses of variance (ANOVA, type III model, using JMP 3.1, SAS, 1995) with the fixed factors site and treatment and the random factor block nested by site were used to examine effects on the following parameters (patches refer to fragments or control plots):

Percent of visited inflorescences

$$= \frac{\text{Mean of visited inflorescences per bumblebee}}{\text{Total number of inflorescences in patch}}$$

Visiting time per patch related to inflorescence number (= “Visiting time per patch”)

$$= \frac{\text{Mean time spent in patch per bumblebee}}{\text{Total number of inflorescences in patch}}$$

Ratio of mean visiting distances

$$= \frac{\text{Mean distance flown between two successively visited inflorescences}}{\text{Mean nearest neighbour distance between inflorescences}}$$

Ratio of total visiting distances

$$= \frac{\text{Total distances between visited inflorescences in patch per bumblebee}}{\text{Total nearest neighbour distances between inflorescences in patch}}$$

As a measure of the pollinators’ flight directionality, turning angles between the arrival and departure directions were assessed from visiting patterns of single bumblebees. For data analysis angles were assigned to 18 classes each of 20°. The distributions of angles recorded in fragments and those from the control plots were compared with a uniform distribution using chi-square goodness of fit test (Zar, 1999). Furthermore, a 2×18 contingency table (G-test) was used to compare the distribution of angles in fragments with those in control plots (Zar, 1999).

### 3. Results

The number of inflorescences per patch as well as the number of open flowers were not affected by the

experimental fragmentation but differed between sites (Table 1). Furthermore, the number of open flowers per inflorescence did not differ between sites ( $F_{1,4}=0.44$ , n.s.) or treatments ( $F_{1,5}=0.17$ , n.s.).

In total, the visiting pattern of 314 flower visitors was recorded. Among them, 218 belonged to the most common species, *Bombus veteranus*. The remaining flower visitors were other Hymenoptera (34), *Zygaena* spp. (42), other Lepidoptera (12) and Diptera (eight). Individuals of *Bombus veteranus* visited the fragments less frequently (69 individuals) than the control plots (149 individuals; Fig. 2) which means 53.7% fewer visits in the fragments.

Fragmentation significantly influenced the behaviour of the pollinator *Bombus veteranus* (Fig. 3). The percentage of visited inflorescences and the ratio of total visiting distances was significantly higher in fragments than in control plots (Fig. 3A,D). Thus, flying longer distances and especially visiting more inflorescences within a fragment indicate more near-neighbour pollination, which may result in increased inbreeding in pollinated plants in the fragments. Furthermore, the “visiting time per patch” tended to be longer in fragments than in control plots (Fig. 3B), while the ratio of mean visiting distances did not differ between fragments and control plots (Fig. 3C). A significant site effect on

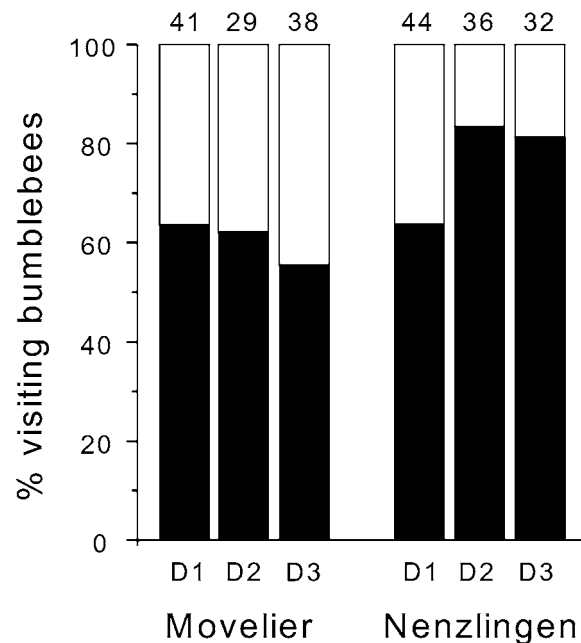


Fig. 2. Percentage of visits of *Bombus veteranus* in fragments (open bars) and corresponding control plots (black bars) at the two different sites, separated per day (D1, D2, D3 = first, second and third observation day, respectively). The numbers above the bar indicate the total number of observed bumblebees at this day. The difference between fragments and control plots was significant for both sites (Movelier:  $\chi^2=4.48$ , d.f. = 1,  $P=0.034$ ; Nenzlingen:  $\chi^2=28.00$ , d.f. = 1,  $P<0.001$ ).



Table 1

(a) Mean number ( $\pm 1$  S.E.) of inflorescences and open flowers of *Betonica officinalis* in fragments ( $n = 3$ ) and control plots ( $n = 3$ ) at the two study sites in Movelier and Nenzlingen. (b) Three-way analyses of variance (ANOVA) for effects of site and fragmentation treatment

(a)								
Site	Treatment	Number of inflorescences per patch (2.25 m <sup>2</sup> )			Number of open flowers per patch (2.25 m <sup>2</sup> )			
Movelier	Fragments	9.9 $\pm$ 3.3			85.8 $\pm$ 36.7			
	Control plots	7.4 $\pm$ 1.7			64.2 $\pm$ 24.5			
Nenzlingen	Fragments	22.9 $\pm$ 1.3			146.0 $\pm$ 8.4			
	Control plots	21.7 $\pm$ 0.5			176.8 $\pm$ 14.5			

(b)								
	d.f.	SS	F	P	d.f.	SS	F	P
Site	1	630.18	35.58	0.004	1	30959.51	15.40	0.017
Treatment	1	17.17	3.87	0.11	1	163.33	0.12	0.75
Block (site)	4	70.84	3.99	0.08	4	8041.43	1.43	0.35
Error	5	22.20			5	7036.28		

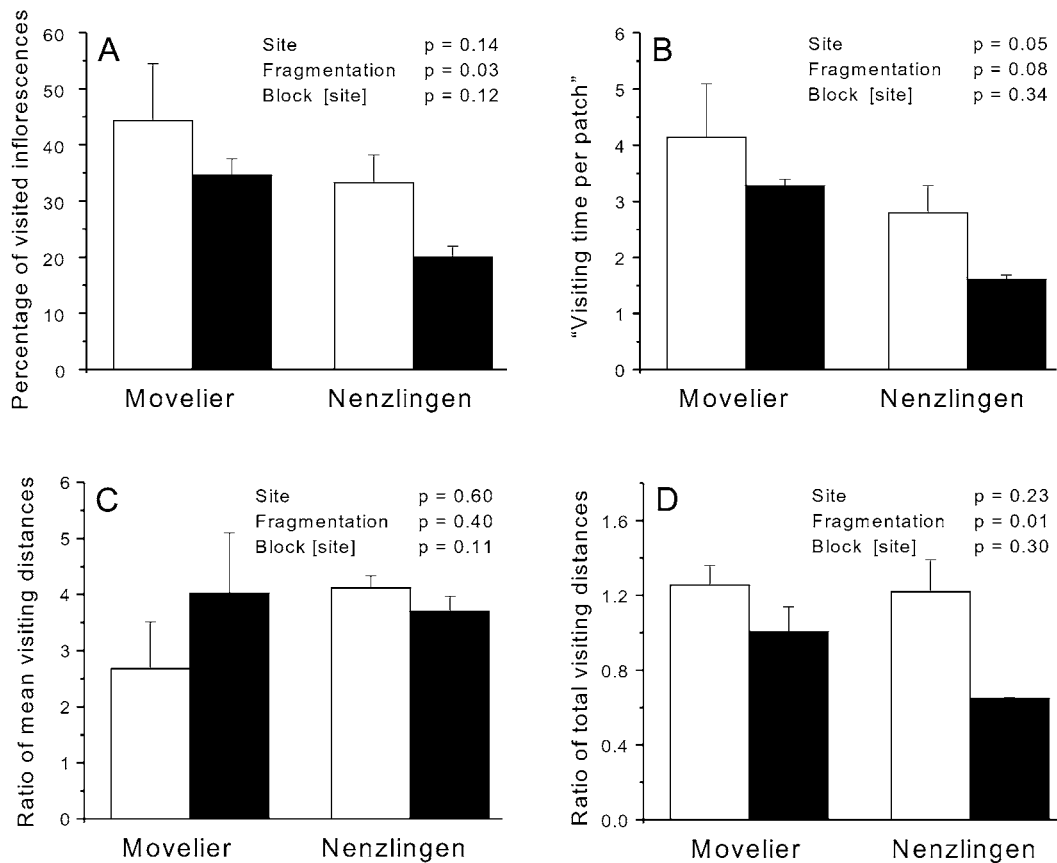


Fig. 3. Effect of habitat fragmentation on the behaviour of the pollinator *Bombus veteranus* visiting *Betonica officinalis* (mean $\pm$ 1 S.E.; open bars = fragments, black bar = control plots) at the sites Movelier and Nenzlingen. (A) percentage of visited inflorescences, (B) visiting time per patch related to inflorescence number ("visiting time per patch"), (C) ratio of mean visiting distances, and (D) ratio of total visiting distances.

the behaviour of *Bombus veteranus* was only found in "visiting time per patch" (Fig. 3B).

The distribution of turning angles of foraging *Bombus veteranus* differed significantly from a uniform distribution in fragments (Fig. 4,  $\chi^2 = 48.28$ , d.f. = 17,  $P < 0.001$ ), but not in the control plots (Fig. 4,

$\chi^2 = 23.79$ , d.f. = 17,  $P = 0.12$ ). There is thus a stronger tendency towards directionality in fragments than in control plots. However, a direct comparison of the distributions of turning angles in fragments and control plots revealed no significant difference ( $G = 14.14$ , d.f. = 17,  $P = 0.66$ ).

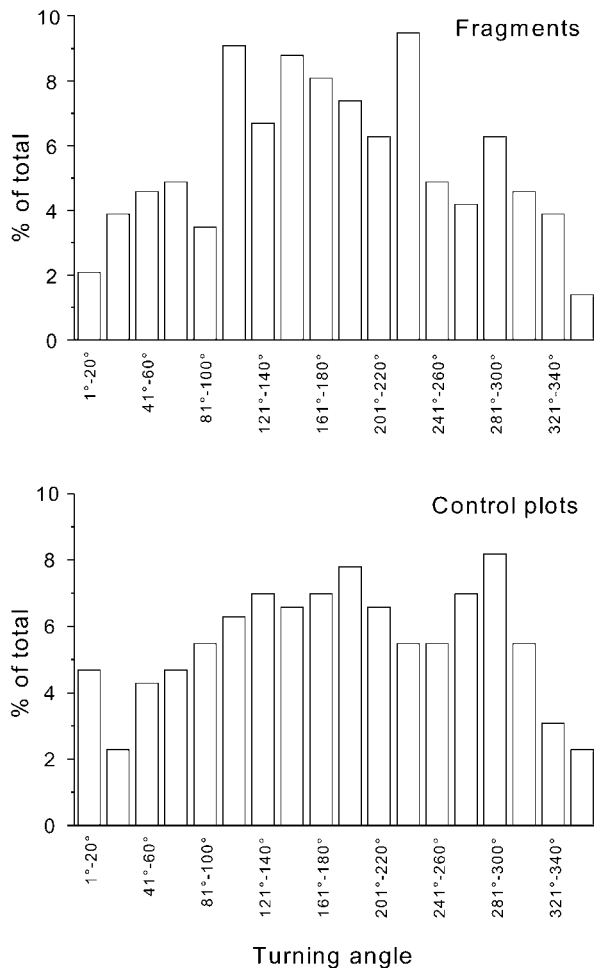


Fig. 4. Distribution of turning angles for *Bombus veteranus* visiting *Betonica officinalis* inflorescences in fragments ( $n=285$ ) and control plots ( $n=256$ ).

#### 4. Discussion

The present study shows that the behaviour of the most common pollinator of *Betonica officinalis*, the bumblebee *Bombus veteranus*, was altered by small-scale fragmentation of calcareous grasslands. Bumblebees visited more inflorescences, flew longer total distances and tended to stay longer in fragments than in control plots (Fig. 3A,B,D). Thus, *Bombus veteranus* preferred to stay within the fragment rather than flying a long distance to reach the next inflorescence outside the fragment. Rasmussen and Brodsgaard (1992) examined visiting patterns of *Bombus lapidarius* in *Lotus corniculatus* patches, which were of different sizes and interspersed with dry areas dominated by mosses, lichens and short grass. Most flights of *Bombus lapidarius* were restricted to single patches (97.4%), although the animals had no difficulty to cross the distance of 10–40 m between patches. Since long distance flying is energetically expensive, the higher visitation rate within patches can be explained by the attempt of pollinators to

optimise net energetic gain during foraging (Zimmerman, 1982; Price, 1997). In the present study, fragments were 53.7% less frequently visited than control plots. As a consequence, nectar rewards of inflorescences in fragments might be higher and pollinators might probe more thoroughly because movement decisions are based on the amounts of nectar encountered in flowers (Heinrich, 1979; Cresswell, 1990). However, measurements of nectar samples of *Betonica officinalis* did not support this assumption. The nectar quantity was smaller in fragments than in control plots, whereas the nectar concentration was higher in fragments than in control plots (H.-P. Rusterholz, unpublished data). These differences could be a result of lower soil moisture in fragments than in control plots resulting from frequent mowing of the surroundings (H.-P. Rusterholz, personal communication). In spite of this, bumblebees visiting fragments could have a more economic net energetic gain if they properly probe all available inflorescences in fragments.

The bumblebees' attempt to achieve the highest net energetic gain is confirmed by the observed difference in "visiting time per patch" between the two study sites (Fig. 3B). At Movelier, where there were fewer inflorescences per patch, bumblebees spent more time in a particular patch relatively to the total number of inflorescences, i.e. they visited more intensively all available inflorescences. This finding is supported by other studies in which bumblebees probed fewer flowers per plant and bypassed more plants with increased plant aggregation (e.g. Zimmerman, 1982; Cresswell, 1997). Furthermore, the directionality of foraging movement of bumblebees decreases with increasing plant aggregation (Cresswell, 1997). Additionally, edge plants in isolated patches provoke more reversals of flight than plants in the centre of patches (Rasmussen and Brodsgaard, 1992). Therefore, we assumed that foraging pollinators show less distinct directionality in their flights in fragments, while in the control plots pollinators would rather pass through the patch and, consequently show a directionality in their flight. Directionality in foraging flight decreases revisitation and results in decreased self-pollination, which in turn may affect the genetic structure of the plant population (Cartar and Real, 1997). In the present study bumblebees tended to fly more directly in fragments than in control plots (Fig. 4). A possible explanation could be an adjusted behaviour pattern of foraging strategy. The directionality of flights between inflorescences is random when rewards are high but approaches 180° when rewards are intermediate or poor (Heinrich, 1979; Richards, 1997). Thus, the lower nectar volume of flowers in fragments mentioned earlier might explain the observed tendency towards directionality in fragments.

Most relevant for plant fitness are the lower visitation rates in fragments and the tendency of bumblebees to

remain in isolated patches. Pollinator limitation may reduce seed set while the frequent neighbour visits may reduce the exchange of pollen between distant plants. Thus, gene flow is reduced between fragments which may decrease the probability of outcrossing. Indeed, genetic investigations conducted in the same fragmentation experiment revealed that offspring of *Betonica officinalis* had a lower genetic diversity and an increased self-fertilisation rate in fragments (H.P. Rusterholz, personal communication). These findings illustrate general processes in fragmented landscapes, which in turn might lead to an Allee effect followed by the extinction of small plant populations (Allee et al., 1949; Courchamp et al., 1999).

We showed that experimental small-scale fragmentation reduced flower visitation and changed the behaviour of a common pollinator. Other pollinator species might be affected in a similar way. The reproductive success of pollinated plants might be reduced in fragments due to higher geitonogamy and increased rate of inbreeding. However, any extrapolation of the findings to large-scale fragmentation should be made with caution.

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Research



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**Authors for correspondence:**

Holly B. Ernest

e-mail: [hernest@uwyo.edu](mailto:hernest@uwyo.edu)


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# A single migrant enhances the genetic diversity of an inbred puma population

Kyle D. Gustafson<sup>1</sup>, T. Winston Vickers<sup>2</sup>, Walter M. Boyce<sup>2</sup> and Holly B. Ernest<sup>1</sup>

<sup>1</sup>Wildlife Genomics and Disease Ecology Laboratory, Department of Veterinary Sciences, University of Wyoming, Laramie, WY 82070, USA

<sup>2</sup>Karen C. Drayer Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, CA 95616, USA

 KDG, 0000-0003-1869-4023; HBE, 0000-0002-0205-8818

Migration is essential for maintaining genetic diversity among populations, and pumas (*Puma concolor*) provide an excellent model for studying the genetic impacts of migrants on populations isolated by increasing human development. In densely populated southern California, USA, puma populations on the east and west side of interstate highway 15 (I-15) have become fragmented into a small inbred population on the west side (Santa Ana Mountains) and a relatively larger, more diverse population on the east side (Eastern Peninsular Range). From 146 sampled pumas, genetic analyses indicate seven pumas crossed I-15 over the last 15 years, including four males from west to east, and three males from east to west. However, only a single migrant (named M86) was detected to have produced offspring and contribute to gene flow across the I-15 barrier. Prior to the M86 migration, the Santa Ana population exhibited inbreeding and had significantly lower genetic diversity than the Eastern Peninsular Range population. After M86 emigrated, he sired 11 offspring with Santa Ana females, decreasing inbreeding measures and raising heterozygosity to levels similar to pumas in the Eastern Peninsular Range. The emigration of M86 also introduced new alleles into the Santa Ana population, although allelic richness still remained significantly lower than the Eastern Peninsular Range population. Our results clearly show the benefit of a single migrant to the genetics of a small, isolated population. However, ongoing development and habitat loss on both sides of I-15 will increasingly strengthen the barrier to successful migration. Further monitoring, and potential human intervention, including minimizing development effects on connectivity, adding or improving freeway crossing structures, or animal translocation, may be needed to ensure adequate gene flow and long-term persistence of the Santa Ana puma population.



# 1. Introduction

Without the benefits of immigration, genetic drift and breeding among closely related individuals can lead to an accumulation of deleterious alleles and inbreeding depression, reducing population fitness and increasing extinction risk [1–3]. Immigration benefits populations primarily by increasing heterozygosity and allelic richness, both of which are critical for population persistence [4,5]. Heterozygosity is of immediate importance to individual and population fitness [6,7], whereas allelic richness is directly related to the adaptive potential and long-term viability of populations [8,9]. In small populations, heterozygosity is lost at a slower rate and regained more quickly than allelic richness [2,10,11]. Although a single migrant per generation may be sufficient for maintaining genetic diversity among populations [12–14], populations are becoming increasingly fragmented by human development [15,16], and the desirable one-migrant-per-generation minimum is not always met [12,17–19].

In the United States, fragmented puma (*Puma concolor*) populations are becoming models for the study of genetics in small, isolated populations [20–24]. Complete geographical isolation of the Florida panther (*P. concolor coryi*) resulting in severe inbreeding is the extreme example [25]. Translocations of pumas from Texas to Florida have successfully alleviated inbreeding depression but, without additional immigration (natural or artificial), long-term population viability is uncertain [22,26]. Puma populations along the highly urbanized west coast of the United States are also becoming isolated, primarily by expanding human development [27–31]. Demographic and genetic concerns, along with threat of disease, have brought the long-term viability of these urban puma populations into question, and genetic restoration may be required [21,23,24,32–34].

Within southern California, our research team has been monitoring puma populations in the Santa Ana Mountains and Eastern Peninsular Range since the early 2000s [34]. Pumas in the Santa Ana Mountains are exhibiting signs of inbreeding, and are isolated from the more genetically diverse Eastern Peninsular Range population by an 8–10 lane freeway (Interstate 15 [21,34]), which is one of two major freeways that run north–south between two of the most urban regions in the United States (the greater Los Angeles area: approx. 18.7 million; San Diego County: approx. 3.3 million [35]). In *P. concolor*, young males (approx. 18 months of age) are the primary dispersers [28,36] and are responsible for significant gene flow among populations [37]. Our team previously documented that a single male crossed I-15 from the Eastern Peninsular Range and successfully produced offspring in the Santa Ana Mountains [21,34]. However, the impact of that individual, and potentially others, on the genetic diversity of the inbred Santa Ana population has not been studied.

To assess the effects that migration can have on small, isolated populations, we studied the impact of inter-population movements on inbreeding, heterozygosity and allelic richness between the Santa Ana and Eastern Peninsular Range puma populations [21,34]. We used morphological data from field captures to estimate ages of individual pumas. Assignment and pedigree models were used to determine population and familial structure, and the identification of family units allowed us to more accurately identify migrants and whether they reproduced. We then estimated inbreeding, heterozygosity and allelic richness in the two populations before and after migration events. Our results demonstrate the extent to which a single migrant can benefit the genetics of a small, isolated population.

## 2. Material and methods

### 2.1. Capture methods and age determination

We captured, marked and monitored radio-collared pumas from 2001 to 2016 in the Santa Ana Mountains and Eastern Peninsular Range. Capture methods are detailed in Vickers *et al.* [34]. We examined movements of radio-collared pumas from 2001 to 2016 to help identify potential migrants among ranges. Permission to carry out fieldwork and necessary permits were obtained from the California Department of Fish and Wildlife (CDFW), California Department of Parks and Recreation, The Nature Conservancy, United States (US) Fish and Wildlife Service, US Forest Service, US Bureau of Land Management, US Navy/Marine Corps, Orange County Parks Department, San Diego County Parks Department, Riverside County Parks Department, San Diego State University, University of California–Riverside, Audubon Starr Ranch, Vista Irrigation District, Rancho Mission Viejo/San Juan Company, Sweetwater Authority, California Department of Transportation, the City of San Diego Water Department and Parks Department, and the Irvine Ranch Conservancy as described in Vickers *et al.* [34].

## 2.2. Genetic sampling and microsatellite DNA data collection

We analysed genetic samples from 146 pumas among the Santa Ana Mountains, San Gabriel Mountains, San Bernardino Mountains and the Eastern Peninsular Range. Genetic sampling is detailed in Ernest *et al.* [21]. Briefly, we obtained blood or tissue samples for analysis of nuclear DNA from pumas captured for telemetry studies, and from those found dead or killed by state authorities for livestock depredation or public safety, some preceding year 2001. Forty-four microsatellites (electronic supplementary material, table S1), which met the assumptions of Hardy–Weinberg proportions and linkage equilibria were used for genotyping individuals. Each sample was genotyped at least twice and genotypes were determined by two independent observers. Negative and positive controls were included in each PCR. Specific extraction, PCR and sequencing methods are detailed in Ernest *et al.* [21].

## 2.3. Population assignment

We used spatially explicit Bayesian population assignment programs GENELAND v. 4.0 [38] and TESS v. 2.3 [39] and followed all developer recommendations. In GENELAND, the number of populations ( $K$ ) is a parameter optimized by the model. First, we ran 15 spatial models from 1 to 10  $K$ . We then ran five spatial models holding  $K$  at the modal  $K$  of the initial runs. We selected the model with the greatest log posterior probability and ran an admixture model. Each run included an uncertainty on coordinate of 0.01 decimal degrees (approx. 11 km), 100 000 iterations, a thinning interval of 100 and a 25% burn-in period.

In TESS,  $K$  must be tested over a range of possible values. First, we ran 10 non-admixture models for each  $K$  from 2 to 10. For model comparisons, TESS computes a deviance information criterion (DIC). We ran 10 spatially conditional auto-regressive admixture models for each  $K$  to the DIC plateau of non-admixture models. All models included pairwise great circle geographical distances, 100 000 iterations, and a 25% burn-in period. We retained 20% of the models which contained the lowest DIC scores and used CLUMPP v. 1.1.2 [40] to perform model-averaging.

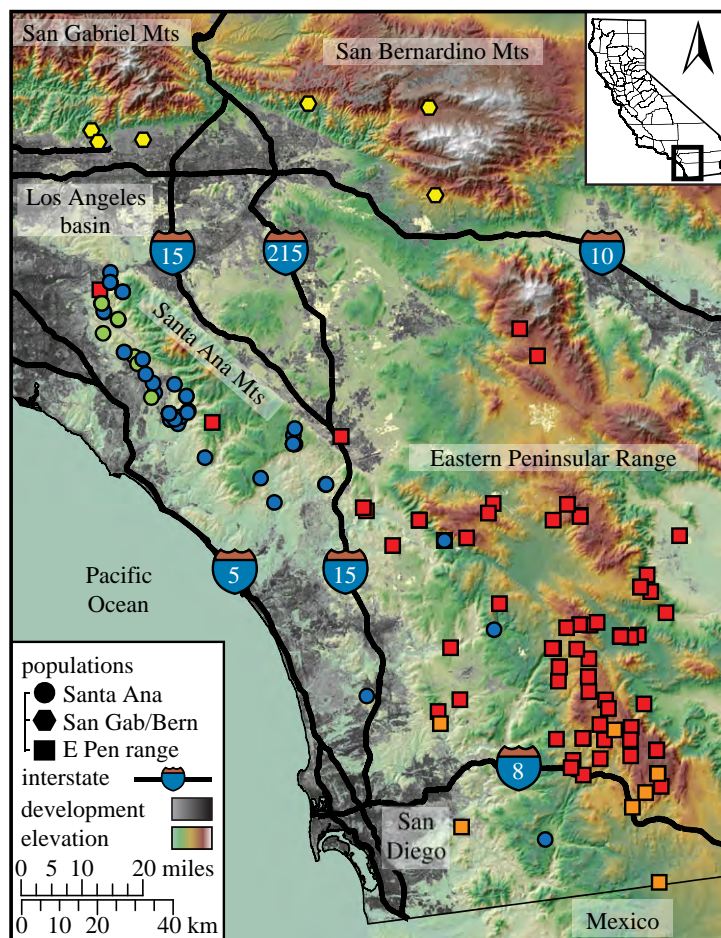
## 2.4. Pedigree reconstruction

We used program CERVUS v. 3.0.7 [41] to construct pedigrees. We ran additional sibship analyses with program COLONY v. 2.0.6.2 [42,43]. In both programs, 1% genotyping error was allowed. Parent–offspring relationships were determined based on age estimates from the morphological data taken during captures.

## 2.5. Measures of genetic diversity and population divergence

To assess inbreeding, we calculated internal relatedness using package R<sub>hh</sub> 1.0.2 in program R v. 3.3.0 [44,45]. Internal relatedness measures a relative outbred–inbred continuum, where negative values are suggestive of outbred individuals and positive scores are suggestive of inbreeding [45]. We calculated unbiased expected heterozygosity ( $\hat{H}_E$ ) in GenAlEx 6.502 [46,47]. Unlike observed heterozygosity and measures of allelic richness,  $\hat{H}_E$  is a robust genetic diversity estimator for small sample sizes [46,48]. To measure the number of alleles, we calculated allelic richness using sample-size correcting rarefaction methods in FSTAT 2.9.3.2 [49,50]. Population divergence ( $F_{ST}$ ) was also calculated in GenAlEx; significance testing was based on 999 permutations [47].

Internal relatedness, heterozygosity and allelic richness data met the assumptions of linear models. Population differences in internal relatedness were calculated using analyses of variance (ANOVAs). To assess the validity of internal relatedness as a measure of inbreeding, we used a  $T$ -test to determine if the internal relatedness of offspring was higher than the average internal relatedness of their consanguineous parents. Temporal and population differences in heterozygosity and allelic richness were tested using a repeated-measures (RM) ANOVA with locus treated as the repeated measure. We used Tukey's honest significant differences *post hoc* tests. Statistics were computed in program R using base software for linear models (ANOVAs,  $T$ -tests) and packages lme4 1.1–12 [51] and lsmeans 2.23–5 [52] for mixed models (RM-ANOVAs). For temporal analyses, samples collected from 2000 to 2016 were divided into five time periods (2000–2003, 2004–2006, 2007–2009, 2010–2012, 2013–2016). If an individual puma was estimated to have been alive at any point during that time period, it was included in the analysis.



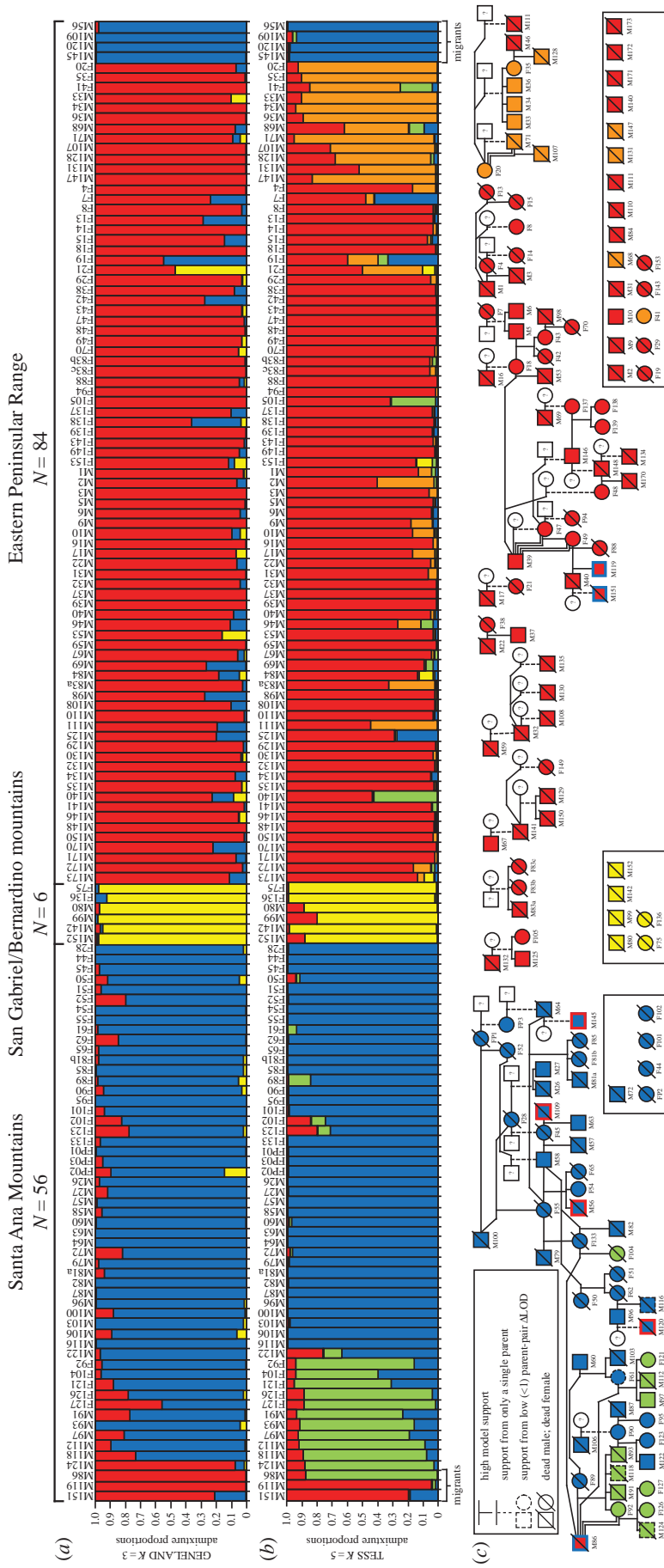
**Figure 1.** Pumas sampled ( $N = 146$ ) in the Los Angeles–San Diego region of California, USA (inset map) were subdivided into three populations separated by major interstate highways (I-15, I-10). Circles, hexagons and squares indicate pumas, respectively, belonging to the Santa Ana, San Gabriel/Bernardino and Eastern Peninsular Range populations identified in GENELAND (figure 2a). Colours correspond to highest subpopulation admixture proportions identified in TESS (figure 2b).

## 3. Results

### 3.1. Population assignments and migrations

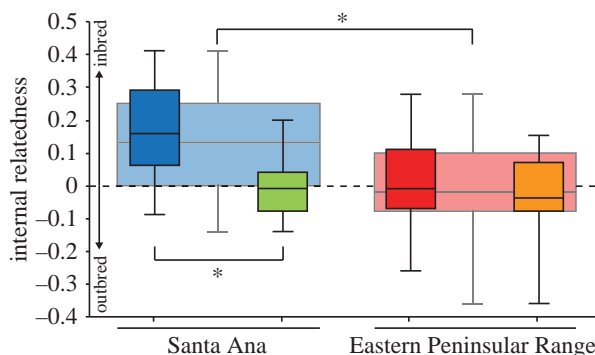
Based on our Bayesian population assignment analyses, we identified three geographically structured populations (Santa Ana, SA; San Gabriel/Bernardino, SGB; Eastern Peninsular Range, EP) with additional substructure within SA and EP (figures 1 and 2). Given the low sample size of SGB pumas ( $N = 6$ ), temporal measures of internal relatedness, heterozygosity and allelic richness could not be calculated and further analyses were restricted to SA and EP. Pedigree analyses indicated the additional substructure within SA was composed of a male migrant (named M86; M/F for male/female, followed by capture number) and his 11 offspring (figure 2b,c). Substructure within EP primarily corresponded to a female puma (F20) and her offspring, but several substructure-assigned individuals were not first-order relatives (i.e. parent–offspring, full-sib) of F20 (figure 2b,c).

With our pedigree analyses, we identified frequent mating within, but not among, populations. There was only one observed instance of mating among populations, which occurred when M86 migrated from EP into the Santa Ana Mountains in 2010 and mated with F61, F89, F133 and mated with his offspring F92 (figure 2). Notably, F92 had the lowest internal relatedness of all pumas sampled in the Santa Ana Mountains ( $-0.14$ ). Additional detections of inbreeding in EP included M39 mating with his daughter F47 to produce F49, with whom he also mated. M71 also mated with his mother, F20.



**Figure 2.** Population assignments (a,b) and pedigree analyses (c) of pumas ( $N = 146$ ) in the Los Angeles–San Diego region of California. Program GENELAND (a) identified three populations including the Santa Ana (blue), San Gabriel/Bernardino (yellow) and Eastern Peninsular Range (red) mountains. Program TESS (b) identified additional substructure within the Santa Ana population (green) and within the Eastern Peninsular Range (orange). Pumas were numbered in the order they were captured and M or F refers to whether that individual was a male or female, respectively (upper x-axis). Migrants from the Eastern Peninsular Range to the Santa Ana Mountains ( $N = 3$ ) are indicated on the left; migrants from the Santa Ana Mountains to the Eastern Peninsular Range ( $N = 4$ ) are indicated on the right. Familial relationships (c) were estimated using the pedigree-reconstruction program CERVUS, and confirmed with program COLONY. Within the pedigree, individual squares (males) and circles (females) are filled based on maximum admixture proportion in TESS (b). Coloured borders indicate the location where immigrant pumas were sampled. Individuals with unknown lineages (i.e. singletons) are pooled in open boxes. Instances of inbreeding are indicated with double lines.





**Figure 3.** Internal relatedness (i.e. relative outbred–inbred continuum) of Santa Ana and Eastern Peninsular Range pumas. Wide background boxplots represent populations identified in GENELAND (figure 2*a*). Colours of foreground boxes correspond to TESS subpopulations (figure 2*b*). Green corresponds to M86 and his offspring. Orange primarily corresponds to F20 and her offspring. Min, max, inter-quartiles and median are presented.

Internal relatedness was significantly ( $T_{137} = 5.4$ ,  $p < 0.001$ ) higher in SA (mean  $\pm$  s.e.:  $0.13 \pm 0.02$ ) than EP ( $0.00 \pm 0.01$ ; figure 3). Inbred offspring had significantly higher internal relatedness relative to the average internal relatedness of their consanguineous parents ( $+\Delta 0.18 \pm 0.05$ ;  $T_{10} = 3.79$ ,  $p = 0.003$ ).

### 3.2. Migration effects on population genetics

Our genetic analyses detected a total of seven migrants across I-15, all of which were males (figure 2). The three migrants originating from EP had negative internal relatedness (M86:  $-0.07$ , M119:  $-0.07$ , M151:  $-0.18$ ), indicative of outbreeding. All but one of four migrants from SA had positive internal relatedness (M56:  $0.29$ , M109:  $-0.09$ , M120:  $0.38$ , M145:  $0.17$ ). M86 was the only migrant known to reproduce, with a total of 11 offspring identified (figure 2*c*). M86 and his offspring had significantly lower internal relatedness compared with other SA pumas (ANOVA  $F_{3,135} = 16.87$ ,  $p < 0.001$ ; Tukey's HSD  $p = 0.007$ ; figure 3). All other subpopulation pairwise comparisons were not significant (Tukey's HSD  $p > 0.8$ ), indicating M86 decreased internal relatedness of his SA-offspring to comparable levels of EP pumas (figure 3).

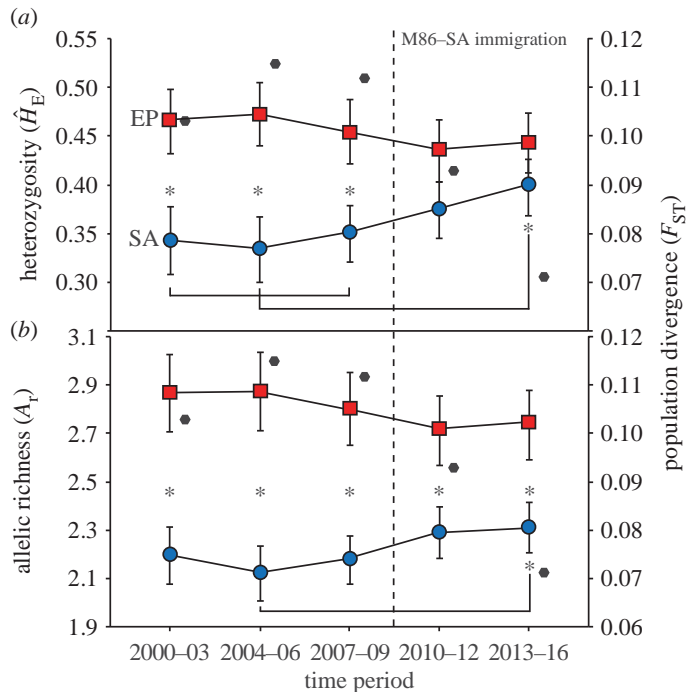
Prior to the M86 migration into the Santa Ana Mountains, SA had significantly lower heterozygosity ( $\hat{H}_E$ ) and allelic richness ( $A_r$ ) than EP in all time periods (RM-ANOVA: Tukey HSD  $p < 0.0001$ ). After the M86 migration,  $\hat{H}_E$  increased in SA and was no longer significantly different from EP ( $p = 0.24$ ,  $p = 0.67$ ; respectively). Although  $A_r$  in SA significantly increased after the M86 immigration, SA had significantly lower  $A_r$  than EP in all time periods ( $p < 0.001$ ). SA–EP population divergence ( $F_{ST}$ ) decreased after the M86 immigration; however, populations remained significantly diverged at all time periods (999 permutation tests,  $p < 0.001$ ; figure 4).

## 4. Discussion

### 4.1. Single-migrant genetic restoration

Our results demonstrate that a single migrant can have immediate positive effects on the genetics of a small, isolated and inbred puma population. Within the urbanized Los Angeles–San Diego region of California, the Santa Ana Mountains (SA) population is inbred and genetically depauperate compared to the Eastern Peninsular Range (EP) population [21]. Our analyses show that prior to the successful immigration and reproduction by a single male (M86), the SA population had significantly higher internal relatedness, significantly lower heterozygosity and significantly lower allelic richness than the EP population. After the immigration of M86, we observed significant improvements in all genetic measurements. M86 produced 11 offspring with four SA females. Even though one of M86's matings was with his daughter, he and all his offspring had significantly lower internal relatedness (i.e. they were less inbred) than other SA pumas and they exhibited internal relatedness values comparable with EP pumas. Heterozygosity and allelic richness both significantly increased in the SA population after the M86 immigration. Heterozygosity increased to the point that it was no longer significantly different from





**Figure 4.** Temporal patterns of (a) unbiased expected heterozygosity, (b) allelic richness, and population divergence ( $F_{ST}$ : black hexagons; right y-axis) for the Eastern Peninsular Range (EP) and Santa Ana (SA) puma populations before (left of vertical dashed line) and after (right of the vertical dashed line) the migration of M86 into SA from EP. Unbiased expected heterozygosity is a robust genetic diversity estimator for small sample sizes; allelic richness was sample-size corrected. All pairwise  $F_{ST}$  estimates were significantly different from zero. Squares/circles are offset from hexagons for easier visualization. Pumas estimated to be alive at any point within time periods were included in time period estimates. Means and s.e.s are presented. Sample sizes include 27 (number of males & females: 13 & 14, respectively), 25 (11 & 14), 26 (16 & 10), 28 (22 & 6), and 33 (26 & 7) for EP; 10 (1 & 9), 9 (5 & 4), 29 (16 & 13), 38 (21 & 17) and 24 (13 & 11) for SA.

the EP population. Allelic richness increased more modestly, remaining significantly lower than the EP population in all time points.

It is possible that the emigration of M86 has resulted in genetic rescue (i.e. alleviation of inbreeding depression). However, genetic rescue is difficult to confirm given the natural variation in individual survival/reproduction rates, population dynamics, and environmental conditions which affect individuals and populations [53]. Pumas in the Santa Ana Mountains have low annual survival rates (mean 0.56; [34]), and five of the seven pumas that have crossed I-15 are known to be deceased. Pumas in the region can legally be shot for depredation events (such as when lions are suspected of killing domestic animals or endangered species), are hit by cars, are killed illegally, die of other causes or have limited food resources [34]. Additionally, young immigrant males have the additional challenge of establishing territories, avoiding fights with conspecifics, finding food and mating in a previously unknown landscape [34]. Thus, the migration of two or more EP population pumas per generation is probably needed for successful reproduction at least once per generation and for maintaining genetic diversity in the SA population.

The significant increase in heterozygosity and allelic richness caused by the emigration of M86 suggests that little or no gene flow occurred between the SA and EP populations in the period immediately prior to this study. Although low sample sizes through 2000–2006 in SA could have biased genetic diversity estimates, the low sample size estimates (i.e. 2000–2003 and 2004–2006) were consistent with each other and with the more-intensively sampled time period prior to M86 (i.e. 2007–2009). Additionally, our estimates of genetic diversity are robust to differences in sample size. Given the high mortality rates in the SA, it is remarkable that M86 produced a large number of offspring ( $N = 11$ ) prior to his death. However, his contribution to gene flow was foreshortened because he was killed by a vehicle strike, and over half of his offspring are either deceased or in captivity. Another migrant from EP to SA (M151) was apparently killed prior to successfully siring offspring in the SA. This puma had the lowest internal relatedness of any migrant pumas we sampled, but he was unable to enhance genetic

diversity in the SA because he was legally shot on a depredation permit after repeatedly preying on domestic animals. Further monitoring of the only remaining migrant (M119) in the Santa Ana Mountains, as well as M86's surviving offspring, will be important for tracking population viability, and assessing the long-term impacts of migration.

In a region north of the Santa Ana Mountains and west of Los Angeles, pumas in the Santa Monica Mountains exist in very low numbers (approx. 10 total pumas at any one time) and are also isolated by a major roadway [23,27]. Over 10 years, a single male migrant was detected to have crossed the road into the Santa Monica Mountains and was the only detected breeding male. Although that male enhanced genetic diversity after producing eight detected offspring, the genetic structure of pumas in the area were completely changed because of low census size. By contrast, M86 increased genetic diversity of SA despite the Santa Ana Mountains supporting multiple breeding males and approximately 20–30 adult pumas at any one time [54]. Pumas in the Santa Ana Mountains are thought to represent a genetically distinct population [21,34]. Thus, our observations differ from the Santa Monica Mountains, which may represent family- or group-level dynamics. The only reported puma population with a lower heterozygosity than the SA population was in Florida, where pumas nearly went extinct from inbreeding depression, but were genetically rescued by translocating pumas from the state of Texas [22,26]. Given that the SA population has similar estimates of genetic diversity to just a few established pumas in the Santa Monica Mountains [23], our results indicate genetics may be an issue for SA population viability in the near future [24]. The SA population and pumas in the Santa Monica Mountain region are genetically distinct and exhibit no gene flow [21], further illustrating how urbanization and road fragmentation can completely separate populations that are geographically close (less than 70 km in this case). This may indicate a widespread issue for pumas throughout the rapidly urbanizing state of California.

## 4.2. Importance of genetic diversity in small populations

The loss of rare alleles and accumulation of deleterious alleles can occur in small populations through genetic drift and inbreeding [2,55,56]. We used internal relatedness, an individual index ranging from outbred to inbred, to estimate degree of inbreeding [45]. In other mammalian systems, high internal relatedness (indicative of inbreeding) correlates with high incidence of disease [57], low reproductive success [45,58] and low survival [59]. Inbreeding depression is well documented in the Florida puma population and associated physical abnormalities included kinked tails [22,60]. Anecdotal evidence of two SA pumas with the highest internal relatedness values also exhibited kinked tails [21], suggesting inbreeding depression may also be present in the SA population. In this study, internal relatedness increased in offspring produced from consanguineous (i.e. highly related) mate-pairs, validating its use as a measure of inbreeding [45]. However, the observed decrease in internal relatedness does not confirm that genetic rescue has occurred [61], and further studies are needed to explicitly assess the extent of inbreeding depression in the SA population [62].

Heterozygosity is a classic measure of genetic diversity and has been correlated to disease resistance [63,64], resistance to toxicants [65], increased fecundity [66,67] and puma survival [68,69]. We observed a significant increase in heterozygosity after the immigration of M86, to the point that heterozygosity of SA pumas was no longer significantly different from that of EP pumas. Whereas heterozygosity is thought to be of immediate importance to individual and population fitness [2], allelic richness is thought to be more important for the adaptive potential of populations because alleles are the raw material on which evolution occurs [2,9,70]. We observed a significant increase in allelic richness after the immigration of M86 into the SA population. However, allelic richness remained significantly lower than that of the EP population. Larger populations have a greater capacity for unique alleles simply because they have more individuals to harbour them [2,70]. Thus, we do not expect the SA population, which has a smaller effective population size and less habitat [21,34], to ever exhibit the same allelic richness as the EP population.

## 4.3. Implications and conclusion

We identified three puma populations in this region, including the SA, SGB and EP populations. Although population assignment models GENELAND [38,71] and TESS [39,72] showed similar patterns, TESS identified genealogical substructure not identified by GENELAND. We determined the additional substructure in the SA population originated from an immigrant male (M86) and his 11 offspring. However, the additional substructure in the EP population appears to be a family-unit admixed from

a currently unsampled population, perhaps from Mexico or Arizona. The SGB population, and the within-population family groups in SA and EP, were not previously identified [21], probably due to limited sampling. Future researchers should consider the behaviour of certain Bayesian clustering algorithms when analysing population genetic structure of populations containing related individuals [73,74]. Without pedigree or relatedness data, family-unit genetic clusters could mistakenly be classified as populations [75].

We identified a total of seven migrants, all males. Four moved east and three moved west across I-15. With the exception of M56 who was GPS-collared when he crossed I-15 in 2010, it is not known exactly when these migrants crossed the I-15 barrier. If they migrated at their dispersal ages, which is most likely, then based on their estimated ages when sampled their crossings would have all occurred between 2008 and 2014. TESS underestimated the number of migrants by including M86 into a SA subpopulation, whereas GENELAND overestimated the number of migrants by incorrectly assigning an inbred offspring (M124) of M86 to the EP population. The addition of our pedigree analysis allowed us to more accurately identify migrants and family groups, and showed that only one of three migrants into the SA population successfully established a territory and mated. Interstates, including I-15, have been reported to be major barriers to puma movement [21,28,34,76], and we suspect I-10 is also a barrier to puma gene flow. However, additional samples and further monitoring in the San Gabriel and San Bernardino Mountains are needed to assess the impact of I-10 on puma movements and population genetics.

Despite the increases in heterozygosity and allelic richness in the SA population, and despite being only separated by a single interstate highway, the SA and EP populations remain significantly diverged (i.e. significant pairwise  $F_{ST}$ ), and SA pumas still face threats from disease, human development, and stochastic demographic, genetic and environmental events [24,33,34,77]. As observed in other systems where a single or a few migrants genetically restored a population [14,23,53,78,79], genetic diversity will decrease and inbreeding will increase, without continuous gene flow [22,26,62,80–82]. Our results clearly show the benefit of a single migrant to the genetics of a small, isolated population. However, if one successfully breeding migrant per generation is required for long-term persistence [12,13], multiple migrants (usually dispersing males) must cross I-15 east to west in each generation to presume one is successful at breeding. Thus, future monitoring, and potential human intervention in the form of improved or new I-15 crossing structures, limitations on new development, or puma translocations, may be needed to ensure adequate gene flow and population viability.

The ability of pumas to cross I-15 is very limited, and will only decrease. Several pumas have been killed on I-15 in the past 30 years, but road mortalities are only one aspect of barrier effects. Other barrier effects include the combination of noise, light, human presence, adjacent development and other anthropogenic factors. It is essential that the ability of pumas to cross over or under I-15 not be reduced further, and mitigation measures to reduce road barrier effects should be pursued. As of this writing, large residential developments are proposed to be constructed within the two primary puma travel corridors between the Eastern Peninsular and Santa Ana Ranges, and immediately adjacent to the existing crossing structures [73–86]. Construction of these developments is likely to further degrade the ability of pumas, especially dispersing males who are essential for gene flow, to move between the Eastern Peninsular and Santa Ana Mountain Ranges. The critical importance of successful migration and reproduction to the long-term persistence of the SA population should be considered in the planning and approval process for any development near these key crossing points. The construction of new I-15 crossing structures between the Eastern Peninsular and Santa Ana Mountain Ranges has been under study and discussion by multiple regional governmental entities and various researchers and stakeholders for more than two decades. However, no engineering studies have been done, costs are expected to be substantial and funding sources have not been identified.

These results, in combination with the challenges of preserving and improving the state of genetic connectivity for pumas in this region, emphasize that despite M86's success in improving some genetic parameters of the SA population, the population remains at risk of further genetic decline. The political and conservation barriers are large, and positive change will depend on a great deal of political-will, and both public and private investments. In the case of the Florida panther and the Santa Monica Mountains pumas, large amounts of funding were mobilized once these subpopulations were threatened with extirpation. The SA population, and possibly other puma populations in California in the future, may also need human intervention to persist.

**Ethics.** All animal capture and handling protocols were approved on university, state and national levels. We operated under Protocol 10950/PHS, Animal Welfare Assurance number A3433-01, with capture and sampling procedures

approved in Protocol number 17233 by the Animal Care and Use Committee at the University of California, Davis, and Memoranda of Understanding and Scientific Collecting Permits from the California Department of Fish and Wildlife (CDFW). Permission and permits to carry out fieldwork is detailed in Material and methods section.

Data accessibility. Data analysed in this paper are accessible through Dryad: (<http://dx.doi.org/10.5061/dryad.1kh2n>) [87].

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# Genetic source–sink dynamics among naturally structured and anthropogenically fragmented puma populations

Kyle D. Gustafson<sup>1,2</sup> · Roderick B. Gagne<sup>1</sup> · T. Winston Vickers<sup>3</sup> · Seth P. D. Riley<sup>4</sup> · Christopher C. Wilmers<sup>5</sup> · Vernon C. Bleich<sup>6</sup> · Becky M. Pierce<sup>7</sup> · Marc Kenyon<sup>8</sup> · Tracy L. Drazenovich<sup>9</sup> · Jeff A. Sikich<sup>4</sup> · Walter M. Boyce<sup>3</sup> · Holly B. Ernest<sup>1</sup>

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## Abstract

Fragmentation of wildlife populations is increasing on a global scale and understanding current population genetic structure, genetic diversity, and genetic connectivity is key to informing wildlife management and conservation. We genotyped 992 pumas (*Puma concolor*) at 42 previously developed microsatellite loci and identified 10 genetic populations throughout the states of California and Nevada, USA. Although some genetic populations had large effective population sizes, others were small and inbred. Genetic diversity was extremely variable (heterozygosity,  $uHe = 0.33–0.53$ ), with some populations nearly as low as an endangered subspecies, the Florida Panther (*P. c. coryi*,  $uHe = 0.24$ ). Specifically, pumas in the Sierra Nevada were genetically diverse and formed the largest genetic source population in the region. In contrast, coastal and southern populations surrounded by urbanization had low genetic diversity, fragmented gene flow, and tended to be genetic sinks. The strong population genetic structuring of pumas across California ( $F_{ST} = 0.05–0.39$ ) is vastly different than other genetic studies in less-urbanized states, including our analysis in Nevada, where pumas had few barriers to gene flow and weak population differentiation. Our results have far-reaching conservation and management implications for pumas and indicate large-scale fragmentation in one of North America's most biodiverse and rapidly-urbanizing regions.

**Keywords** Mountain lion · Cougar · *Puma concolor* · Population genetics · Genetic structure

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✉ Holly B. Ernest  
holly.ernest@uwyo.edu

- <sup>1</sup> Wildlife Genomics and Disease Ecology Laboratory, Department of Veterinary Sciences, University of Wyoming, Laramie, WY 82070, USA
- <sup>2</sup> Department of Biology & Environmental Health, Missouri Southern State University, Joplin, MO 64870, USA
- <sup>3</sup> Karen C. Drayer Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, CA 95616, USA
- <sup>4</sup> National Park Service, Santa Monica Mountains National Recreation Area, Thousand Oaks, CA 91360, USA

## Introduction

Fragmentation of wildlife habitat and resultant impacts to populations are increasing worldwide and urbanization is one of the primary contributors (Crooks et al. 2017; Fahrig 2003; Haddad et al. 2015; Newbold et al. 2016). Unlike

- <sup>5</sup> Environmental Studies Department, University of California, Santa Cruz, CA 95064, USA
- <sup>6</sup> Department of Natural Resources and Environmental Science, University of Nevada Reno, Reno, NV 89557, USA
- <sup>7</sup> Bishop, CA 93515, USA
- <sup>8</sup> Division of Fish, Wildlife, & Parks, Wisconsin Department of Natural Resources, Wisconsin Rapids, WI 54494, USA
- <sup>9</sup> Department of Medicine and Epidemiology, School of Veterinary Medicine, University of California, Davis, CA 95616, USA

natural barriers that have impacts over a geological timescale (Albert et al. 2016), urbanization can have more immediate effects on gene flow among populations (Balkenhol and Waits 2009; Karlson et al. 2014). Gene flow is critically important to individual fitness and to the evolutionary potential of populations because successful migrants can diversify gene combinations (i.e., increase heterozygosity) and introduce new genetic material (i.e., increase allelic richness) (Caballero and García-Dorado 2013; Chapman et al. 2009; Frankham 2015). Without receiving gene flow, small populations are especially subject to inbreeding, genetic drift, and increased extinction risk (Carlson et al. 2014; Wootton and Pfister 2015).

Population fragmentation is increasingly evident for species located in the urbanized western United States (Buchalski et al. 2016; Delaney et al. 2010; Fisher and Shaffer 1996; Tuma et al. 2016), including the puma (*Puma concolor*) (Beier 1995; Gray et al. 2016), which is becoming a model for studying genetics of isolated populations (Ernest et al. 2014; Gustafson et al. 2017; Johnson et al. 2010; Riley et al. 2014). Despite the long-distance dispersal ability of pumas (Hawley et al. 2016; Newby et al. 2013; Pierce et al. 1999; Thompson and Jenks 2005), gene flow among adjacent puma populations has been nearly negated by freeways in densely populated Southern California (Ernest et al. 2014; Gustafson et al. 2017; Riley et al. 2014). Consequently, some California puma populations have become functionally isolated and have experienced rapid population divergence and inbreeding (Ernest et al. 2014; Gustafson et al. 2017; Riley et al. 2014; Vickers et al. 2015) with concerns for extinction (Benson et al. 2016). Given that *P. concolor* and other wide-ranging species serve as umbrella species (Carroll et al. 2001; Maehr et al. 2002; Thorne et al. 2006)—the conservation of which indirectly provides protection for many other species (Roberge and Angelstam 2004)—the low genetic diversity of puma populations in human-fragmented habitats suggests that a large-scale ecological problem may be occurring in some of the most biologically-diverse regions of North America (Calsbeek et al. 2003; Dobson et al. 1997).

During the late Pleistocene, pumas were extirpated from North America and repopulated by migrants from South America (Culver et al. 2000). As a result, pumas in North America compose a single phylogenetic group (based on mtDNA) and exhibit founder effects (i.e., reduced population genetic diversity based on mtDNA and microsatellites) compared to pumas in South America and Central America (Culver et al. 2000). Therefore, it is critical to understand effects of fragmentation on populations from this North American lineage. A previous genetic analysis along the west coast of the United States indicated that pumas in California did not exist as a single population and suggested urbanization may have led to genetically-depauperate, fragmented populations (Ernest et al. 2003). In addition, a population

genetic analysis in Nevada indicated there were asymmetric migration rates between the two states, and that pumas from Nevada were a genetic source for genetic-sink populations in California (Andreasen et al. 2012). However, these previous reports relied on a limited number of genetic loci ( $\leq 13$  microsatellites) and investigators did not sample across the two states. In this study, we attempted to address these limitations and provide a more comprehensive view of puma genetic diversity and gene flow within and among California and Nevada.

Our aim was to identify the number and spatial structure of puma populations across California and Nevada and the extent of gene flow among the populations. In doing so, we were able to identify genetic source and sink populations as well as isolated populations with limited gene flow. We expected pumas would exhibit genetic structure associated with both natural geographic features and anthropogenic development. Given the complex structure of ecoregions and large human population in California ( $> 39$  million people;  $92.5/\text{km}^2$ ; US Census Bureau 2016), we hypothesized pumas in California would exhibit more population divergence and less interpopulation gene flow relative to pumas in Nevada, which have access to more contiguous ecoregions with fewer humans ( $< 3$  million people;  $10.3/\text{km}^2$ ; US Census Bureau 2016). To address these hypotheses, we genotyped 992 pumas at 42 microsatellite loci across California and Nevada. We then identified regional populations using population assignment models and evaluated functional connectedness of puma populations by modeling population divergence and computing bi-directional migration rate estimates.

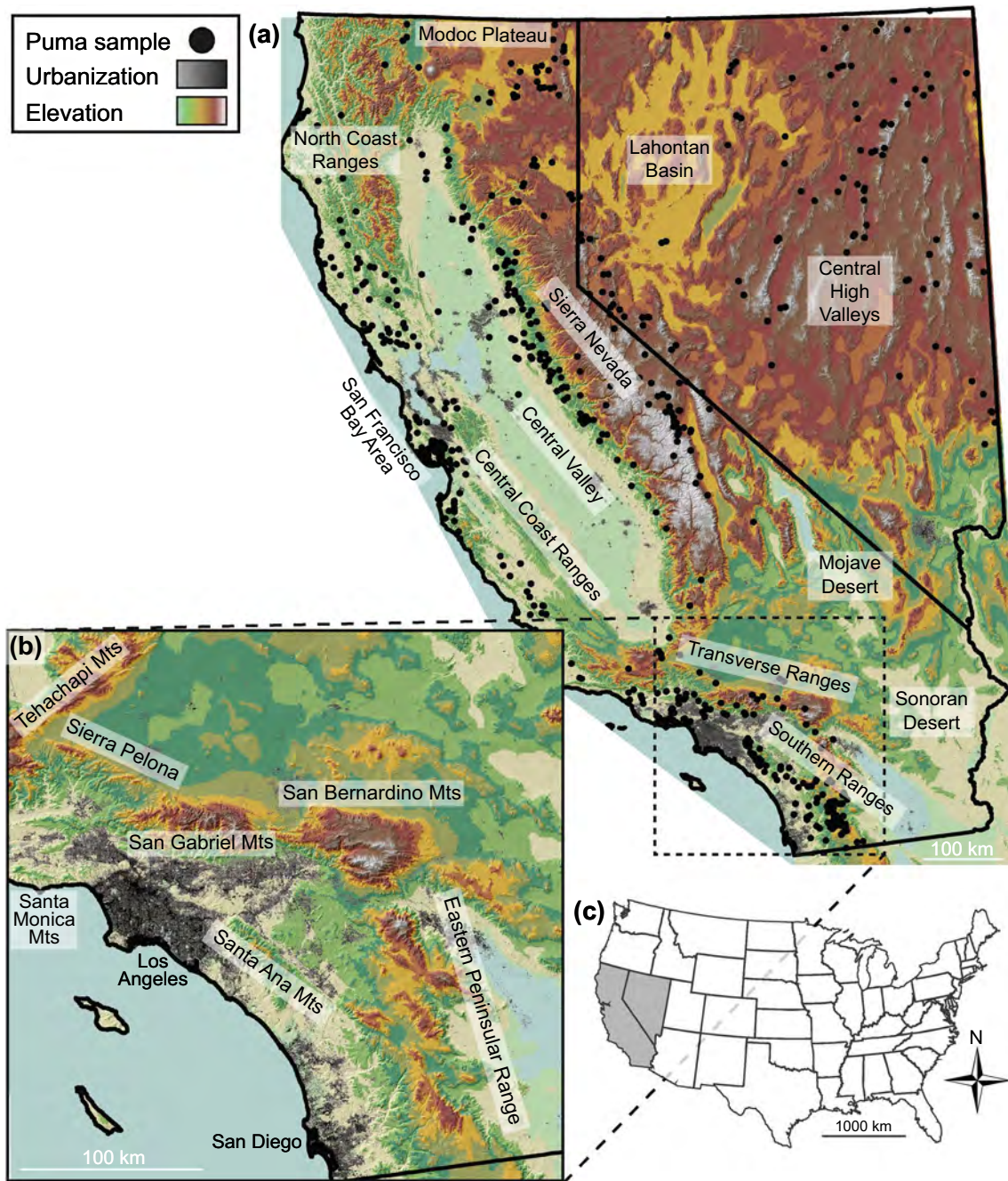
## Materials and methods

### Sampling and extractions

We obtained tissue or blood samples from 992 pumas captured alive, found dead, or legally killed by authorized agencies for livestock depredation, public safety, or sport hunting (Nevada only) during 1992–2016 (Fig. 1). Approximately 49% of individuals sampled were legally killed, 31% were from captures, 11% were hit by vehicles, and the rest were found dead of other causes. We isolated genomic DNA using QIAGEN DNeasy Blood & Tissue kits (QIAGEN Inc., Valencia, CA, USA).

### Genotyping

We genotyped each individual puma at 42 previously developed microsatellite loci, plus a single sex-linked locus (Ernest et al. 2003, 2014; Riley et al. 2014) and ran polymerase chain reactions on ABI 2720 thermocyclers (Life Technologies, Carlsbad, CA, USA) using QIAGEN



**Fig. 1** Map of our study system, including **a** sampling locations of 992 pumas and ecoregions, **b** specific mountain ranges within the Transverse and Southern Ranges, and **c** an inset map of the United States of America showing the locations of California and Nevada. Elevation data source: USGS national elevation dataset (<http://natio>

[nalmap.gov](http://natio)). Dark circles indicate locations where pumas were sampled, the gray to black scale indicates low to high urbanization, and the blue to white scale indicates 0 m elevation (sea level) to 4,421 m elevation

Multiplex PCR kits with Q solution (Table S1) following the protocols of Gustafson et al. (2017). We included negative and positive controls in each PCR run and visualized fragments with STRand version 2.3.69 (Toonen and Hughes 2001). For each locus, we confirmed heterozygous

genotypes at least twice and homozygous genotypes at least three times.



## Population genetic structure

The spatial arrangement of sample locations can confound population genetic analyses (Meirmans 2012; Schwartz and McKelvey 2009). Thus, we used spatially-explicit hierarchical Bayesian clustering programs TESS 2.3 (Durand et al. 2009a) and GENELAND 4.0 (Guillot et al. 2005b). We tested for consistency among programs because TESS has been shown to identify finer-scale hierarchical puma population genetic structure compared to GENELAND (Gustafson et al. 2017). In general, TESS outperforms GENELAND in the presence of isolation-by-distance (Safner et al. 2011) whereas GENELAND outperforms TESS at detecting genetic barriers to dispersal (Blair et al. 2012; Safner et al. 2011).

In TESS, the number of populations ( $K$ ) must be specified and tested over a range of possible values. Model selection must be used to determine the  $K$  with the best fit to the data. We followed developer instructions for determining  $K$  and population assignments. First, we ran 10 non-admixture models for each  $K$  from 2 to 20. For model comparisons, TESS computes a deviance information criterion (DIC). We ran 10 spatially-conditional auto-regressive admixture models for each  $K$  to the DIC plateau of non-admixture models (Figs. S1, S2). All models included pairwise great circle geographic distances for weighting the Voronoi neighborhood, 100,000 iterations, and a 25,000 iteration burn-in period. We retained 20% of the models exhibiting the lowest DIC scores and used CLUMPP 1.1.2 to perform model-averaging (Jakobsson and Rosenberg 2007).

In GENELAND,  $K$  is optimized by the model. We followed developer recommendations for determining  $K$  and individual population assignments (Guillot et al. 2005a). First, we identified a distribution of  $K$  from initial models, and then we ran correlated allele frequency models allowing  $K$  to vary within its distribution from the initial models (Fig. S1). Finally, we ran 5 spatial, correlated allele frequency models with  $K$  fixed at the mode and selected the model with the highest negative log-likelihood value for further inference. Each run included an uncertainty on GPS coordinates of 0.1 decimal degrees ( $\sim 11$  km), 1,000,000 iterations, a thinning interval of 10,000, and a 25% burn-in period prior to extracting model output. We assigned individuals to populations based on their highest assignment probability. To visualize the probability of population membership across the study area, we used package POPSutilities 1.0 in R 3.3.0, which interpolates admixture coefficients using geospatial kriging (Jay et al. 2012).

Temporal variation in sampling can bias spatial population genetic analyses; however, spatially-explicit Bayesian clustering models should account for most temporal variation (Durand et al. 2009b; François and Durand 2010). Populations did not group based on sampling date in TESS

or GENELAND. Additionally, isolation-by-distance was significant across our study area ( $R^2 = 0.15$ ,  $P < 0.001$ ). Although TESS and GENELAND showed nearly identical results, we used TESS admixture models for analyses and inferences because TESS outperforms GENELAND in the presence of isolation-by-distance.

## Genetic diversity

We tested for linkage disequilibrium, deviations from Hardy–Weinberg proportions, and null alleles in GENEPOP 4.5.1 (Rousset 2008). For each identified population, we calculated standard measures of genetic diversity and used 1000 permutations to test for significant genetic isolation-by-distance in GenAlEx 6.502 (Peakall and Smouse 2006, 2012). To measure the number of alleles, we calculated allelic richness using rarefaction methods which correct for sample size in FSTAT 2.9.3.2 (Goudet 1995). To assess inbreeding, we calculated internal relatedness using package Rhh 1.0.2 in Program R 3.3.0 (Alho et al. 2010). We calculated effective population size ( $N_e$ ) for each population using NeEstimator 2.01 using the linkage disequilibrium method assuming random mating (Do et al. 2014). Because the inclusion of low-frequency alleles can upwardly bias estimates of  $N_e$  (Waples and Do 2010), we ran two separate models including alleles with frequencies  $\geq 5\%$  or  $\geq 1\%$ . To test for evidence of recent reductions in  $N_e$  (i.e., genetic bottlenecks), we used program BOTTLENECK 1.2.02 to determine if a population exhibited a significant number of loci with heterozygote excess (Piry et al. 1999). For each population identified by assignment models, we performed bottleneck analyses using two-phase (70:30 step-wise:infinite-alleles) microsatellite mutation models for 100,000 iterations.

We used biotools 3.1 (da Silva et al. 2017) in R to obtain spatial unbiased genetic diversity estimates [uHe: unbiased expected heterozygosity; (Nei 1978)] based on the interpolation of individual estimates (Manel et al. 2007). We minimized spatial extrapolation by using a radius of 500 m and reduced bias by setting the neighborhood size (i.e., minimum number of individuals used to calculate uHe) to 2. The mean size of each neighborhood was 14.6 and 42.5% of the neighborhoods contained at least 10 individuals.

## Population differentiation and genetic source–sink dynamics

We used three complementary approaches to assess functional population connectivity, including a discriminant analysis of principal components (DAPC), pairwise estimates of population divergence ( $F_{ST}$ ), and pairwise estimates of bi-directional migration rates ( $m$ ). The DAPC uses linear combinations of alleles to maximize between-population genetic variation and provides a graphical representation



of functional connectivity among genetic clusters (Jombart et al. 2010).

We implemented the DAPC in program R using package *adegenet* 2.0.1 (Jombart 2008). The identified number of genetic clusters in *adegenet* agreed with TESS and GENELAND (Fig. S3). Because the algorithm for individual assignments in *adegenet* is not as powerful as Bayesian population assignment algorithms (Jombart et al. 2010), we defined populations in the DAPC using results from the Bayesian population assignments. Because we were not assigning individual membership probabilities in the DAPC, we retained all information (i.e., 344 PCA axes and all 9 discriminant functions) in the analysis. Our results from retaining all information did not differ from results when only retaining an estimated optimal number of PCA axes using the  $\alpha$ -score method. Pairwise population divergence estimates ( $F_{ST}$ ) were calculated in GenAlEx using 999 permutation tests for significance. To conform to the expectations of genetic isolation-by-distance, rather than an island model, we also calculated Rousset's  $F_{ST}/(1 - F_{ST})$  (Rousset 1997).

We used program BayesAss 3.0 to estimate migration rates ( $m$ ) among populations identified by population assignment models (Wilson and Rannala 2003). We used 10 randomly-seeded runs each with 5,000,000 iterations, a burnin of 1,000,000, and thinning interval of 1000. Posterior mean parameter estimates were nearly identical among runs, and all trace files indicated convergence of model parameters (Meirmans 2014). We tested the hypothesis of Andreasen et al. (2012) that Nevada pumas were a genetic source for California pumas by summing emigration rates and subtracting the sum of immigration rates for each population (Andreasen et al. 2012). Positive numbers indicate the population was a genetic source whereas negative numbers indicate a sink. We used package *circlize* 0.3.7 in program R to visualize bi-directional migration rates estimated in BayesAss (Gu et al. 2014).

## Results

### Population genetic structure and diversity

Our analyses revealed that pumas in California exhibited strong population genetic structure and some California populations had extremely low levels of genetic diversity. We identified nine genetic clusters in California and one genetic cluster in Nevada (Figs. 2, S1, S2, S4). We classified these 10 genetic clusters as genetic populations, including the Nevada (NV), Eastern Sierra Nevada (ESN), Western Sierra Nevada (WSN), North Coast (NC), Northern section of the Central Coast (CC-N), Central section of the Central Coast (CC-C), Southern section of the Central Coast (CC-S),

San Gabriel/San Bernardino (SGSB), Santa Ana (SA), and Eastern Peninsular Range (EP) populations (Fig. 2).

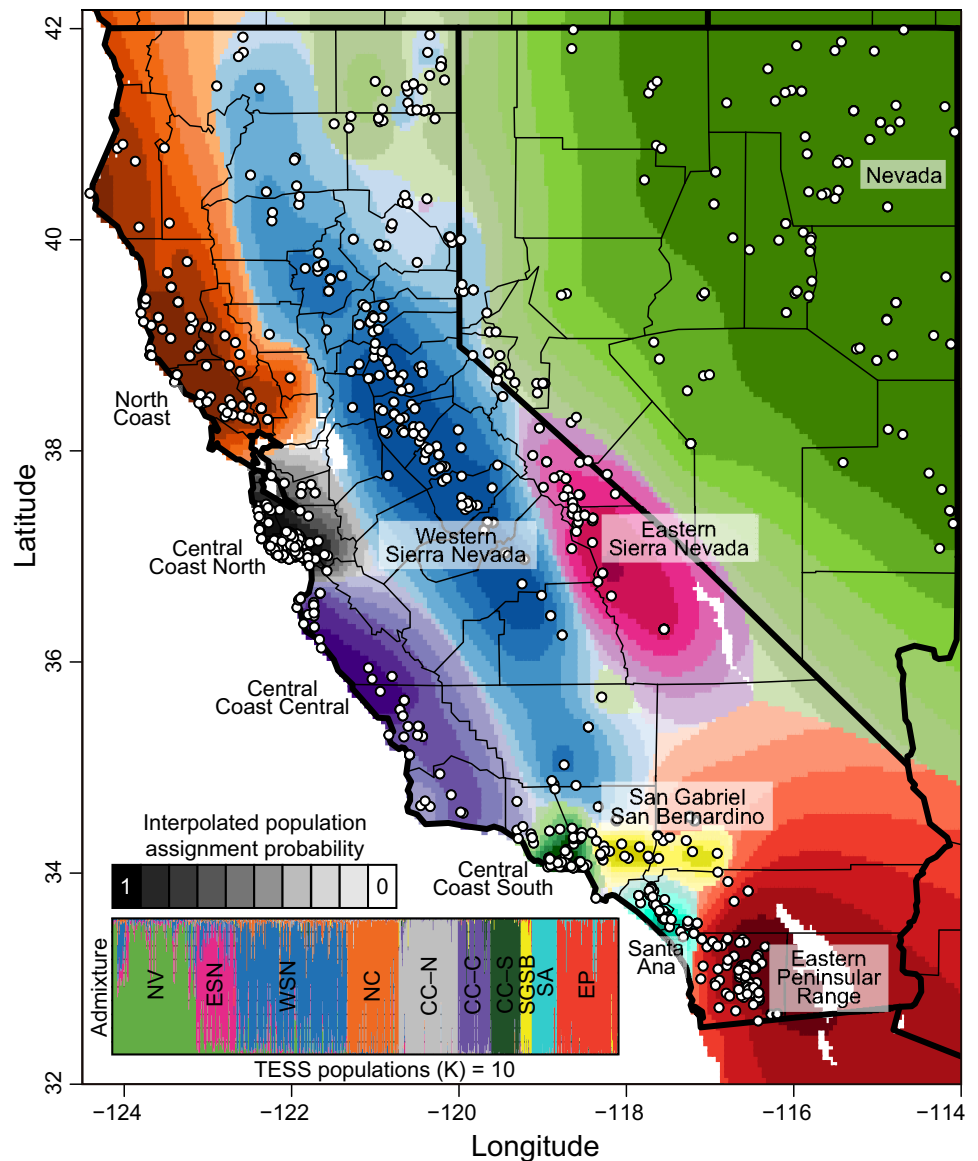
The genetic diversity of California puma populations exhibited a large amount of variation with some populations having estimates similar to other large populations and some exhibiting estimates nearly as low as the endangered Florida Panther. The NV, ESN, and WSN populations had the highest estimates of genetic diversity compared to other populations (Table 1). Regionally, the Modoc Plateau and Sierra Nevada contained individuals that had consistently high genetic diversity (Fig. 3). Although the NV population had high genetic diversity, the individual-based analysis indicated spatially-heterogeneous genetic diversity across Nevada with low levels occurring near the Lahontan Basin (Fig. 3). The CC-C population had relatively intermediate levels of genetic diversity (Table 1). The SA population had the lowest genetic diversity observed across all estimates, followed by the SGSB, NC, CC-S, and CC-N populations. SA also had the highest measure of internal relatedness. WSN had the largest effective population size ( $N_e$ ), followed by NV, NC, and CC-C (Table 2). All other populations had an  $N_e$  of  $< 50$  (often given as a desirable minimum from a conservation genetics point of view; Frankham 1995; Mace et al. 2008), and CC-S and SGSB had extremely low effective population sizes ( $\leq 5$ ). All populations except NV and NC exhibited evidence of a prior genetic bottleneck (Table 2).

### Population differentiation and genetic source–sink dynamics

Our discriminant analysis of principal components (DAPC) revealed that puma populations in California had low connectivity compared to pumas in Nevada which were composed of a single genetic population that exhibited high connectivity with several California populations. The first axis (x-axis; 33.3% of total variation) of the DAPC broadly corresponded to a latitudinal population separation with north to the left and south to the right (Fig. 4a). The second axis (y-axis; 24.4%) separated populations longitudinally and primarily separated central coast populations from southern populations (Fig. 4a). The NV, ESN, WSN, and NC populations grouped together, as did the CC-N, CC-C, and CC-S populations. The SA and EP populations grouped slightly but were separated from all other populations (Fig. 4a). Lastly, the SGSB was intermediate relative to all other populations, but was most closely-related to the WSN population (Fig. 4a).

Bi-directional migration rate models indicated there were 5 genetic source populations (i.e., ESN, WSN, CC-N, CC-C, EP) and 5 genetic sink populations (i.e., NV, NC, CC-S, SGSB, SA), however, there was only weak evidence indicating CC-N and NC were source and sink populations, respectively. Bi-directional migration

**Fig. 2** Population genetic structure of pumas across California and Nevada. Individual admixture proportions from TESS (inset barplot) were spatially-interpolated. Each color represents a genetic population. The decay in color intensity on the map represents lower probabilities of population assignment and indicates areas with admixture between populations. State and county borders are displayed for reference. *NV* Nevada, *ESN* Eastern Sierra Nevada, *WSN* Western Sierra Nevada, *NC* North Coast, *CC-N* Northern section of the Central Coast, *CC-C* Central section of the Central Coast, *CC-S* Southern section of the Central Coast, *SGSB* San Gabriel/San Bernardino, *SA* Santa Ana, *EP* Eastern Peninsular Range



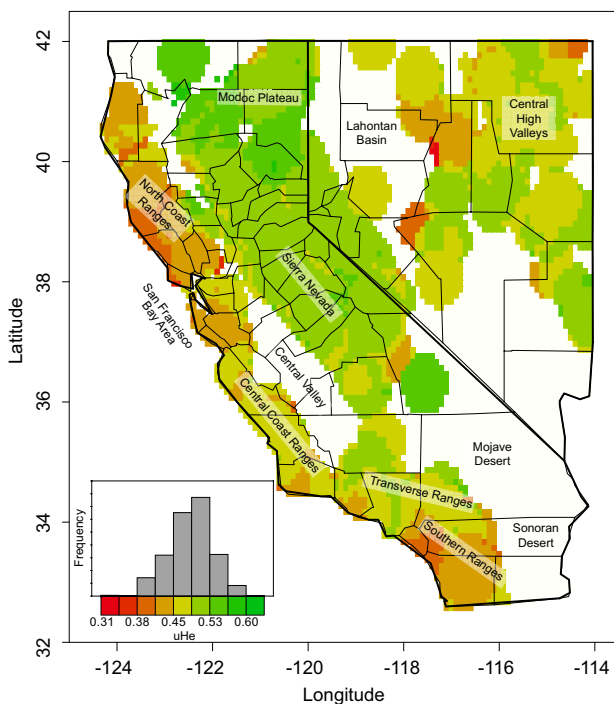
rate estimates showed connectivity patterns similar to the DAPC (Fig. 4). Although there was gene flow among the NV, ESN, and WSN populations based on bi-directional migration rates, the NC population primarily exchanged migrants with the ESN and WSN populations (Fig. 4b). The populations in the Sierra Nevada (ESN, WSN) were the greatest genetic source populations but exhibited limited gene flow with the populations along the central coast of California (CC-N, CC-C, CC-S), and neither NV nor NC exhibited appreciable gene flow with central coast populations (Fig. 4b; Table S2). The SA population exhibited gene flow only with the EP population, and

the EP population had low connectivity with the SGSB population (Fig. 4b). The puma population in the Transverse Ranges (SGSB) was the largest genetic sink but exchanged some genetic material with the WSN, CC-C, and EP populations (Fig. 4b). Populations in the Southern Ranges (SA, EP) were largely disconnected from all other populations (Fig. 4b).

**Table 1** Allelic and genetic diversity of puma populations, including sample-size corrected allelic richness, the number of private alleles, the percent of polymorphic loci, observed heterozygosity, unbiased expected heterozygosity, and average internal relatedness (a measure of inbreeding)

Population	N	Allelic richness	Private alleles	Polymorphic Loci (%)	Observed heterozygosity	Expected heterozygosity	Internal relatedness
NV	166	3.47 (0.09)	9	100	0.50 (0.03)	0.52 (0.03)	0.15 (0.01)
ESN	79	3.46 (0.13)	5	100	0.52 (0.03)	0.53 (0.03)	0.11 (0.01)
WSN	217	3.63 (0.08)	5	100	0.51 (0.03)	0.52 (0.03)	0.09 (0.01)
NC	101	3.06 (0.10)	5	97.6	0.40 (0.03)	0.41 (0.03)	0.28 (0.01)
CC-N	116	2.62 (0.08)	1	97.6	0.41 (0.03)	0.42 (0.03)	0.27 (0.01)
CC-C	63	3.00 (0.12)	1	95.2	0.45 (0.03)	0.46 (0.03)	0.19 (0.02)
CC-S	60	2.63 (0.13)	1	92.9	0.41 (0.04)	0.41 (0.03)	0.27 (0.02)
SGSB	22	2.75 (0.17)	0	95.2	0.40 (0.03)	0.42 (0.03)	0.29 (0.03)
SA	48	2.27 (0.12)	0	85.7	0.34 (0.03)	0.33 (0.03)	0.39 (0.02)
EP	120	3.07 (0.11)	3	100	0.44 (0.03)	0.44 (0.03)	0.21 (0.01)

NV Nevada, ESN Eastern Sierra Nevada, WSN Western Sierra Nevada, NC North Coast, CC-N Northern section of the Central Coast, CC-C Central section of the Central Coast, CC-S Southern section of the Central Coast, SGSB San Gabriel/San Bernardino, SA Santa Ana, EP Eastern Peninsular Range. Standard errors are presented in parentheses



**Fig. 3** Gene diversity (uHe: unbiased expected heterozygosity) heat map of pumas in California and Nevada. Neighborhood size was not significantly related to uHe ( $R^2=0.005$ ,  $P<0.001$ )

### Discussion

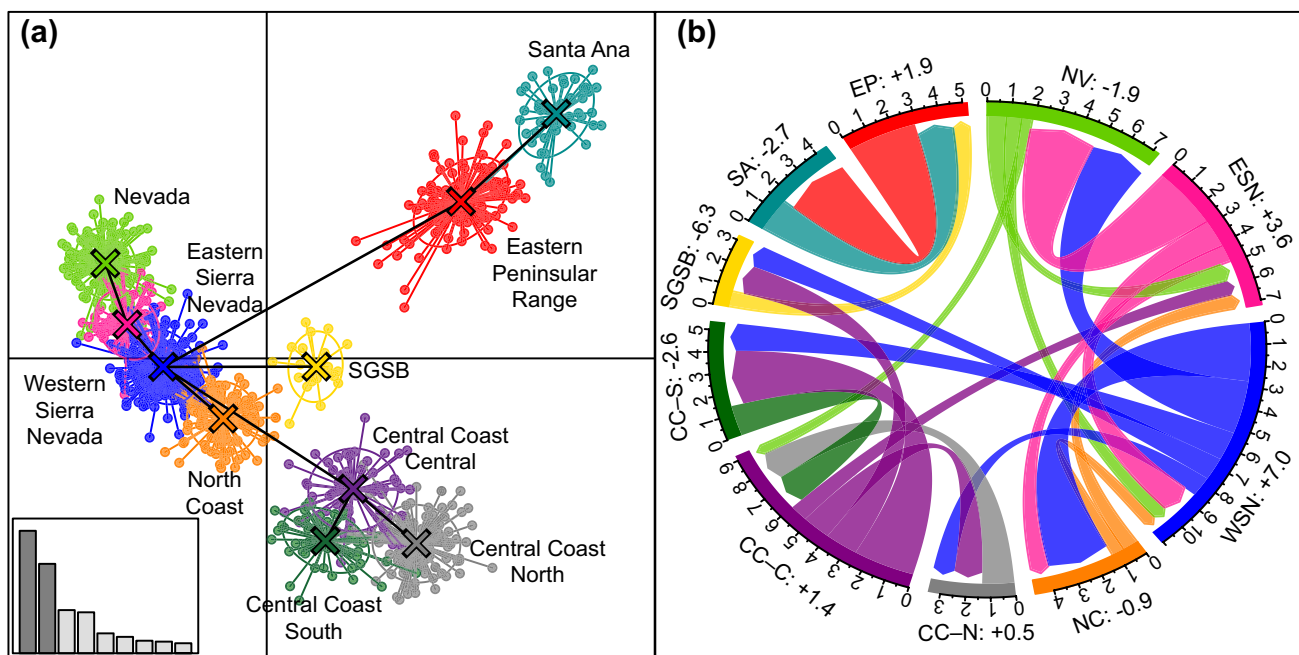
We identified 10 genetically-distinct puma populations within California and Nevada that varied considerably in genetic diversity (uHe range 0.33–0.53) and effective population size ( $N_e$  range 5–157). Some of our previous

analyses identified family-level genetic structure which was not observed here (Ernest et al. 2014; Gustafson et al. 2017; Riley et al. 2014), indicating these genetic populations are not the result of sampling related individuals. The large number of populations ( $N=9$ ) and the strong genetic differences among neighboring puma populations in California differed from other studies at similar spatial scales (Anderson et al. 2004; Holbrook et al. 2012; Loxterman 2011; McRae et al. 2005), including Nevada (Andreasen et al. 2012). Most state-wide studies have been conducted in less-developed locations with more continuous habitat and showed that geographic distance and natural landscape components were the most common factors associated with the broad-scale genetic structure of puma populations (Anderson et al. 2004; Holbrook et al. 2012; Loxterman 2011; McRae et al. 2005; Wright 1943). In contrast, mountain ranges in California are variable in size and arrangement and there are vast areas of inter-mountain anthropogenic development throughout the state. Previous local studies in California have identified individual roadways and associated human development as major barriers to puma movements (Ernest et al. 2014; Gustafson et al. 2017; Riley et al. 2014; Vickers et al. 2015), and our study confirms, on a broad geographic scale, strong population structure among adjacent puma populations. The considerable variation in genetic diversity and effective population size among California and Nevada populations is likely attributable to the variation in the amount of suitable habitat and their degree of isolation. The Western Sierra Nevada population had the largest effective size and was closely related (i.e., lowest  $F_{ST}$  values) to every population except for the Northern Central Coast population and populations south of Los Angeles (Santa Ana, Eastern Peninsular Range), suggesting puma populations form a

**Table 2** Summary of effective population size and bottleneck analyses for each population

Population	Sample size	Effective population size ( $N_e$ ) $N_e$ with AFs $\geq 0.05$	Bottleneck $N_e$ with AFs $\geq 0.01$	P-value
NV	166	92.2 (84.2–101.4)	107.2 (98.5–117.1)	0.123
ESN	79	22.6 (20.8–24.5)	26.5 (24.7–28.5)	< <b>0.001</b>
WSN	217	157.5 (141.2–176.8)	180.6 (164.1–199.7)	<b>0.038</b>
NC	101	82.5 (71.3–96.8)	66 (59.3–73.9)	0.256
CC-N	116	16.6 (15.1–18.2)	15.5 (14.2–16.8)	<b>0.001</b>
CC-C	63	56.6 (47.4–69.0)	63 (53.3–75.8)	<b>0.018</b>
CC-S	60	2.7 (2.5–2.9)	3.6 (3.4–3.9)	<b>0.008</b>
SGSB	22	5 (3.3–6.4)	7.5 (6.2–9.1)	<b>0.046</b>
SA	48	15.6 (13–18.7)	21.7 (18–26.4)	<b>0.007</b>
EP	120	31.6 (29.1–34.4)	37.4 (34.5–40.5)	<b>0.021</b>

AF allele frequencies, NV Nevada, ESN Eastern Sierra Nevada, WSN Western Sierra Nevada, NC North Coast, CC-N Northern section of the Central Coast, CC-C Central section of the Central Coast, CC-S Southern section of the Central Coast, SGSB San Gabriel/San Bernardino, SA Santa Ana, EP Eastern Peninsular Range. Parametric 95% confidence intervals are presented in parentheses. Bottleneck P-values from standardized differences tests are presented



**Fig. 4** Functional connectedness of puma populations, based on **a** a discriminant analysis of principal components and **b** bi-directional migration rate estimates (multiplied by 100 for visualization). Each dot represents an individual (**a**). Each color **a, b** represents a population. Black lines **a** indicate the most closely-related population based on genetic dissimilarities. The inset barplot **a** shows which axes are being displayed (i.e., discriminant functions 1 and 2) and the relative proportion of variation explained by each of the 9 discriminant functions. Two-thirds of the individuals in each population are contained within the corresponding ellipsoid. For a biologically meaningful interpretation, only estimates of interpopulation migration

rates with 95% confidence intervals that do not cross 0 are presented (**b**; Table S2). Net genetic source-sink migration rates are presented next to population names with positive values indicating a net genetic source and negative values indicating a net genetic sink (e.g., WSN exported 9% of migrants and received 2%, so its net rate is +7.0). NV Nevada, ESN Eastern Sierra Nevada, WSN Western Sierra Nevada, NC North Coast, CC-N Northern section of the Central Coast, CC-C Central section of the Central Coast, CC-S Southern section of the Central Coast, SGSB San Gabriel/San Bernardino, SA Santa Ana, EP Eastern Peninsular Range



“horseshoe” network around the Central Valley with San Francisco Bay acting as a major barrier along the coast (Hooper 1944). The large National Parks and National Forests (e.g., Sequoia–Kings Canyon and Yosemite National Parks) in the Sierra Nevada provide contiguous habitat for pumas with minimal anthropogenic infrastructure (Ernest et al. 2000).

Our results are consistent with a previous report (Andreasen et al. 2012) indicating pumas from Nevada form a single genetic cluster and are distinct from pumas in the Sierra Nevada of California, but our results contrast with their suggestion that pumas from Nevada are a genetic source for pumas in California. There are several differences between the studies that could explain the inconsistencies. Andreasen et al. (2012) used considerably fewer genetic markers than the present study (9 microsatellites vs. 42). Because the number of loci used in bi-directional migration rate models has the largest effect on the accuracy of the estimates (Faubet and Gaggiotti 2008; Wilson and Rannala 2003), we expect the differences are driven by the different number of loci. Although we sampled fewer pumas from Nevada and more pumas from California, sample size differences generally only affect the variance and not the accuracy of the bi-directional migration rate estimates (Faubet and Gaggiotti 2008; Wilson and Rannala 2003). Further, sample size alone likely does not explain the contrasting results and the multiple lines of evidence supporting the Sierra Nevada populations as a genetic source for the surrounding populations, including Nevada.

Both our population-level and individual-based analyses clearly indicated that the Western Sierra Nevada population had the highest genetic diversity, which is likely being maintained by the large effective population size and not via migrants from the Nevada population, which had lower genetic diversity estimates. Further, instead of testing migration rates among the two populations ( $K=2$ ) which had the highest model support in their study, Andreasen et al. (2012) tested among five genetic clusters ( $K=5$ ) which had average within-cluster migration estimates of only 54% (and a large SD of 8.4%) compared to our within-population migration estimates of 94% ( $\pm 1.9\%$ ). Thus, their examination of genetic source–sink dynamics was based on significantly less distinct genetic units ( $F_{ST}=0.05–0.09$  compared to our study where Rousset’s  $F_{ST}=0.05–0.39$ ), which is computationally problematic with a small number of loci (Faubet and Gaggiotti 2008; Wilson and Rannala 2003). Additionally, puma hunting is legal in Nevada but not California, and puma densities that have been reduced regionally from hunter harvest are known to be compensated by higher immigration rates from neighboring populations (Cooley et al. 2009; Robinson et al. 2008), which is biologically consistent with our observations.

The North Coast and inland populations (Nevada, Eastern Sierra Nevada, Western Sierra Nevada) appear to be large (i.e., high  $N_e$ ), genetically diverse, and well-connected, and may form an evolutionary significant unit (ESU: a group of populations that have accumulated adaptive differences from other populations in part from reproductive isolation; Palsbøll et al. 2007). However, genome-wide data and gene–environment correlation studies will be needed to evaluate whether these population are exhibiting adaptations to specific habitats or ecoregions. Within this group of populations, we detected evidence for bottlenecks in the Eastern Sierra Nevada population and Western Sierra Nevada population. The bottleneck in the Eastern Sierra Nevada population is not surprising given that the puma abundance in this region may have been reduced by 50% after a severe decline in mule deer (Pierce and Bleich 2014; Pierce et al. 2000; Villepique et al. 2011). Besides the North Coast and Nevada populations, all of the other populations also exhibited evidence of genetic bottlenecks; however, we do not know if this was caused by urbanization, a decrease in prey abundance, or some other factor, because the demographic and genetic histories of these populations are not well-documented.

The Central population of the Central Coast exhibited intermediate levels of genetic diversity, and maintaining gene flow from this population to the genetically-depauperate Northern and Southern Central Coast populations is critically important for their long-term viability (Benson et al. 2016; Gray et al. 2016; Riley et al. 2014). A previous report examined the southern area of the central coast region specifically and observed extremely low genetic diversity in the Santa Monica Mountains, south of Highway 101 in the Los Angeles Area (Riley et al. 2014). At a statewide level, we found pumas in the Santa Monica Mountains to be part of a larger genetic population including pumas in the Simi Hills and Santa Susana Mountains; however, our larger sample from the Southern Central Coast population revealed only slightly higher estimates of genetic diversity than pumas sampled from the Santa Monica Mountains alone (Riley et al. 2014). Road-isolated pumas in the Santa Monica Mountains only receive rare migrants from the Simi Hills and Santa Susana Mountains and are at a high risk of extirpation from isolation and subsequent demographic and genetic stochasticity (Benson et al. 2016). These results emphasize the need to conserve within-population connectivity, specifically from the Coast Ranges and the Sierra Nevada through the Santa Susana Mountains and Simi Hills to the Santa Monica Mountains.

Despite being very close geographically, the puma populations around Los Angeles (Southern Central Coast, San Gabriel/San Bernardino, Santa Ana) are highly diverged. For example, the Santa Ana and Southern Central Coast population are among the closest populations geographically



(~ 100 km apart) but are among the most genetically distant populations we observed (Rousset's  $F_{ST}=0.32$ ). Additionally, the Southern Range populations (Santa Ana, Eastern Peninsular Range) are largely disconnected from all other populations in this study, including those just to the north of the Los Angeles Basin. These observations are consistent with the hypothesis of reduced connectivity from habitat fragmentation by human development (i.e., the Los Angeles metropolitan area), including major roads (i.e., I-10, I-15, I-210, etc.) (Ernest et al. 2003). The San Gabriel/San Bernardino population was most genetically similar to the Western Sierra Nevada, Central region of the Central Coast, and Eastern Peninsular Range populations, indicating it is an area of intersection between multiple populations. We suggest the small mountain ranges in this area (i.e., Tehachapi, Sierra Pelona, San Gabriel, and San Bernardino Mountains) are necessary for contiguous statewide genetic connectivity and that pumas occupying those ranges, and the wildlands habitat in those ranges, should be considered conservation priorities (Beier et al. 2009; Ernest et al. 2003; Wildlands 2008).

The Santa Ana population exhibited the lowest measures of genetic diversity and the highest measures of inbreeding among all populations, with levels nearing those of Florida panthers (most recent estimates of  $He=0.24$ ), which nearly went extinct from genetic factors prior to artificial genetic rescue (Johnson et al. 2010). It is important to note, however, that out of the 42 microsatellite loci used in this study, only 4 were shared with the 23 microsatellite loci used in the Florida panther study. A set of shared markers would be most appropriate for direct interpopulation comparisons (e.g., Culver et al. 2000). A single immigrant from the Eastern Peninsular Range recently enhanced the genetic diversity of Santa Ana pumas and is likely responsible for the higher effective population size than previously observed (Ernest et al. 2014). Nevertheless, genetic diversity of Santa Ana pumas will decline without additional immigration (Gustafson et al. 2017). The Eastern Peninsular Range population had the highest genetic diversity and effective size among the populations in the Los Angeles—San Diego area (Southern Central Coast, San Gabriel/San Bernardino, Santa Ana, Eastern Peninsular Range). Restoring connectivity with the Eastern Peninsular Range and reducing further impacts from development on gene flow among the adjacent populations, including pumas from Arizona and Mexico (Gustafson et al. 2017), are critically important to avoiding extirpation of genetically-depauperate populations (Benson et al. 2016).

By identifying puma populations and measuring gene flow among them, our analyses can help guide and inform puma conservation and management. Whenever possible, government agencies and other stakeholders should consider population connectivity and prevent further fragmentation by human development both within and among populations.

In contrast to other studies in 7 western states that generally indicated weak puma genetic structure (Anderson et al. 2004; Holbrook et al. 2012; Loxterman 2011; McRae et al. 2005), our study showed strong genetic structure. Although puma habitat in California is aggregated and separated by valleys, it is unlikely these valleys would have been such strong barriers to gene flow pre-development given that pumas have been documented to move across the entire Central Valley post-development (Ernest et al. 2003; McClanahan et al. 2017). Further, similar geographic features, such as the Wyoming Basin, have not been reported to structure puma populations (Anderson et al. 2004). Instead, we hypothesize that human-associated infrastructure within the valleys are artificially isolating pumas beyond what they would naturally experience among ecoregions.

Population-level conservation strategies are needed to reintegrate fragmented, at-risk populations into a connected multi-state, multi-landscape population network (Zeller et al. 2017). Gene flow via maintenance of existing occupied habitat combined with improved and additional networks of wildlife corridors (Bennett 2017; Gloyne and Clevenger 2001; Johnson et al. 2010; Sawaya et al. 2013) will ultimately be necessary to promote the long-term persistence of isolated populations (Benson et al. 2016; Ernest et al. 2014; Gustafson et al. 2017; Riley et al. 2014). Without such measures, it is likely too late to expect a natural increase in genetic connectivity or selection for increased dispersal (Burdett et al. 2010; Cheptou et al. 2017), and assisted gene flow may be needed in perpetuity for several populations to remain viable (Benson et al. 2011, 2016; Ernest et al. 2014; Gustafson et al. 2017; Johnson et al. 2010; Vickers et al. 2015).

In some of these populations, individual migrants are of immediate conservation importance, and human-induced mortality should be avoided to the extent possible. The effects of fragmentation on multiple populations of this umbrella species are likely indicative of a larger ecological problem in one of the most biologically diverse regions of North America (Calsbeek et al. 2003; Dobson et al. 1997; Thorne et al. 2006). We strongly encourage land owners and managers to proactively consider broad-scale wildlife connectivity in future development proposals. However, in the absence of maintaining habitat of a spatial scale grand enough to ensure the persistence of prey and predator populations, the issue of connectivity will become a moot point.

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**Data availability** Through agreements with non-profit organizations, private landowners, and Native American Tribes, exact GPS locations of puma samples are not to be publicly shared. Thus, puma GPS locations are referenced to the nearest town or city. Sampling locations and microsatellite genotypes are available on Dryad: <https://doi.org/10.5061/dryad.j76c4k4>.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** Permission to carry out fieldwork and necessary permits were obtained from CDFW, California Department of Parks and Recreation, The Nature Conservancy, United States (U.S.) Fish and Wildlife Service, U.S. Forest Service, U.S. Bureau of Land Management, U.S. Navy/Marine Corps, Orange County Parks Department, San Diego County Parks Department, Riverside County Parks Department, San Diego State University, University of California—Riverside, Audubon Starr Ranch, Vista Irrigation District, Rancho Mission Viejo/San Juan Company, Sweetwater Authority, California Department of Transportation, the City of San Diego Water Department and Parks Department, and the Irvine Ranch Conservancy.

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# Habitat fragmentation and its lasting impact on Earth's ecosystems

Nick M. Haddad,<sup>1\*</sup> Lars A. Brudvig,<sup>2</sup> Jean Clobert,<sup>3</sup> Kendi F. Davies,<sup>4</sup> Andrew Gonzalez,<sup>5</sup> Robert D. Holt,<sup>6</sup> Thomas E. Lovejoy,<sup>7</sup> Joseph O. Sexton,<sup>8</sup> Mike P. Austin,<sup>9</sup> Cathy D. Collins,<sup>10</sup> William M. Cook,<sup>11</sup> Ellen I. Damschen,<sup>12</sup> Robert M. Ewers,<sup>13</sup> Bryan L. Foster,<sup>14</sup> Clinton N. Jenkins,<sup>15</sup> Andrew J. King,<sup>9</sup> William F. Laurance,<sup>16</sup> Douglas J. Levey,<sup>17</sup> Chris R. Margules,<sup>18,19</sup> Brett A. Melbourne,<sup>4</sup> A. O. Nicholls,<sup>9,20</sup> John L. Orrock,<sup>12</sup> Dan-Xia Song,<sup>8</sup> John R. Townshend<sup>8</sup>

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We conducted an analysis of global forest cover to reveal that 70% of remaining forest is within 1 km of the forest's edge, subject to the degrading effects of fragmentation. A synthesis of fragmentation experiments spanning multiple biomes and scales, five continents, and 35 years demonstrates that habitat fragmentation reduces biodiversity by 13 to 75% and impairs key ecosystem functions by decreasing biomass and altering nutrient cycles. Effects are greatest in the smallest and most isolated fragments, and they magnify with the passage of time. These findings indicate an urgent need for conservation and restoration measures to improve landscape connectivity, which will reduce extinction rates and help maintain ecosystem services.

## INTRODUCTION

Destruction and degradation of natural ecosystems are the primary causes of declines in global biodiversity (1, 2). Habitat destruction typically leads to fragmentation, the division of habitat into smaller and more isolated fragments separated by a matrix of human-transformed land cover. The loss of area, increase in isolation, and greater exposure to human land uses along fragment edges initiate long-term changes to the structure and function of the remaining fragments (3).

Ecologists agree that habitat destruction is detrimental to the maintenance of biodiversity, but they disagree—often strongly—on the extent to which fragmentation itself is to blame (4, 5). Early hypotheses based on the biogeography of oceanic islands (6) provided a theoretical framework to understand fragmentation's effect on extinction in terrestrial landscapes composed of “islands” of natural habitat scattered across a “sea” of human-transformed habitat. Central to the controversy has been a lingering uncertainty about the role of decreased

fragment size and increased isolation relative to the widespread and pervasive effects of habitat loss in explaining declines in biodiversity and the degradation of ecosystems (7). Observational studies of the effects of fragmentation have often magnified the controversy because inference from nonmanipulative studies is limited to correlation and because they have individually often considered only single aspects of fragmentation (for example, edge, isolation, and area) (8). However, together with these correlative observations, experimental studies reveal that fragmentation has multiple simultaneous effects that are interwoven in complex ways and that operate over potentially long time scales (9).

Here, we draw on findings of the world's largest and longest-running fragmentation experiments that span 35 years and disparate biomes on five continents. Their rigorous designs and long-term implementation overcome many limitations of observational studies. In particular, by manipulating and isolating individual aspects of fragmentation while controlling for others, and by doing so on entire ecosystems, they provide a powerful way to disentangle cause and effect in fragmented landscapes. Here, we present experimental evidence of unexpected long-term ecological changes caused by habitat fragmentation.

Highlighting one ecosystem type as an example, we first present a global analysis of the fragmentation of forest ecosystems, quantifying for the first time the global hotspots of intensive historical fragmentation. We then synthesize results from the set of long-term experiments conducted in a wide variety of ecosystems to demonstrate consistent impacts of fragmentation, how those impacts change over time, and how they align with predictions from theory and observation. Finally, we identify key knowledge gaps for the next generation of fragmentation experiments.

## GLOBAL ANALYSIS OF THE EXTREME MAGNITUDE AND EXTENT OF FRAGMENTATION

New satellite data sets reveal at high resolution how human activities are transforming global ecosystems. Foremost among these observations are those of forest cover because of the high contrast between forest

<sup>1</sup>Department of Biological Sciences, North Carolina State University, Raleigh, NC 27695, USA.

<sup>2</sup>Department of Plant Biology, Michigan State University, East Lansing, MI 48824–1312, USA.

<sup>3</sup>Station d'Ecologie Expérimentale du CNRS a Moulis USR 2936, Moulis, 09200 Saint-Girons, France.

<sup>4</sup>Department of Ecology and Evolutionary Biology, UCB 334, University of Colorado, Boulder, CO 80309, USA.

<sup>5</sup>Department of Biology, McGill University, Montreal, Quebec H3A 1B1, Canada.

<sup>6</sup>Department of Biology, University of Florida, Gainesville, FL 32611, USA.

<sup>7</sup>Department of Environmental Science and Policy, George Mason University, Fairfax, VA 22030, USA.

<sup>8</sup>Global Land Cover Facility, Department of Geographical Sciences, University of Maryland, College Park, MD 20702, USA.

<sup>9</sup>CSIRO Land and Water Flagship, GPO Box 1700, Canberra, Australian Capital Territory 2601, Australia.

<sup>10</sup>Department of Biology, Colby College, 5746 Mayflower Hill, Waterville, ME 04901, USA.

<sup>11</sup>Department of Biological Sciences, St. Cloud State University, St. Cloud, MN 56301, USA.

<sup>12</sup>Department of Zoology, University of Wisconsin, Madison, WI 53706, USA.

<sup>13</sup>Department of Life Sciences, Imperial College London, Silwood Park Campus, Buckhurst Road, Ascot, Berkshire SL5 7PY, UK.

<sup>14</sup>Department of Ecology and Evolutionary Biology and Kansas Biological Survey, University of Kansas, 2101 Constant Avenue, Lawrence, KS 66047–3759, USA.

<sup>15</sup>Instituto de Pesquisas Ecológicas, Rod. Dom Pedro I, km 47, Caixa Postal 47, Nazaré Paulista, São Paulo 12960-000, Brazil.

<sup>16</sup>Centre for Tropical Environmental and Sustainability Science and College of Marine and Environmental Sciences, James Cook University, Cairns, Queensland 4878, Australia.

<sup>17</sup>National Science Foundation, Arlington, VA 22230, USA.

<sup>18</sup>Centre for Tropical Environmental and Sustainability Science, School of Earth and Environmental Sciences, James Cook University, Cairns 4878, Australia.

<sup>19</sup>Research Center for Climate Change, University of Indonesia, Kota Depok, Java Barat 16424, Indonesia.

<sup>20</sup>The Institute for Land, Water and Society, Charles Sturt University, Thurgooona Campus, Albury, New South Wales 2640, Australia.

\*Corresponding author. E-mail: nick\_haddad@ncsu.edu

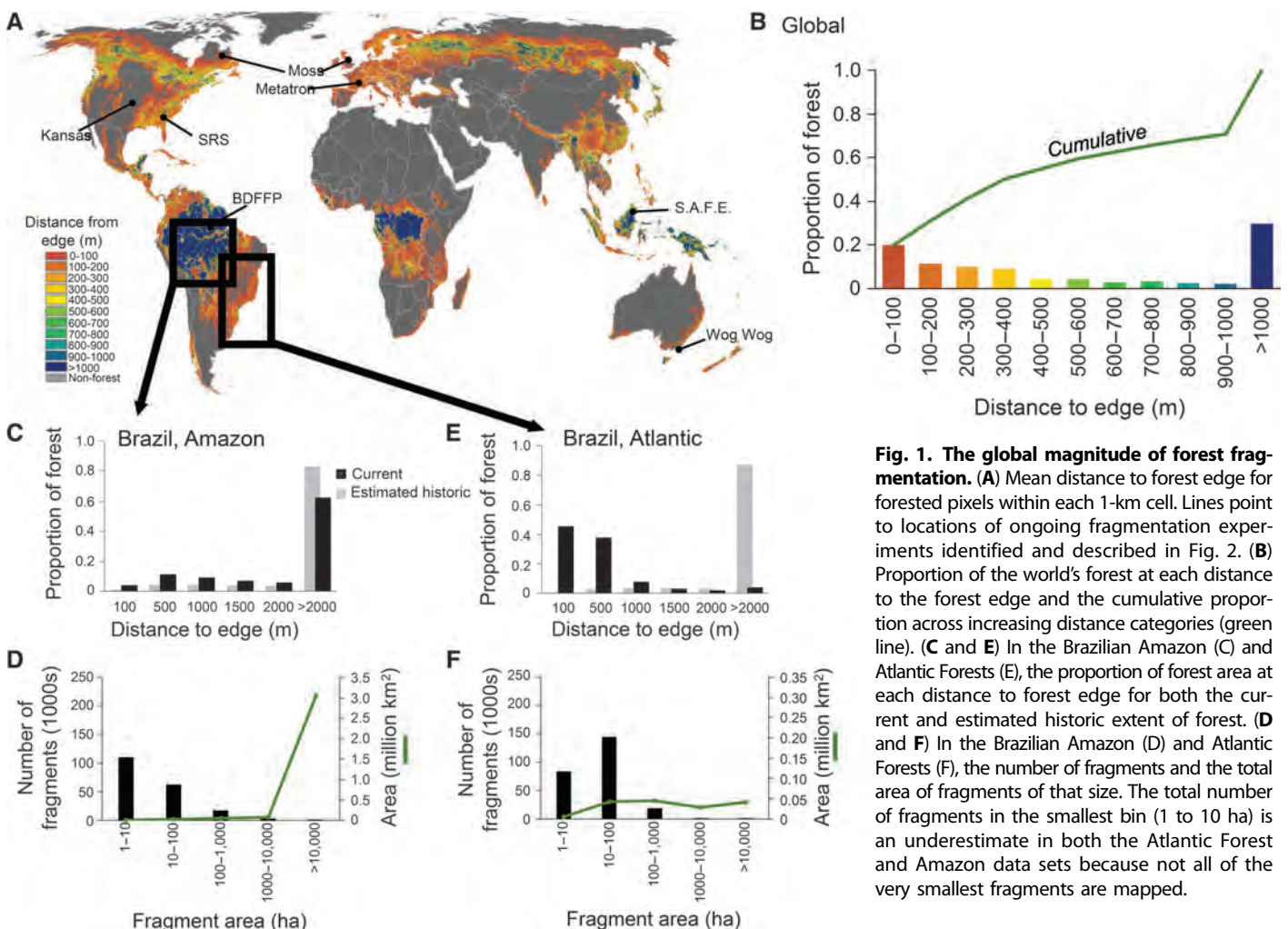


and anthropogenic land cover types. Deforestation, which was already widespread in temperate regions in the mid-18th to 20th centuries and increased in the tropics over the past half century, has resulted in the loss of more than a third of all forest cover worldwide (10, 11). Beyond the direct impacts of forest loss and expanding anthropogenic land cover (for example, agricultural fields and urban areas), remnant forests are likely to suffer from being smaller, more isolated, and with a greater area located near the edge of the forest (12).

We analyzed the world's first high-resolution map of global tree cover (13) to measure the magnitude of forest fragmentation. This analysis revealed that nearly 20% of the world's remaining forest is within 100 m of an edge (Fig. 1, A and B)—in close proximity to agricultural, urban, or other modified environments where impacts on forest ecosystems are most severe (14). More than 70% of the world's forests are within 1 km of a forest edge. Thus, most forests are well within the range where human activities, altered microclimate, and nonforest species may influence and degrade forest ecosystems (15). The largest contiguous expanses of remaining forests are in the humid tropical regions of the Amazon and Congo River Basins (Fig. 1A). Large areas of more disjunct forest also remain in southeastern Asia, New Guinea, and the boreal biomes.

Historical data enable the study of the process of forest fragmentation over time. We reconstructed the historical forest extent and timing of fragmentation in two forested regions of Brazil that provide a stark contrast in land-use dynamics. The Brazilian Amazon is a rapidly changing frontier (10), yet most of its forests remain contiguous and far from an edge despite recent increases in fragmentation (Fig. 1, C and D). In contrast, the Brazilian Atlantic Forest is a largely deforested landscape, cleared for agriculture and logged for timber over the last three centuries (11). This remaining forest is dominated by small fragments, with most fragments smaller than 1000 ha and within 1000 m of a forest edge (Fig. 1, E and F) (16). In the Brazilian Amazon, the proportion of forest farther than 1 km from the forest edge has decreased from 90% (historical) to 75% (today), and in the Brazilian Atlantic, from 90% to less than 9%.

These two forested regions of Brazil define extremes of the fragmentation process and are representative of the extent of fragmentation in forested landscapes worldwide (Fig. 1), as well as many other biomes including temperate grasslands, savannas, and even aquatic systems (17). For example, although a spatial analysis similar to that of forest is not currently possible in grasslands, 37% of the world's grassland eco-regions are classified as “highly fragmented” (18, 19).



**Fig. 1. The global magnitude of forest fragmentation.** (A) Mean distance to forest edge for forested pixels within each 1-km cell. Lines point to locations of ongoing fragmentation experiments identified and described in Fig. 2. (B) Proportion of the world's forest at each distance to the forest edge and the cumulative proportion across increasing distance categories (green line). (C and E) In the Brazilian Amazon (C) and Atlantic Forests (E), the proportion of forest area at each distance to forest edge for both the current and estimated historic extent of forest. (D and F) In the Brazilian Amazon (D) and Atlantic Forests (F), the number of fragments and the total area of fragments of that size. The total number of fragments in the smallest bin (1 to 10 ha) is an underestimate in both the Atlantic Forest and Amazon data sets because not all of the very smallest fragments are mapped.

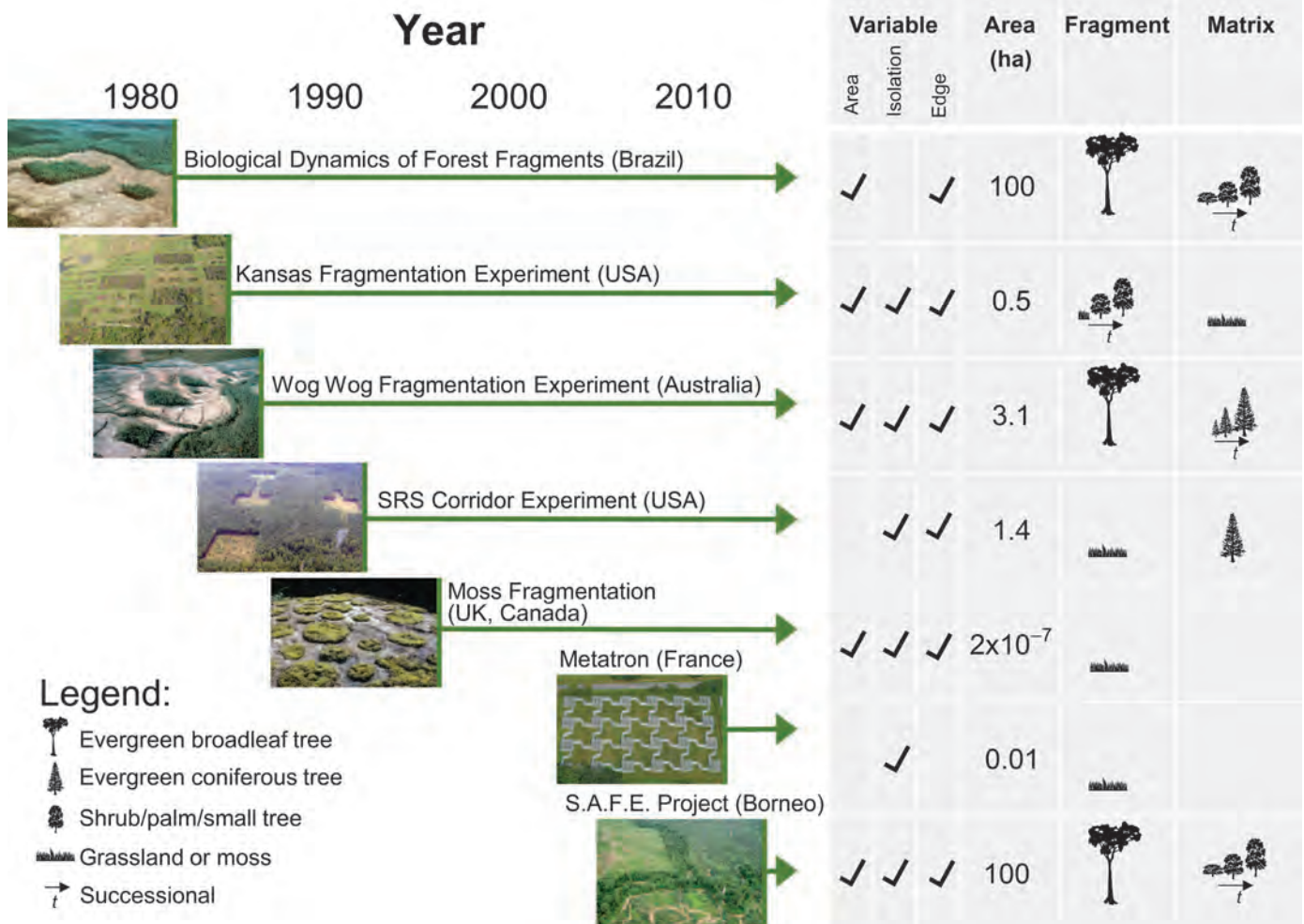
Robust knowledge of how habitat fragmentation affects biodiversity and ecosystem processes is needed if we are to comprehend adequately the implications of this global environmental change.

**THE VALUE OF LONG-TERM FRAGMENTATION EXPERIMENTS**

Long-term experiments are a powerful tool for understanding the ecological consequences of fragmentation (20). Whereas observational studies of fragmented landscapes have yielded important insights (9, 21), they typically lack rigorous controls, replication, randomization, or baseline data. Observational studies have limited ability to isolate the effects of fragmentation from concomitant habitat loss and degradation per se (4, 7, 22). Remnant fragments are embedded in different types and qualities of surrounding habitat, complicating interpretation because the surrounding habitat also influences biodiversity and ecosystem productivity (23).

The long-term fragmentation experiments we analyze here comprise the entire set of ongoing terrestrial long-term experiments. They

occur in several biomes (Fig. 2 and Supplementary Materials) and were designed to manipulate specific components of fragmentation—habitat size, isolation, and connectivity—while controlling for confounding factors such as the amount of habitat lost across a landscape (Fig. 2). The largest fragments across these experiments match the size of fragments commonly created by anthropogenic activities (Figs. 1 and 2). Distances to the edge of experimental fragments range to 500 m, encompassing edge distances found in more than half of forests worldwide (Fig. 1B). In each experiment, different fragmentation treatments with replication were established, starting from continuous, nonfragmented landscapes and controlling for background environmental variation either by experimental design (blocking) or by measurement of covariates for use in subsequent analyses. Tests were conducted within fragments that varied experimentally in area or edge, within fragments that were experimentally isolated or connected, or within experimental fragments compared to the same area within continuous habitat. All treatments were replicated. Experiments were created by destroying or creating precise amounts of habitat across replicate landscapes, allowing tests of fragmentation effects independent of habitat loss. The robust



**Fig. 2. The world’s ongoing fragmentation experiments.** All experiments have been running continuously since the time indicated by the start of the associated arrow (with the exception of the moss fragmentation experiment, which represents a series of studies over nearly two dec-

ades). The variables under study in each experiment are checked. The area is that of the experiment’s largest fragments. Icons under “Fragment” and “Matrix” indicate the dominant community and its relative height, with multiple trees representing succession.



and comparable experimental designs allow for powerful tests of the mechanisms underpinning the ecological impacts of fragmentation, and the long-term nature of ensuing studies has revealed consistent emergent effects.

These experiments mimic anthropogenic fragmentation; they are whole-ecosystem manipulations in which all species and processes experienced the same treatment (24). Emergent responses thus reflect the multiple direct and indirect effects of interacting species and processes. Further, because experimentally fragmented ecosystems are open to fluxes of individuals and resources, fragmentation effects can manifest across multiple levels of ecological organization (Fig. 3). Long-term experiments have the power to detect lagged and/or chronic impacts.

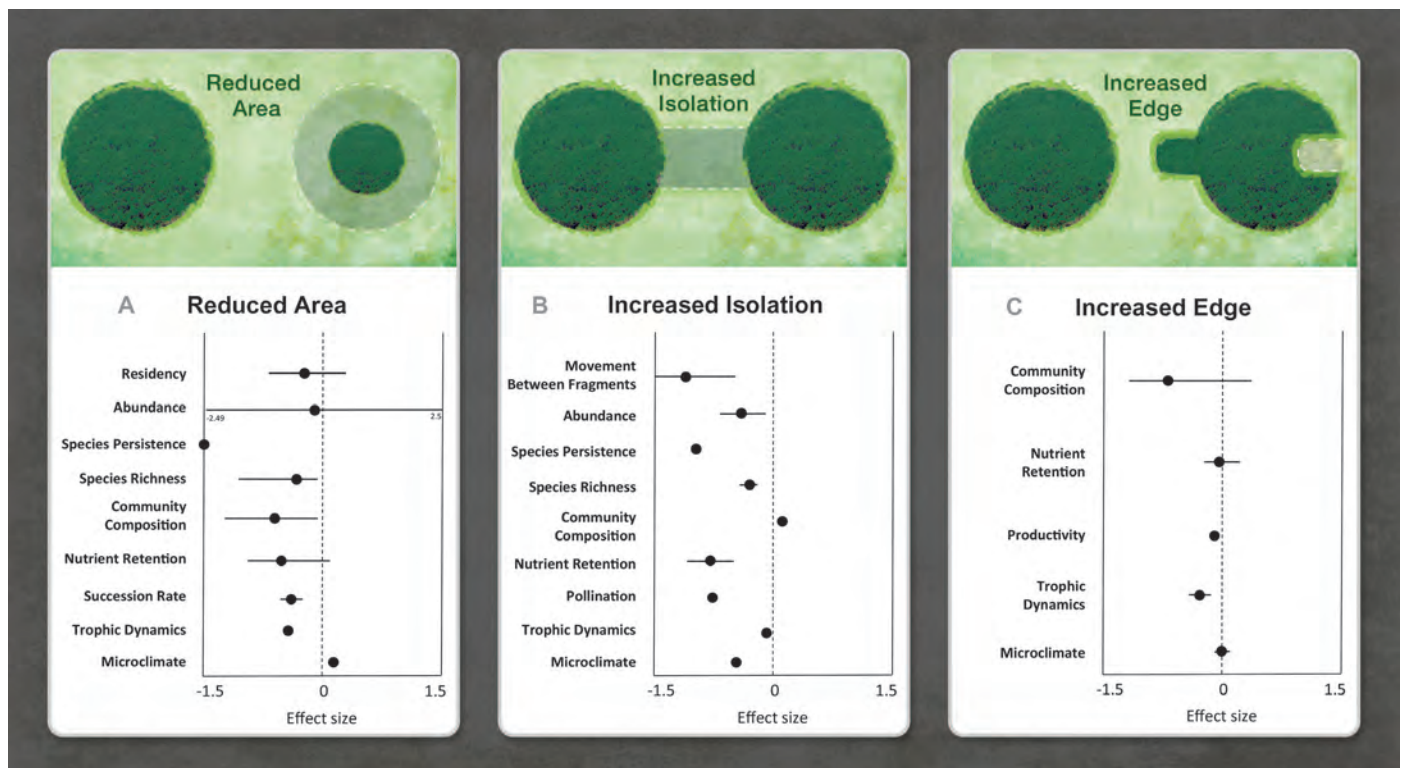
The first fragmentation experiments, now more than three decades old, were created to test effects of fragment area on both species persistence and patterns of immigration, reflecting concern in conservation biology about the role of fragmentation in reducing population sizes below viable levels (25) (Fig. 2). Subsequent experiments, created two decades ago, shifted focus to modifying habitat isolation, reflecting recognition of the potential to mitigate negative effects of fragmentation by recreating habitat—specifically with corridors—to increase connectivity among fragments (26) (Fig. 2). The newest experiments test emerging questions about potentially deleterious synergies between fragmentation and global changes in climate and land use (Fig. 2).

We synthesized results available 31 January 2014 for all studies within these experiments that were conducted in all treatments and replicates, and tested fragmentation effects on dispersal, abundance, extinction, species richness, community composition, and ecosystem functioning. We first calculated effect sizes of fragmentation as log response ratios (Fig. 3). Data from 76 different studies across the five longest-running experiments were drawn from published and unpublished sources (table S1). We synthesized results according to three fragmentation treatments: reduced fragment area [the focus of Biological Dynamics of Forest Fragments Project (BDFFP), Wog Wog, and Kansas; see Fig. 2 for identifiers of experiments], increased fragment isolation [Savannah River Site (SRS) and Moss], and increased proportion of edge (all experiments). Fragmented treatments were compared directly to non- or less-fragmented habitats that were either larger or connected via structural corridors (table S1).

### Strong, consistent, and accumulating effects of habitat fragmentation

Our synthesis revealed strong and consistent responses of organisms and ecosystem processes to fragmentation arising from decreased fragment area, increased isolation, and the creation of habitat edges (Fig. 3).

Community and ecosystem responses emerge from observed responses at the level of populations. Reduced area decreased animal



**Fig. 3. Fragmentation effects propagate through the whole ecosystem.** (A to C) For each fragmentation treatment [reduced area in BDFFP, Wog Wog, Kansas (A); increased isolation in SRS and Moss (B); and increased edge in all experiments (C)], we summarize major findings for ecological processes at all levels of ecological organization. Each dot represents the mean effect size [computed as log response

ratio:  $\ln(\text{mean in more fragmented treatment}/\text{mean in non- or less-fragmented treatment})$ ] for an ecological process. Effect sizes are statistical, such that negative or positive values could represent degrading function. Horizontal bars are the range when a dot is represented by more than one study. Details, including individual effect sizes for each study, are reported in table S1.

residency within fragments, and increased isolation reduced movement among fragments, thus reducing fragment recolonization after local extinction (Fig. 3, A and B). Reduced fragment area and increased fragment isolation generally reduced abundance of birds, mammals, insects, and plants (Fig. 3, A and B). This overall pattern emerged despite complex patterns of increases or declines in abundance of individual species (Fig. 3A) with various proximate causes such as release from competition or predation, shifts in disturbance regimes, or alteration of abiotic factors (14, 27–29). Reduced area, increased isolation, and increased proportion of edge habitat reduced seed predation and herbivory, whereas increased proportion of edge caused higher fledgling predation that had the effect of reducing bird fecundity (represented together as trophic dynamics in Fig. 3, A to C). Perhaps because of reduced movement and abundance, the ability of species to persist was lower in smaller and more isolated fragments (Fig. 3, A and B).

As predicted by theory (6, 30, 31), fragmentation strongly reduced species richness of plants and animals across experiments (Fig. 3, A and B), often changing the composition of entire communities (Fig. 3, A to C). In tropical forests, reduced fragment size and increased proportion of edge habitat caused shifts in the physical environment that led to the loss of large and old trees in favor of pioneer trees (Fig. 3, A and C), with subsequent impacts on the community composition of insects (32). In grasslands, fragment size also affected succession rate, such that increased light penetration and altered seed pools in smaller fragments impeded the rate of ecological succession relative to that of larger fragments (33) (Fig. 3A).

Consistently, all aspects of fragmentation—reduced fragment area, increased isolation, and increased edge—had degrading effects on a disparate set of core ecosystem functions. Degraded functions included reduced carbon and nitrogen retention (Fig. 3, A to C), productivity (Fig. 3C), and pollination (Fig. 3B).

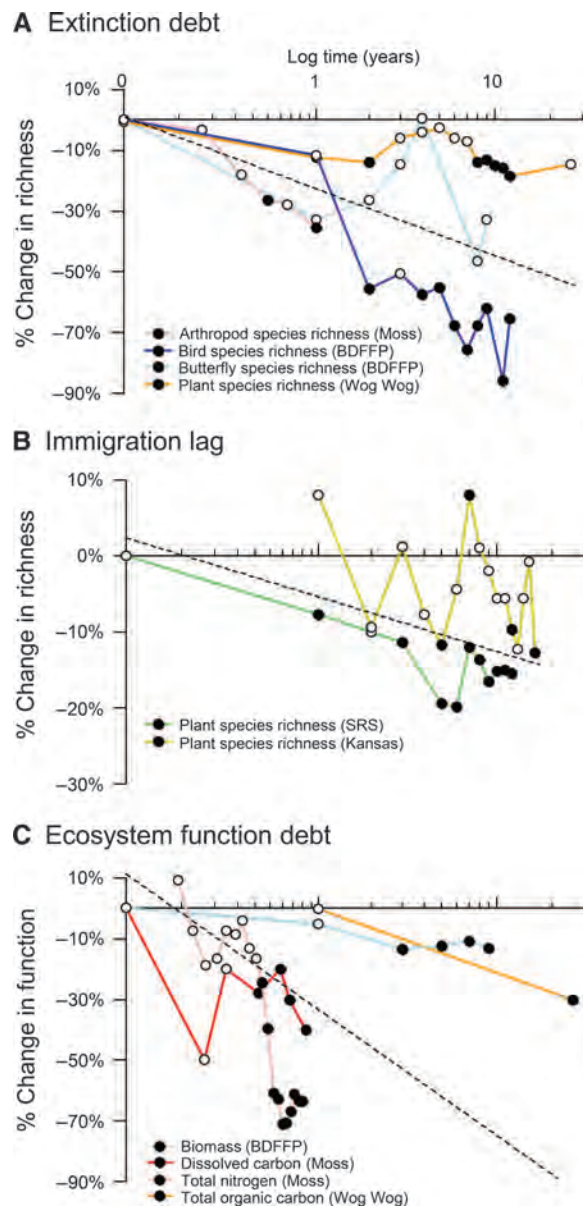
In summary, across experiments spanning numerous studies and ecosystems, fragmentation consistently degraded ecosystems, reducing species persistence, species richness, nutrient retention, trophic dynamics, and, in more isolated fragments, movement.

### Long-term consequences of fragmentation

To synthesize all time series of species richness and ecosystem functioning gathered across experiments, we measured effects of fragmentation over the course of each study. The effect of fragmentation was calculated over time as the proportional change in fragmented relative to non- or less-fragmented treatments (Fig. 4).

In most cases, the large and consistent effects of fragmentation revealed by the experiments were predicted from theory. However, we were struck by the persistence of degradation to biodiversity and ecosystem processes and by the increase in many of the effects over time (Fig. 4). For example, extreme rainfall events at Wog Wog appeared to delay the decline in plant species richness for 5 years after fragmentation. In the Kansas Experiment, a lag of 12 years occurred before fragmentation effects on plant succession were detected. Our results thus reveal long-term and progressive effects of fragmentation and provide support for three processes proposed by recent studies in spatial ecology: extinction debt, immigration lag, and ecosystem function debt (Fig. 4).

First, we found strong evidence for temporal lags in extinction [that is, “extinction debt” (30)] in fragments. Species richness of plants, arthropods, and birds sampled in the experiments conducted in mature forest fragments and replicated moss landscapes showed decreases of



**Fig. 4. Delayed effects of fragmentation on ecosystem degradation.**

(A) The extinction debt represents a delayed loss of species due to fragmentation. (B) The immigration lag represents differences in species richness caused by smaller fragment area or increased isolation during fragment succession. (C) The ecosystem function debt represents delayed changes in ecosystem function due to reduced fragment size or increased isolation. Percent loss is calculated as proportional change in fragmented treatments [for example, (no. of species in fragment – no. of species in control)/(no. of species in control) × 100]. Fragments and controls were either the same area before and after fragmentation, fragments compared to unfragmented controls, or small compared to large fragments. Filled symbols indicate times when fragmentation effects became significant, as determined by the original studies (see table S2). Mean slopes (dashed lines) were estimated using linear mixed (random slopes) models. Mean slope estimates (mean and SE) were as follows: (A) –0.22935 (0.07529); (B) –0.06519 (0.03495); (C) –0.38568 (0.16010).

20 to 75% after fragmentation (Fig. 4A). Some declines were evident almost immediately after fragmentation, whereas others increased in magnitude over the experiment's duration. Across experiments, average loss was >20% after 1 year, >50% after 10 years, and is still increasing in the longest time series measured (more than two decades). The rate of change appears to be slower in larger fragments [in BDFFP, 50% decline in bird species after 5 years in 1-ha fragments, but after 12 years in 100-ha fragments; in Moss, 40% decline in arthropod species richness of small fragments and 26% reduction in large fragments after 1 year (34, 35)]. As predicted by theory (36), the extinction debt appears to take longer to pay in larger fragments.

Second, we observed that reduced richness was coincident with an "immigration lag" (37), whereby small or isolated fragments are slower to accumulate species during community assembly (33, 38) (Fig. 4B). Immigration lags were observed in experiments conducted in successional systems that were initiated by creating new habitat fragments, rather than by fragmenting existing habitats. After more than a decade, immigration lags resulted in 5% fewer species after 1 year, and 15% fewer species after 10 years in small or isolated fragments compared to large or connected fragments (Fig. 4B).

Third, we observed an ecosystem function debt caused by fragmentation (39) in forest and moss fragments (Fig. 4C). An ecosystem function debt is manifest both as delayed changes in nutrient cycling and as changes to plant and consumer biomass. Loss of function amounted to 30% after 1 year, rising to 80% after a decade in small and isolated fragments when compared to larger and more connected fragments (Fig. 4C). Functional debts can result from biodiversity loss, as when loss of nutrients and reduction in decomposition are caused by simplification of food webs. Alternatively, the impact is exhibited through pathways whereby fragmentation changes biotic (for example, tree density in successional systems) or abiotic conditions (for example, light regimes or humidity) in ways that alter and potentially impair ecosystem function [for example, biomass collapse in fragments; Figs. 3 and 4; altered nitrogen and carbon soil dynamics (40)].

### A new understanding of the effects of fragmentation

By testing existing theory, experiments play a pivotal role in advancing ideas and developing new theory. We draw on experimental evidence to highlight two ways that the understanding of fragmentation has been enriched by the interplay between long-term experiments and development of theory.

First, island biogeography (6) was among the earliest theories to predict extinction and immigration rates and patterns of species richness in isolated biotas, which were later used to predict the effects of fragmentation on these variables. Experiments in continental settings tested the theory and gave rise to fresh perspectives. For example, islands are surrounded by sea, a thoroughly inimical matrix for island-dwelling species. Habitat islands, or fragments, are surrounded by a matrix that may not be so unsuitable for some species. In terms of all of the ecological variables studied in our long-term experiments, our results support the conclusion that ecological dynamics in human-modified fragments are a stark contrast to the dynamics in intact habitats that remain. Observational studies that have devoted more detailed consideration to the countryside within which fragments are embedded explain the diversity of ecological responses in remaining fragments (41). At the same time as experiments supported the core predictions of classical theories about effects of fragment size and isolation (Figs. 3 and 4), they spurred and tested new theories such as metacommunity theory (42) to account

for variation in connectivity and habitat quality within and between fragments (33, 43–45), spatial dynamics (14, 46), and spatially varying interspecific interactions (47).

Second, experiments have demonstrated that the effects of fragmentation are mediated by variation in traits across species. More realistic predictions of community responses to fragmentation emerged after explicit consideration of species traits such as rarity and trophic levels (48, 49), dispersal mode (50–52), reproductive mode and life span (29, 53), diet (54), and movement behavior (55, 56). Increasingly, the simple theoretical prediction that fragmentation reduces species richness is being modified to account for species identity through models that focus on how species vary in their traits (4, 21, 36, 48, 57, 58). Consideration of traits may help to interpret variation around the overarching pattern that fragmentation consistently reduces species richness across many species and biomes (Figs. 3 and 4).

### A NEW GENERATION OF FRAGMENTATION EXPERIMENTS

New foci are emerging for studying ecosystem fragmentation, including (i) synergies between fragmentation and global changes, (ii) eco-evolutionary responses of species to fragmentation, and (iii) ecological responses to fragmentation in production landscapes—that is, ecosystems whose services are under extreme appropriation by humans (59).

First, conclusions from experiments thus far are likely to have been conservative because impacts from other environmental changes have been mostly excluded. Most forms of global change known to reduce population sizes and biodiversity will be exacerbated by fragmentation (58, 60), including climate change (61), invasive species (62, 63), hunting (64), pollution [including light, noise, and chemicals (65)], and altered disturbance regimes (66).

More complex experiments with unparalleled control and capacity to simultaneously manipulate fragmentation and other global changes are now under way (53). The Metatron, created in 2011 in southern France (67), enables ecologists to assess effects of variation in temperature and other abiotic factors in addition to habitat isolation. The SAFE Project is being created in the rainforest of Borneo (68) and will embed a fragmentation experiment within a production agricultural plantation in which poaching will occur. Other synergies should be investigated experimentally, including the interaction between fragmentation and hunting, fire, infectious disease outbreaks, or nitrogen deposition. Within these experiments, fragmentation and loss of habitat can then be varied independently.

Second, current experiments have stopped short of examining how fragmentation drives evolution through genetic bottlenecks, ecological traps, changing patterns of selection, inbreeding, drift, and gene flow (69–72). Extensive fragmentation has occurred over many years, and in some regions over millennia (11). Changes caused by fragmentation undoubtedly lead to altered patterns of selection and trait evolution. Evolutionary responses to fragmentation have already been suggested (73, 74), and it is likely that such changes will, in turn, feed back to influence population persistence and ecosystem resilience in fragmented landscapes. Linking long-term experiments with the tools of landscape genetics (75) may provide powerful insights into the evolutionary dynamics of species inhabiting fragmented landscapes.

Third, new experiments should address the management of natural habitats in production landscapes by monitoring vegetation, networks of interacting species, and ecosystem services at ecologically relevant



spatial and temporal scales (76–78). Some ecosystem services have global consequences, for example, local carbon sequestration affects global atmospheric CO<sub>2</sub>. However, in many cases the benefits obtained by people depend on their proximity to habitat fragments (79). For example, crop pollination and biological pest control from natural areas adjacent to farms are made available by the very process of habitat fragmentation, bringing people and agriculture closer to those services. Yet, further fragmentation reduces access to many services and ultimately may push landscapes past tipping points, beyond which essential ecosystem services are not merely diminished but lost completely (80). This complex relationship creates a double-edged sword, for which locally optimal levels and arrangements of habitat must be sought. New fragmentation experiments should consider how multiple fragments in a landscape interact, creating an ecological network in which the collective benefit of ecosystem services may be greater than the sum of services provided by individual fragments (81, 82). Experimental inferences may then be tested beyond their spatiotemporal domains and, if successful, extrapolated across scales. Such research will be aided by satellite monitoring of ecosystems and human land use across the globe. The most powerful research programs will integrate experiments, observational studies, air- and space-borne imaging, and modeling.

## CONCLUSIONS

Fragmentation experiments—some of the largest and longest-running experiments in ecology—provide clear evidence of strong and typically degrading impacts of habitat fragmentation on biodiversity and ecological processes. The findings of these experiments extend to a large fraction of the terrestrial surface of the Earth. Much of the Earth's remaining forest fragments are less than 10 ha in area, and half of the world's forest is within 500 m of the forest edge—areas and distances matched to existing long-term experiments (Figs. 1 and 2) from which consistent effects of fragmentation have emerged (Figs. 3 and 4).

Reduced fragment area, increased isolation, and increased edge initiate changes that percolate through ecosystems (Fig. 3). Fragmentation has the capacity to generate persistent, deleterious, and often unpredicted outcomes, including surprising surges in abundance of some species and the pattern that long temporal scales are required to discern many strong system responses. In light of these conclusions and ongoing debates, we suggest that fragmentation's consistency, pervasiveness, and long-term degrading effect on biodiversity and ecosystem function have not been fully appreciated (9).

Without gains in yield and efficiency of agricultural systems (83), the expansion of human populations will inevitably continue to reduce and fragment natural areas. The area of Earth's land surface devoted to cropland already occupies 1.53 billion hectares (83) and may expand 18% by the middle of this century (84), and the area committed to urban centers is predicted to triple to 0.18 billion hectares by 2030 (85). The capacity of the surviving forests and other natural habitats to sustain biodiversity and ecosystem services will hinge upon the total amount and quality of habitat left in fragments, their degree of connectivity, and how they are affected by other human-induced perturbations such as climate change and invasive species. Long-term experiments will be even more needed to appreciate, explain, and predict long-term effects. New efforts should work in concert, coordinating a network of experiments across ecosystems and spatial extents.

The effects of current fragmentation will continue to emerge for decades. Extinction debts are likely to come due, although the counteracting immigration debts may never fully be paid. Indeed, the experiments here reveal ongoing losses of biodiversity and ecosystem functioning two decades or longer after fragmentation occurred. Understanding the relationship between transient and long-term dynamics is a substantial challenge that ecologists must tackle, and fragmentation experiments will be central for relating observation to theory.

Experimental results to date show that the effects of fragmentation are strong and markedly consistent across a diverse array of terrestrial systems on five continents. Increasingly, these effects will march in concert with other global changes. New experiments should be coupled with emerging technologies, landscape genetics, and detailed imagery of our planet, and should be coordinated with current ecological theory to understand more deeply the coupled dynamics of ecological and social systems. These insights will be increasingly critical for those responsible for managing and prioritizing areas for preservation and ecological restoration in fragmented landscapes.

## SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at <http://advances.sciencemag.org/cgi/content/full/1/2/e1500052/DC1>

Materials and Methods

Fig. S1. Map of the BDFFP experiment and location within Brazil.

Fig. S2. Map of the Kansas fragmentation experiment.

Fig. S3. Map of the Wog Wog experiment and location within Australia.

Fig. S4. Map of the SRS experiment showing locations of the eight blocks in the second SRS Corridor Experiment within the SRS, South Carolina, USA.

Fig. S5. Design of the Moss experiment.

Fig. S6. Design of the Metatron experiment with 48 enclosed fragments and adjoining enclosed corridors.

Fig. S7. Map of the SAFE experiment and location within Borneo [after Ewers *et al.* (68)].

Table S1. Metadata for Fig. 3 in the main text.

Table S2. Metadata for Fig. 4 in the main text.

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## Habitat fragmentation and its lasting impact on Earth's ecosystems

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## Review

# Biodiversity management in the face of climate change: A review of 22 years of recommendations

Nicole E. Heller\*, Erika S. Zavaleta

Environmental Studies Department, University of California, Santa Cruz, Santa Cruz, CA 95606, United States

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### ABSTRACT

Climate change creates new challenges for biodiversity conservation. Species ranges and ecological dynamics are already responding to recent climate shifts, and current reserves will not continue to support all species they were designed to protect. These problems are exacerbated by other global changes. Scholarly articles recommending measures to adapt conservation to climate change have proliferated over the last 22 years. We systematically reviewed this literature to explore what potential solutions it has identified and what consensus and direction it provides to cope with climate change. Several consistent recommendations emerge for action at diverse spatial scales, requiring leadership by diverse actors. Broadly, adaptation requires improved regional institutional coordination, expanded spatial and temporal perspective, incorporation of climate change scenarios into all planning and action, and greater effort to address multiple threats and global change drivers simultaneously in ways that are responsive to and inclusive of human communities. However, in the case of many recommendations the how, by whom, and under what conditions they can be implemented is not specified. We synthesize recommendations with respect to three likely conservation pathways: regional planning; site-scale management; and modification of existing conservation plans. We identify major gaps, including the need for (1) more specific, operational examples of adaptation principles that are consistent with unavoidable uncertainty about the future; (2) a practical adaptation planning process to guide selection and integration of recommendations into existing policies and programs; and (3) greater integration of social science into an endeavor that, although dominated by ecology, increasingly recommends extension beyond reserves and into human-occupied landscapes.

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\* Corresponding author: Present address: Climate Central, 95 Emerson Street, Palo Alto, CA 94301, United States. Tel.: +1 650 833 9049.

E-mail address: [heller.nicole@gmail.com](mailto:heller.nicole@gmail.com) (N.E. Heller).

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## 1. Introduction

Climate change poses major new challenges to biodiversity conservation. As atmospheric CO<sub>2</sub> increases over the next century, it is expected to become the first or second greatest driver of global biodiversity loss (Sala et al., 2000; Thomas et al., 2004). Global average temperatures have increased 0.2 °C per decade since the 1970s, and global average precipitation increased 2% in the last 100 years (IPCC, 2007a). Moreover, climate changes are spatially heterogeneous. Some locations, such as the Arctic, experience much larger changes than global means, while others are exposed to secondary effects like sea level rise (IPCC, 2007a). Climate change may have already resulted in several recent species extinctions (McLaughlin et al., 2002; Pounds et al., 2006). Many species ranges have moved poleward and upward in elevation in the last century (Parmesan and Yohe, 2003; Root et al., 2003) and will almost certainly continue to do so. Local communities are disaggregating and shifting toward more warm-adapted species (Parmesan, 2005). Phenological changes in populations, such as earlier breeding or peak in biomass, are decoupling species interactions (Walther et al., 2002).

These changes raise concerns about the effectiveness of existing biodiversity protection strategies (Halpin, 1997; Hannah et al., 2002; Peters and Darling, 1985; Scott et al., 2002). Biodiversity conservation relies predominately on fixed systems of protected areas, and the mandated goals of many conservation agencies and institutions are to protect particular species assemblages and ecosystems within these systems (Lemieux and Scott, 2005; Scott et al., 2002). With the magnitude of climate change expected in the current century, many vegetation types and individual species are expected to lose representation in protected areas (Araujo et al., 2004; Burns et al., 2003; Lemieux and Scott, 2005; Scott et al., 2002). Reserves at high latitudes and high elevations, on low-elevation islands and the coast, and those with abrupt landuse boundaries are particularly vulnerable (Sala et al., 2000; Shafer, 1999). Landscapes outside of protected areas are hostile to the survival of many species due to human infrastructure and associated stressors, such as invasive species, hunting, cars, and environmental toxins. Such fragmentation directly limits species migration and gene flow. Projected rates of climate change are also faster than they were in the past – so rapid that in situ genetic adaptation of most populations to new climate conditions is not likely

(Jump and Penuelas, 2005), nor is migration likely to be fast enough for many species (Davis and Shaw, 2001). Moreover, even if major global action reduced emissions significantly within the next years or capped them at year 2000 levels, the thermal inertia of the oceans will continue to drive climate change for decades and will require adaptive responses (Meehl et al., 2005; Wigley, 2005). A recent update of atmospheric CO<sub>2</sub> growth rate, which has more than doubled since the 1990s as global economic activity increases and becomes more carbon-intensive, makes clear that significant global emissions reductions are a distant goal at best (Canadell et al., 2007).

How should we modify our biodiversity protection strategies to deal with climate change? Here we focus on adaptation strategies. Adaptation is broadly defined as adjustment in human or natural systems, including structures, processes, and practices (IPCC, 2007b). Scientists have written about adaptation with increasing frequency over the last two decades, but developments in this area have progressed slowly. For years, emissions mitigation has largely been the only game in town, with little governmental or private support for climate change adaptation. For instance, the United States National Park Service (NPS) in collaboration with the Environmental Protection Agency (EPA) has created a ‘Climate Friendly Park’ program. It aims to reduce greenhouse gas emissions, but it does not include measures or incentives to park managers to build and test adaptation strategies to preserve biodiversity under climate change. In many ways, adaptation science has begun to develop only very recently in response to recent widespread acceptance by governments and private citizens of the certainty of climate change.

In this paper we review the growing, published literature specifically addressed at biodiversity management and adaptation in the face of climate change. We consider biodiversity to include all types of organisms at all scales, from genes to ecosystems. The genesis for our review was the 2006 annual meeting of the California Invasive Plant Council, where climate change was identified by both researchers and practitioners as a key issue for action. Discussions throughout the meeting, however, made clear that practitioners felt at a loss for practical steps to take. Managers working at local preserves were particularly uncertain about what, if anything, they could do to prepare for climate change. We use this review in order to highlight what actions and actors scientists have so far identified to address climate change, and to

explore how recommendations inform an adaptation planning process at various management scales. Scott and Lemioux (2005) reviewed a similar literature but focused on park management. Here we explore adaptation planning across scales and in both protected and unprotected areas.

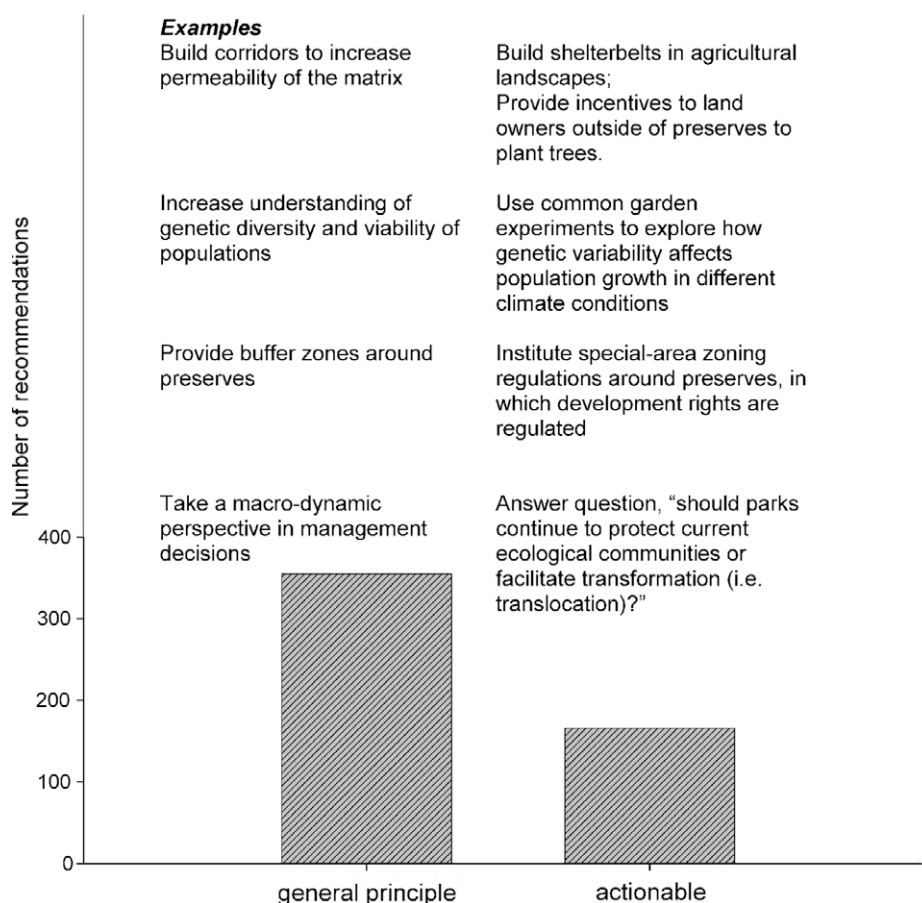
## 2. Methods

We used Web of Science, including Science Citation Index Expanded, Social Science Citation Index, and Arts and Humanities Citation databases from 1975 to March 2007, to search for published journal articles on climate change and biodiversity management. We used the search terms “climate change”, “global warming”, “climatic change”, “climate-change” and “changing climate” in all possible combinations with the search string “management OR biodiversity OR adaptation OR conservation OR restoration OR planning OR reserve design OR strategy OR land-use OR landuse OR landscape OR protected area OR park”. Articles that discussed strategies for both biodiversity and related ecosystem services were included, but we excluded articles that only addressed ecosystem services such as management strategies for carbon stocks, human infrastructure, and food security. We also did not attempt to review studies that explore climate

impacts on ecosystem components and processes without making explicit recommendations for biodiversity management. This literature is large and has been reviewed elsewhere (Kappelle et al., 1999; McCarty, 2001; Walther et al., 2002). From these searches, we identified and read 281 prospective articles, and from these culled those that provided explicit recommendations for management in the face of climate change. An additional four articles published after March 2007 were included, which were found through personal communication.

To analyze recommendations, we created a database in which we recorded every recommendation for action or information in the exact language used in the paper and answered a series of questions designed to synthesize recommendations and identify biases in the literature to date. We asked:

- (1) *In what formal and informal contexts does action need to occur?* To answer this question, we categorized recommendations into broad spheres of activity: (1) policy reform, (2) science and technology effort and advances, (3) changes in conservation sector activity including restoration, or (4) changes in individual and community behavior, such as by farmers, ranchers, and other private landowners.



**Fig. 1 – Examples and distribution of recommendations classified as “general principle” and “actionable”. Most recommendations offer general principles for climate change adaptation but lack specificity needed for implementation.**

- (2) *What is the basis for the recommendation?* We recorded what information an author used to formulate their recommendation. Categories included empirical experimental data, simulation, literature review, case studies, interviews, or workshops. We also included the term ‘ecological reasoning’ to encompass studies based predominately on theory and opinion.
- (3) *Is the recommendation a general principle or actionable?* A recommendation was considered a “general principle” if it provided a guiding concept, such as “build flexibility”, but was generic open-ended and without example of who should act or what one should do (see Fig. 1). “Actionable” was given to those recommendations that identified a very clear who and what and often gave examples, such as, “[in restoration] use a broader range of species than prescribed solely on local basis to build system resilience (Harris et al., 2006)”.
- (4) *Is the recommendation for biodiversity or for biodiversity and related ecosystem services?*
- (5) *Is there a geographic context for the recommendation?*
- (6) *Does the article focus on a biome or ecosystem-type?*
- (7) *Where in the landscape would the recommendation apply?* We categorized recommendations as applying to reserve (any public or private land-holding dedicated to biodiversity protection and maintenance, synonymous with protected area), or human-use lands (the matrix), or non-specific, meaning the recommendation could be enacted in either reserve or matrix land.
- (8) *Does the recommendation describe an information need or a necessary action?* All recommendations for research were categorized as information needs, while the ‘action’ category included recommendations such as building corridors, reforming policy or buying more land.

To minimize variation in how articles were classified as a function of when they were read (i.e. the 1st paper entered compared to the 100th), records in the database were periodically shuffled by different criteria (i.e. year published or geographic context) and then re-classified. In addition, both authors coded a sub-sample of recommendations. After compiling the database, similar records were grouped into ‘recommendation’ categories. We tabulated the most common recommendations and ranked them by frequency cited overall.

### 3. Results and discussion

We recorded 524 recommendations from 113 papers, published in 57 different source journals and three books. Recommendations ranged from calls for specific types of modeling (e.g. inexact-fuzzy multiobjective programming (Huang et al., 1998) to broad shifts in governance structures (Tompkins and Adger, 2004) (Table 1). The number of papers published on this topic has increased dramatically in recent years (Fig. 2). Thirty-three percent of recommendations addressed biodiversity protection in conjunction with related ecosystem services, including forest products, fisheries and hunting, agriculture and grazing, and human health. Recommendations call for research, leadership and reform by a

range of actors in several sectors; Emphasis in this set of literature is on science and nature conservation rather than on social or political adaptation measures (Fig. 3), with an emphasis somewhat more focused on reserve land over the matrix (Fig. 4a). Action is weighted more than information needs (Fig. 4b). When information needs were identified, they were overwhelmingly calls for more ecological rather than social scientific data (Fig. 4c). Recommendations are biased toward North America and Europe (Fig. 5a) and forests ecosystems (Fig. 5b).

Recommendations address various stages in an adaptation process, from research needs to methods for impact assessments to large-scale changes in policies by governmental, academic or non-governmental institutions (Table 1). About 70% of recommendations were classified as general principles under our classification scheme rather than specific, actionable strategies or tactics (Fig. 1). For example, seven authors suggest flexibility in management approaches, but only Millar et al. (2007) suggest flexibility and follow with a definition of what that means: willingness to change course, risk-taking including doing nothing, and capacity to reassess conditions frequently. Climate change adaptation work, at least in this literature, is still largely at the “idea” stage – it is based predominately on ecological reasoning rather than specific research, case studies, or empirical data (Fig. 5c), and it is largely nonspecific in the geographic areas or biome types that it targets (Fig. 5a and b). Many articles based on concrete modeling work or empirical studies of species responses to climate change tended either to not elaborate their results to management directives, or to present recommendations in vague terms such as, “restoration should be considered”. Alternatively, very specific recommendations were proposed and not generalized for use outside of the target system. There appears to be a need for a happy medium between highly specific recommendations useful only in target areas and highly generalized recommendations that fail to inspire application (Halpin, 1997). This happy medium is likely to emerge rapidly as climate change adaptation science grows.

In the literature reviewed here, few recommendations suggested a process a manager could use to develop an adaptation plan and evaluate its usefulness (but see Hannah et al., 2002). More information on adaptation frameworks are developed in reports by Parks Canada (Welch, 2005), the NCEAS Conservation and Climate Change Working Group 2 (personal communication), and England’s Department for Food Environment and Rural Affairs (<http://www.defra.gov.uk/wildlife-countryside/resprog/findings/ebs-climate-change.pdf>), which were not reviewed here. In practice, planners and managers could apply recommendations in at least three ways. At the broadest scale, long-term planning and policy formulation should tackle adaptation for whole landscapes and regions, with tools like reserve selection, ecosystem management, and landuse zoning schemes. Second, managers of individual reserves might want to know what they can do at their sites, individually or in concert with other sites. Third, rather than initially pursuing an idealized regional, landscape, or site-scale plan, the first practical step for many managers, conservation stakeholders and policymakers is to evaluate and adapt existing conservation plans. In the following

**Table 1 – List of recommendations for climate change adaptation strategies for biodiversity management assembled from 112 scholarly articles. 524 records were condensed into 113 recommendation categories and are ranked by frequency of times cited in different articles.**

Rank	Recommendation	No. articles	References
1	Increase connectivity (design corridors, remove barriers for dispersal, locate reserves close to each other, reforestation)	24	Beatley (1991), Chambers et al. (2005), Collingham and Huntley (2000), Da Fonseca et al. (2005), de Dios et al. (2007), Dixon et al. (1999), Eeley et al. (1999), Franklin et al. (1992), Guo (2000), Halpin (1997), Hulme (2005), Lovejoy (2005), Millar et al. (2007), Morecroft et al. (2002), Noss (2001), Opdam and Wascher (2004), Rogers and McCarty (2000), Schwartz et al. (2001), Scott et al. (2002), Shafer (1999), Welch (2005), Wilby and Perry (2006) and Williams (2000)
2	Integrate climate change into planning exercises (reserve, pest outbreaks, harvest schedules, grazing limits, incentive programs)	19	Araujo et al. (2004), Chambers et al. (2005), Christensen et al. (2004), Dale and Rauscher (1994), Donald and Evans (2006), Dyer (1994), Erasmus et al. (2002), Hulme (2005), LeHouerou (1999), McCarty (2001), Millar and Brubaker (2006), Peters and Darling (1985), Rounsevell et al. (2006), Scott and Lemieux (2005), Scott et al. (2002), Soto (2001), Staple and Wall (1999), Suffling and Scott (2002) and Welch (2005)
3	Mitigate other threats, i.e. invasive species, fragmentation, pollution	17	Bush (1999), Chambers et al. (2005), Chornesky et al. (2005), Da Fonseca et al. (2005), de Dios et al. (2007), Dixon et al. (1999), Halpin (1997), Hulme (2005), McCarty (2001), Noss (2001), Opdam and Wascher (2004), Peters and Darling (1985), Rogers and McCarty (2000), Shafer (1999), Soto (2001), Welch (2005) and Williams (2000)
4	Study response of species to climate change physiological, behavioral, demographic	15	Alongi (2002), Chambers et al. (2005), Crozier and Zabel (2006), Dyer (1994), Erasmus et al. (2002), Fukami and Wardle (2005), Gillson and Willis (2004), Honnay et al. (2002), Hulme (2005), Kappelle et al. (1999), McCarty (2001), Mulholland et al. (1997), Noss (2001), Peters and Darling (1985) and Swetnam et al. (1999)
	Practice intensive management to secure populations	15	Bartlein et al. (1997), Buckland et al. (2001), Chambers et al. (2005), Chornesky et al. (2005), Crozier and Zabel (2006), Dixon et al. (1999), Dyer (1994), Franklin et al. (1992), Hulme (2005), Morecroft et al. (2002), Peters and Darling (1985), Soto (2001), Thomas et al. (1999), Williams (2000) and Williams et al. (2005)
	Translocate species	15	Bartlein et al. (1997), Beatley (1991), Chambers et al. (2005), de Dios et al. (2007), Halpin (1997), Harris et al. (2006), Honnay et al. (2002), Hulme (2005), Millar et al. (2007), Morecroft et al. (2002), Pearson and Dawson (2005), Peters and Darling (1985), Rogers and McCarty (2000), Schwartz et al. (2001), Shafer (1999) and Williams et al. (2005)
5	Increase number of reserves	13	Burton et al. (1992), Dixon et al. (1999), Hannah et al. (2007), Hughes et al. (2003), LeHouerou (1999), Lovejoy (2005), Peters and Darling (1985), Pyke and Fischer (2005), Scott and Lemieux (2005) (2007), van Rensburg et al. (2004), Wilby and Perry (2006) and Williams et al. (2005)
6	Address scale problems match modeling, management, and experimental spatial scales for improved predictive capacity	12	Chornesky et al. (2005), Da Fonseca et al. (2005), Dale and Rauscher (1994), Ferrier and Guisan (2006), Guisan and Thuiller (2005), Huang (1997), Hughes et al. (2003), Kueppers et al. (2004), Kueppers et al. (2005), Mulholland et al. (1997), Noss (2001), Root and Schneider (1995) and Root and Schneider (2006)
	Improve inter-agency, regional coordination	12	Bartlein et al. (1997), Cumming and Spiesman (2006), Da Fonseca et al. (2005), Grumbine (1991), Hannah et al. (2002), Lemieux and Scott (2005), Rounsevell et al. (2006), Scott and Lemieux (2005), Soto (2001), Suffling and Scott (2002), Tompkins and Adger (2004) and Welch (2005)
7	Increase and maintain basic monitoring programs	11	Chambers et al. (2005), Cohen (1999), Huang (1997), Rogers and McCarty (2000), Root and Schneider (1995), Schwartz et al. (2001), Shafer (1999), Staple and Wall (1999), Suffling and Scott (2002), Wilby and Perry (2006) and Williams (2000)
	Practice adaptive management	11	Allison et al. (1998), Chambers et al. (2005), Hulme (2005), Lasch et al. (2002), Maciver and Wheaton (2005), Millar et al. (2007), Scott and Lemieux (2005), Staple and Wall (1999), Suffling and Scott (2002), Tompkins and Adger (2004) and Welch (2005)
	Protect large areas, increase reserve size	11	Beatley (1991), Bellwood and Hughes (2001), Burton et al. (1992), Bush (1999), Halpin (1997), Hulme (2005), Morecroft et al. (2002), Peters and Darling (1985), Shafer (1999), Soto (2001) and Watson (2005)



Table 1 – continued

Rank	Recommendation	No. articles	References
8	Create and manage buffer zones around reserves	10	Bush (1999), de Dios et al. (2007), Halpin (1997), Hannah et al. (2002), Hartig et al. (1997), Hughes et al. (2003), Millar et al. (2007), Noss (2001), Shafer (1999) and van Rensburg et al. (2004)
9	Create ecological reserve networks large reserves, connected by small reserves, stepping stones	8	Allison et al. (1998), Collingham and Huntley (2000), de Dios et al. (2007), Gaston et al. (2006), Opdam et al. (2006), Opdam and Wascher (2004), Shafer (1999) and Welch (2005)
	Develop improved modeling and analysis capacity i.e. more effective software, integration with GIS, integrate greater complexity	8	Chornesky et al. (2005), Ferrier and Guisan (2006), Guisan and Thuiller (2005), Guo (2000), Huang et al. 1998, Mulholland et al. (1997), Peters and Darling (1985) and Rounsevell et al. (2006)
	Do integrated study of multiple global change drivers	8	Dale and Rauscher (1994), Desanker and Justice (2001), Donald and Evans (2006), Halpin (1997), Hannah et al. (2002), McCarty (2001), Watson (2005) and Williams (2000)
	Improve techniques for and do more restoration wetlands, rivers, matrix	8	Da Fonseca et al. (2005), de Dios et al. (2007), Dyer (1994), Hartig et al. (1997), Lovejoy (2005), Millar et al. (2007), Mulholland et al. (1997) and Shafer (1999)
	Increase interdisciplinary collaboration	8	Gillson and Willis (2004), Guisan and Thuiller (2005), Hannah et al. (2002), Hulme (2005), Kappelle et al. (1999), Root and Schneider 1995, Soto (2001) and Williams (2000)
	Promote conservation policies that engage local users and promote healthy human communities	8	Chapin et al. (2006), Desanker and Justice (2001), Eeley et al. (1999), Lovejoy (2005), Opdam and Wascher (2004), Ramakrishnan (1998), Tompkins and Adger (2004) and McClanahan et al. (2008)
	Protect full range of bioclimatic variation	8	Bush (1999), Eeley et al. (1999), McCarty (2001), Noss (2001), Pyke et al. (2005), Pyke and Fischer (2005), Shafer (1999) and Thomas et al. (1999)
	Soften landuse practices in the matrix	8	Beatley (1991), Burton et al. (1992), Da Fonseca et al. (2005), Franklin et al. (1992), Hannah et al. (2002), Noss (2001), Williams (2000) and Woodwell (1991)
10	Adopt long-term and regional perspective in planning, modeling, and management	7	Eeley et al. (1999), Ferrier and Guisan (2006), Franklin et al. (1992), Guo (2000), Lovejoy (2005), Millar and Brubaker (2006), Opdam and Wascher (2004), Peters and Darling (1985), Peterson et al. (1997), Scott et al. (2002) and Welch (2005)
	Re-asses conservation goals (i.e. move away from concepts of natural, embrace processes over patterns)	7	Franklin et al. (1992), Hulme (2005), Millar et al. (2007), Scott and Lemieux (2005) (2007), Scott et al. (2002) and Suffling and Scott (2002)
	Study species dispersal across landuse boundaries, gene flow, migration rates, historic flux	7	Guo (2000), Halpin (1997), Hughes et al. (2003), Kappelle et al. (1999), Lovejoy (2005), Opdam and Wascher (2004) and Rice and Emery (2003)
	Study species distributions current and historic	7	Da Fonseca et al. (2005), Eeley et al. (1999), Erasmus et al. (2002), Guo (2000), Hannah et al. (2002), Kappelle et al. (1999) and Millar and Brubaker (2006)
11	Broaden genetic and species diversity in restoration and forestry	6	Burton et al. (1992), de Dios et al. (2007), Harris et al. (2006), Maciver and Wheaton (2005), McCarty (2001), Millar et al. (2007), Rice and Emery (2003) and Staple and Wall (1999)
	Develop adaptation strategies now; early adaptation is encouraged	6	Huang et al. (1998), Hulme (2005), Lemieux and Scott (2005), Scott and Lemieux (2005) (2007) and Welch (2005)
	Do not implement CO <sub>2</sub> emission mitigation projects that negatively impact biodiversity	6	Chambers et al. (2005), Klooster and Masera (2000), Koziell and Swingland (2002), Kueppers et al. (2004) and Streck and Scholz (2006), Welch (2005)
	Manage for flexibility, use of portfolio of approaches, maintain options	6	Eeley et al. (1999), Hulme (2005), Kappelle et al. (1999), Lovejoy (2005), Millar et al. (2007) and Welch (2005)
	Validate model results with empirical data	6	Dale and Rauscher (1994), Guisan and Thuiller (2005), Hulme (2005), Malcom et al. (2006), Opdam and Wascher (2004) and Watson (2005)
12	Do regional impact assessments	5	Cohen (1999), Desanker and Justice (2001), Lasch et al. (2002), Lindner et al. (1997) and Suffling and Scott (2002)
	Identify indicator species	5	Chambers et al. (2005), Hulme (2005), Noss (2001), Underwood and Fisher (2006) and Welch (2005)
	Initiate long-term studies of species responses to climate	5	Mulholland et al. (1997), Noss (2001), Opdam and Wascher (2004), Peters and Darling (1985) and Root and Schneider (2006)
	Model species ranges in the future	5	Allison et al. (1998), Da Fonseca et al. (2005), Hannah et al. (2002), Kerr and Packer (1998) and Kriticos et al. (2003)
	Protect refugia current and predicted future	5	Bush (1999), Chambers et al. (2005), Eeley et al. (1999), Noss (2001) and Scott et al. (2002)
	Study adaptive genetic variation	5	Harris et al. (2006), Hughes et al. (2003), Jump and Penuelas (2005), Kappelle et al. (1999) and Rice and Emery (2003)

(continued on next page)



Table 1 – continued

Rank	Recommendation	No. articles	References
13	Leadership by those with power senior management, government agencies	4	Scott and Lemieux (2005) (2007), Tompkins and Adger (2004) and Welch (2005)
	Limit CO <sub>2</sub> emissions	4	Hannah et al. (2007), Hannah et al. (2005), Mayer and Rietkerk (2004) and Rogers and McCarty (2000)
	Predict effects of directional climate change on ecosystems, communities, populations	4	Allison et al. (1998), de Dios et al. (2007), Kappelle et al. (1999) and Root and Schneider (2006)
	Preserve genetic diversity in populations	4	Chambers et al. (2005), de Dios et al. (2007) and Lovejoy (2005), Noss (2001)
	Represent each species in more than one reserve	4	Halpin (1997), Millar et al. (2007), Peters and Darling (1985) and Shafer (1999)
14	Create culturally appropriate adaptation/management options	3	Dixon et al. (1999), Huang (1997), Tompkins and Adger (2004)
	Create education programs for public about landuse practices and effects on and with climate	3	Bush (1999) and Welch (2005), Williams (2000)
	Develop best management practices for climate change scenarios	3	Mulholland et al. (1997), Rogers and McCarty (2000) and de Dios et al. (2007)
	Institute flexible zoning around reserves	3	Halpin (1997), Peters and Darling (1985) and Soto (2001)
	Increase investment in climate related research	3	Lemieux and Scott (2005), Lovejoy (2005) and Peters and Darling (1985)
	Increase communication of knowledge about climate change impacts to policymakers and stakeholders	3	Erasmus et al. (2002), Opdam and Wascher (2004) and Welch (2005)
	Initiate dialogue among stakeholders	3	McKenzie et al. (2004), Rogers and McCarty (2000) and Scott et al. (2002)
	Institute government reform (i.e. adaptive governance)	3	Chapin et al. (2006), Tompkins and Adger (2004) and Williams (2000)
	Locate reserves in areas of high heterogeneity, endemism	3	Halpin (1997), Opdam and Wascher (2004) and Peters and Darling (1985)
	Maintain natural disturbance dynamics of ecosystems	3	Halpin (1997), Noss (2001) and Shafer (1999)
	Practice proactive management of habitat to mitigate warming	3	Halpin (1997), Mulholland et al. (1997) and Wilby and Perry (2006)
	Secure boundaries of existing preserves	3	Hannah et al. (2007), van Rensburg et al. (2004) and Welch (2005)
	Start strategic zoning of landuse to minimize climate related impacts	3	Bush (1999), Solecki and Rosenzweig (2004) and Tompkins and Adger (2004)
	Study and monitor ecotones and gradients	3	Halpin (1997), Lovejoy (2005) and Stohlgren et al. (2000)
	Study effectiveness of corridors	3	Graham 1988, Halpin (1997) and Williams et al. (2005)
Use predictive models to make decisions on where to situate new reserves	3	Bush (1999), Hannah et al. (2007) and Pearson and Dawson (2005)	
15	Anticipate surprises and threshold effects i.e. major extinctions or invasions	2	Bartlein et al. (1997) and Millar et al. (2007)
	Design biological preserves for complex changes in time, not just directional change	2	Bartlein et al. (1997) and Graham (1988)
	Locate reserves at northern boundary of species' ranges	2	Peters and Darling (1985) and Shafer (1999)
	Manage the matrix	2	Eeley et al. (1999) and Lovejoy (2005)
	Practice proactive research on climate change	2	Harris et al. (2006) and Williams (2000)
	Protect many small reserves rather than single large	2	Opdam and Wascher (2004) and Pearson and Dawson (2005)
	Provide education opportunities and summaries of primary literature for management staff to learn and network about climate change	2	Grumbine (1991) and Welch (2005)
	Study and protect metapopulations	2	Crozier and Zabel (2006) and Opdam and Wascher (2004)
	Study processes of change at multiple spatial and temporal scales	2	Dale and Rauscher (1994) and Watson (2005)
	Use GIS to study species distributions and landscape patterns	2	Brown (2006) and Da Fonseca et al. (2005)

Table 1 – continued

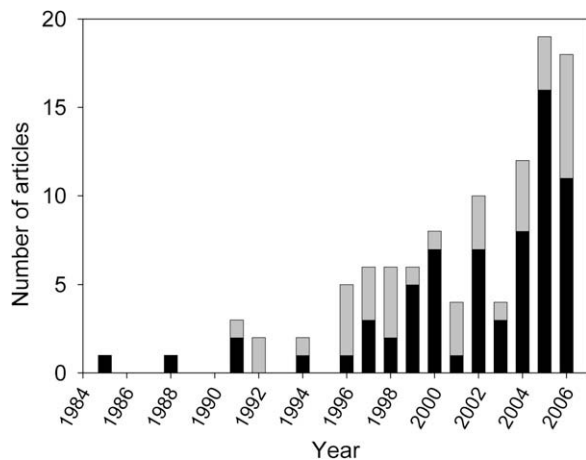
Rank	Recommendation	No. articles	References
16	Action plans must be time-bound and measurable	1	Welch (2005)
	Adjust park boundaries to capture anticipated movement of critical habitats	1	Welch (2005)
	Create institutional flexibility	1	Millar et al. (2007)
	Create linear reserves oriented longitudinally	1	Pearson and Dawson (2005)
	Establish cross-national collaboration	1	Desanker and Justice (2001)
	Establish neo-native forests plant species where they were in the past, but are not found currently	1	Millar et al. (2007)
	Experiment with refugia	1	Millar et al. (2007)
	Focus protection on sensitive biomes	1	Scott et al. (2002)
	Focus on annual plants rather than perennials near climate boundaries	1	Buckland et al. (2001)
	Increase wetland protection	1	Hartig et al. (1997)
	Institutional capacity enhancement to address climate change	1	Lemieux and Scott (2005)
	Institute reform to improve support for interdisciplinary, multi-institutional research	1	Root and Schneider (1995)
	Locate reserves so major vegetation transitions are in core	1	Halpin (1997)
	Locate reserves at core of ranges	1	Araujo et al. (2004)
	Manage for landscape asynchrony	1	Millar et al. (2007)
	Manage human-wildlife conflict as change occurs	1	Wilby and Perry (2006)
	Manage populations to reduce temporal fluctuations in population sizes	1	Rice and Emery (2003)
	Develop guidelines for climate sensitive restoration and infrastructure development	1	Welch (2005)
	Need to increase social acceptance of shared resilience goals	1	Tompkins and Adger (2004)
	Promote personal action plans among employees to reduce emissions	1	Welch (2005)
	Protect endangered species ex situ	1	Noss (2001)
	Protect functional groups and keystone species	1	Noss (2001)
	Protect mountains	1	Peterson et al. (1997)
	Protect primary forests	1	Noss (2001)
	Protect urban green space	1	Wilby and Perry (2006)
	Quantify environmental susceptibility versus adaptive capacity to inform conservation planning	1	McClanahan et al. (2008)
	Schedule dam releases to protect stream temperatures	1	Rogers and McCarty (2000)
	Study changes in populations at rear of range rather than only range fronts	1	Willis and Birks (2006)
	Study response of undisturbed areas to climate change	1	Mulholland et al. (1997)
	Study social agency and human decision making	1	Desanker and Justice (2001)
	Study time-series data on species dynamics	1	Erasmus et al. (2002)
	Substitute space for time to study the responses of species to climate change	1	Millar and Brubaker (2006)
	Train more taxonomists	1	Huber and Langor (2004)
	Use caution in predictive modeling because the responses of some species are not well predicted	1	Willis and Birks (2006)
	Use simple decision rules for reserve planning	1	Meir et al. (2004)
	Use social networks for education about climate change	1	Huang (1997)
	Use triage in short-term to prioritize action	1	Millar et al. (2007)

sections, we discuss how recommendations in the literature to date inform these three scales of application.

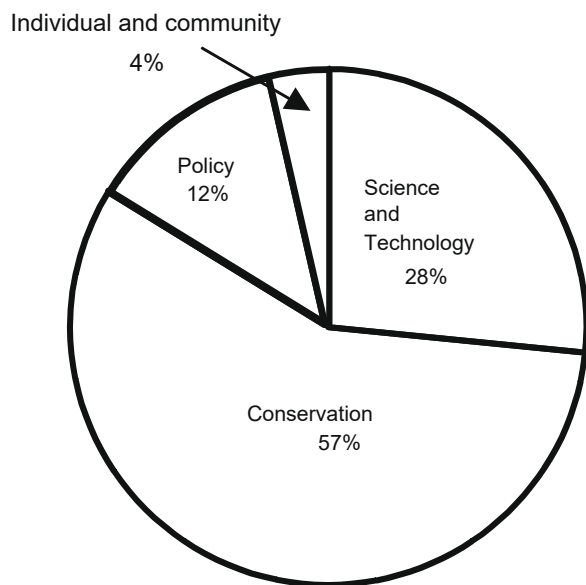
#### 4. Regional policy and planning

Species historically respond to changing climate with distributional shifts, and many species are expected to lose current habitat representation in the future. In light of this, many recommendations call for greater integration of species protection plans, natural resource management, research and development agendas across wider geographic areas, on long-

er time-scales, and involving more diverse actors than in current practice. (1) Long-term, regional perspective and (2) improved coordination among scientists, land managers, politicians and conservation organizations at regional scales are among the most frequently cited recommendations to protect biodiversity in the face of climate change (Rank 10 and 6 respectively, see references in Table 1 and for all ranks mentioned hereafter). Increased interdisciplinary collaboration (Rank 9) as well as regional-scale impact assessments are also frequently identified (Rank 12). Recommendations for adaptation to regional policy and planning focus on two comple-



**Fig. 2 – Frequency distribution by publication year of papers included in this review, including articles addressing biodiversity only (black) or biodiversity in conjunction with ecosystem services (grey). Records from 2007 were only partially covered in this review and not included.**



**Fig. 3 – Distribution of recommendations calling for climate change adaptation among different activity sectors: conservation (e.g. reserve purchases, management, restoration and regional coordination), science and technology (e.g. research and modeling), policy (e.g. land-zoning, governance structure and institutional capacity), and individuals and communities (e.g. private landowner practices and grassroots action). Recommendations were counted in all applicable sectors.**

mentary strategies: reserve planning and improving landscape connectivity. We discuss these issues further in the following two sections.

#### 4.1. Reserve planning

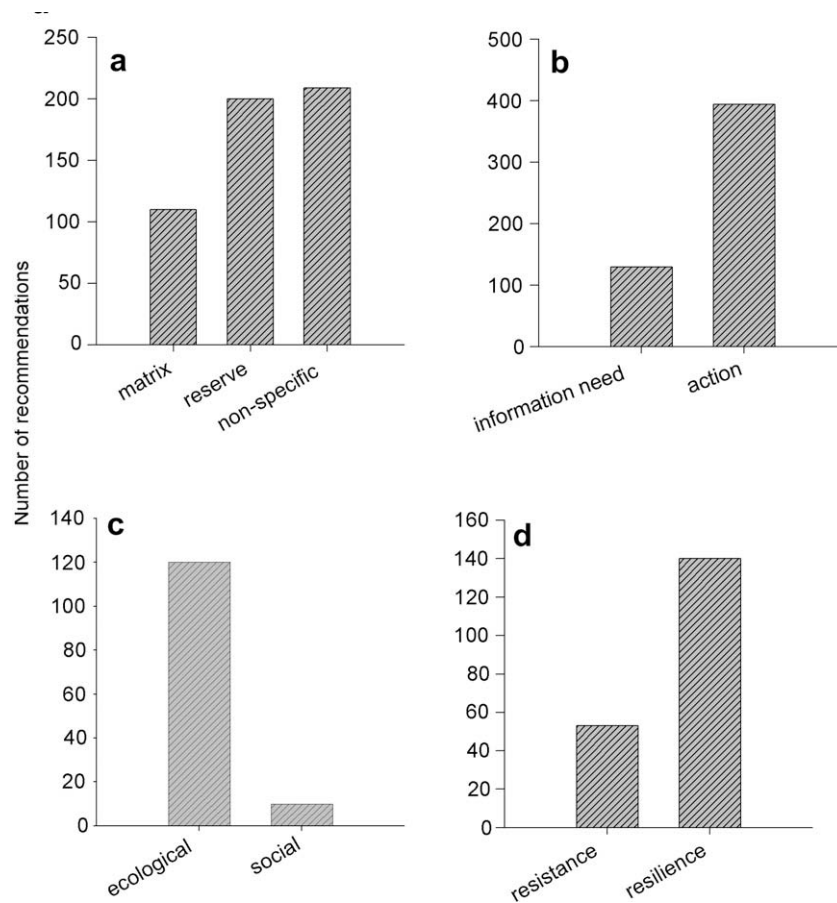
Basing reserve acquisition priorities on predictions of future biome, community or individual species distributions under

different climate scenarios is one method for climate change adaptation. The guiding principle is that reserves should be accumulated in areas predicted to be hotspots for biodiversity in the future or to provide habitat for species of high conservation value, warranting increased effort to model species distributions in the future (Rank 12). There are, however, several limitations to the accuracy and precision of simulation and analytical models of future species, biome or community distributions, leading some authors to recommend improved modeling capacity as the first step (Rank 9).

Model prediction error results from variation in model types, emissions, landuse and socio-economic scenarios. There are little-understood, but important, interactions between climate change and other global change drivers that could influence where species and habitats occur in the future (Rank 9). Insufficient data on species distributions (Rank 10) the effects of species interactions on distribution (Ferrier and Guisan, 2006; Kappelle et al., 1999), dispersal (Rank 10) and species, community or ecosystem responses to climate change (Rank 4) are also widely expressed concerns and lead authors to advocate for increased research in these areas before models are accepted. For example, bioclimatic envelope modeling uses current species distributions to predict future distributions as a function of climate. For many species such models can be productive, but in cases where species distributions are limited by factors other than climate, this extrapolation will prove misleading. Willis and Birks (2006) discuss the accuracy of bioclimatic models. Species-envelope model runs were conducted for backward predictions of species distributions and compared to paleo-ecological records. Many species distributions were predicted well, but some were largely inaccurate.

Problems of scaling also raise uncertainty (Rank 6), including scaling-down global climate models (GCMs) to fit management scales, or scaling-up empirical observations typically made at small spatial scales to predict larger scale processes (Root and Schneider, 1995). The scales of global climate models (GCM) and management activities simply do not match. Most reserves are smaller than a single grid cell in a GCM. Climate can vary sharply within this scale, and this variation often drives local patterns of species distribution and abundance – particularly in mountainous or coastal areas. Regional climate models, which are only available for small areas of the globe, are a more appropriate choice for management and planning (Dale and Rauscher, 1994; Guisan and Thuiller, 2005; Kueppers et al., 2005; Mulholland et al., 1997), though they remain limited by key uncertainties, assumptions and costs (Root and Schneider, 1995).

Not surprisingly, these inherent limitations of bioclimatic envelope models generate debate about whether and how to apply them to reserve selection. Some strongly advocate including climate change in reserve selection models and locating new reserves with expected changes in climate (Araujo et al., 2004; Bush, 1996; Dyer, 1994; Pearson and Dawson, 2005). Araujo et al. (2004) compare the ability of six existing reserve selection methods to secure European plant species in the context of climate change. They found species loss from protected reserves on the order of 6–11% of taxa for all models, and they conclude that new reserve-selection models specific to climate change are needed. Hannah et al. (2007)



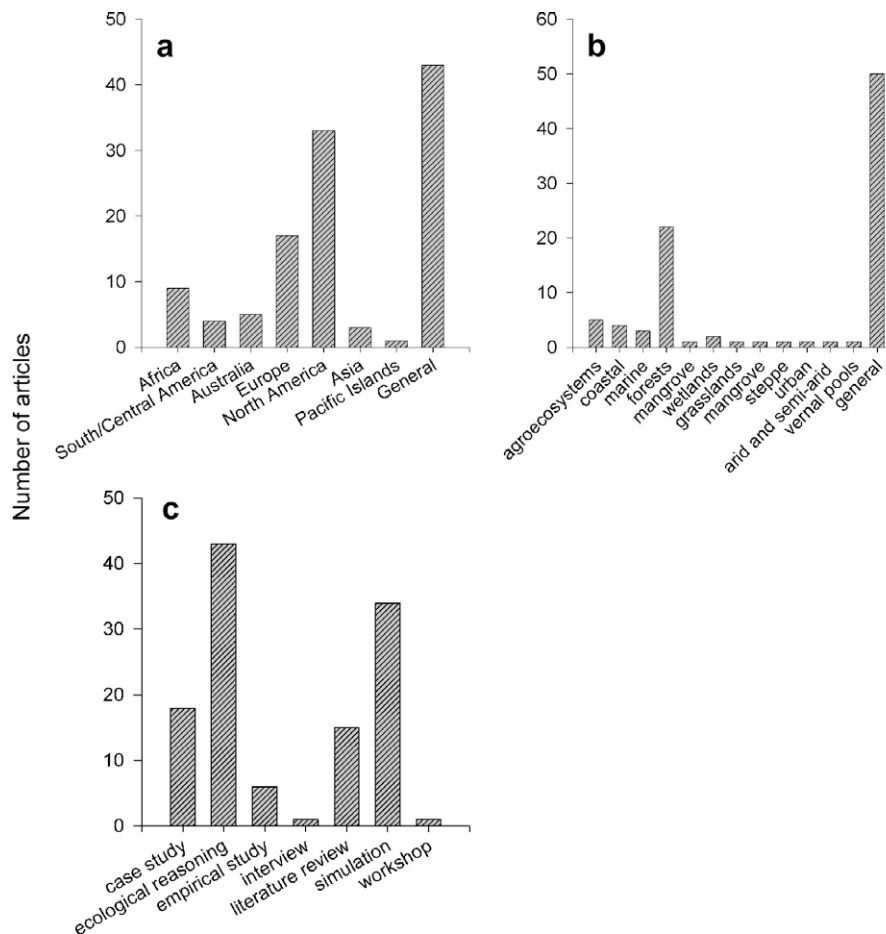
**Fig. 4 – Distribution of recommendations among broad categories referring to (a) type of land targeted, (b) information need or action, (c) type of information need, and (d) management goal. Y-axis ranges vary across graphs because not all recommendations fit into every set of categories.**

make a compelling case for not waiting to incorporate climate change forecasts into reserve selection models despite uncertainty. They use bioclimatic envelope models to explore the need for additional protected areas to achieve representation for thousands of species in three regions (Mexico, South Africa Cape, and Europe) in current and future climate and find that less land is needed in the long-term if planning models are designed to solve for both current and future conditions simultaneously.

Others argue, however, that given tremendous uncertainty, the priority should be to acquire new reserves in locations that minimize the spatial distances among new and existing reserves so that species can migrate (Allison et al., 1998; Collingham and Huntley, 2000; Halpin, 1997; Opdam and Wascher, 2004; Shafer, 1999). Williams et al. (2005) used a simulation model to estimate that 50% more protected land area in particular locations was needed to create reserve corridors to protect *Proteaceae* in the South African Cape region through 2050. Citing a number of sources of potential error in model results, however, they recommend that as much reserve area as possible be set aside. Such strategies do not require extensive modeling capacity and resources and instead focus on rapid acquisition of land as it becomes available to create porous landscapes. Other authors reason that to facilitate migration and adaptation potential, reserves should be

located with reference to focal species or community distributions, such as in their cores (Araujo et al., 2004; Halpin, 1997) or at their northern boundaries (Peters and Darling, 1985; Shafer, 1999). There seems to be little consensus or data to inform this debate. More research is needed about where in a species' range individuals are most likely to survive, migrate or adapt to rapid environmental change (Willis and Birks, 2006).

Debate also arises around the relative advantages of few large versus several small reserves in the context of climate change. The tension is whether large reserves will be large enough to allow species to track changing climate and remain inside reserve boundaries, and whether small preserves along latitudinal, elevational or other climate gradients will be close enough together for species to move between them. Eleven sources recommend protecting large areas (Beatley 1991; Bellwood and Hughes 2001; Burton et al. 1992; Bush 1996; Halpin 1997; Hulme 2005; Morecroft et al. 2002; Peters and Darling 1985; Shafer 1999; Soto 2001; Watson 2005), while two advocate focusing on many small areas (Opdam and Wascher, 2004; Pearson and Dawson, 2005). Eight suggest a compromise strategy of creating ecological networks of small and large reserves embedded within intermediate land uses (Allison et al., 1998; Collingham and Huntley, 2000; de Dios et al., 2007; Gaston et al., 2006; Opdam et al., 2006; Opdam and Wascher, 2004; Shafer, 1999; Welch, 2005).



**Fig. 5 – The (a) geographic focus, (b) biome focus, and (c) evidence basis for recommendations addressing climate change adaptation strategies for biodiversity management.**

What all of the recommendations for reserve selection share is an urge to protect more land rapidly (Rank 5). This push will certainly help buffer biodiversity against climate change as well as other threats. However, climate change is likely to exacerbate existing tensions and tradeoffs between protecting areas and meeting basic human needs. Creating more new reserves might be feasible in some settings but must be guided by targeted, well-informed strategies likely to maximize effectiveness in the face of climate change. In most areas, action in lands outside of reserves must also be a part of climate change strategies for biodiversity conservation (Franklin et al., 1992; Lovejoy, 2005).

#### 4.2. Landscape connectivity

To improve landscape connectivity, so that species can move, is the most frequent recommendation for climate change adaptation in the literature reviewed here (Rank 1). Authors recommend some form of corridor creation via the designation of new parks (de Dios et al., 2007; Halpin, 1997; Scott et al., 2002) oriented longitudinally (Eeley et al., 1999; Noss, 2001; Shafer, 1999), or through actions in non-reserve land, such as protecting riparian habitat and railway lines in cities (Wilby and Perry, 2006), or by planting trees and shrubs to cre-

ate shelterbelts and hedgerows in farmlands (Donald and Evans, 2006; Guo, 2000; Schwartz et al., 2001). There was little guidance in this literature set for corridor implementation beyond common-sense reasoning, however. Illustrative examples of current corridor projects or elaboration of specific ecological or political tactics for corridor creation might help jump-start this process. For example, case studies of the Dutch Ecological Network and other similar national models to plan and link protected areas may be particularly informative at this stage of adaptation planning (Gaston et al., 2006). Further, despite widespread favor for ecological networks, assessment of their effectiveness remains in its infancy. Similarly, the field of corridor ecology, while recognized as integral to conservation practice in fragmented landscapes for years, is still young (see Hilty et al., 2006). Some authors warn of a significant need for more empirical data to support the effectiveness of corridors, optimize their spatial arrangement, and minimize risks of increased transmission of disease or invasive species before the conservation community embraces corridors uniformly as the tool to combat biodiversity loss in the face of global climate change (Graham, 1988; Halpin, 1997; Scott and Lemieux, 2005; Williams et al., 2005).

A second popular recommendation for improving landscape connectivity is to change how we manage the matrix



(Da Fonseca et al., 2005; Eeley et al., 1999; Lovejoy, 2005). Many authors advocate creating buffer zones around reserves (Rank 8) or flexible landuse zoning at reserve boundaries to allow for land swaps in the future as species distributions shift (Rank 14). Others recommend urban planning and zoning to avoid climate-related risks (Rank 14). In general, enlisting people and human communities to ‘soften’ landuse through sustainable or less damaging practices (e.g. low intensity forestry or alternatives to building sea walls) (Rank 9) and to restore habitat (Rank 9) will facilitate species movement and persistence in the future.

Despite wide acknowledgement, these connectivity strategies were among the most poorly developed recommendations, limited mainly to very general actions (e.g. “build flexibility”, “manage the matrix”, “modify landuse practices”) without identification of kinds of actors that might need to be involved (e.g. reserve managers, policymakers, individuals) or information gaps. Landuse reform likely needs to bring together local governments, urban planners, community groups and conservation organizations and to involve high degrees of coordination across multiple jurisdictions to provide landscape cohesion (Press et al., 1995). Substantial work to flesh out this process, as well as to guide information acquisition, is needed before new forms of management across landuse types can be implemented.

Even with good landscape connectivity, some species will not be able to migrate. For these species – such as dispersal-limited species, those restricted to rare or confined habitat types, or those with life history traits like low reproductive rates – translocations from within their current range to locations suitable in the future are widely advocated (Rank 4). Translocations are a contentious issue because of the challenges associated with moving populations successfully and predicting suitable future habitats, as well as the potential for unintended consequences from introducing new species into existing communities (Lemieux and Scott, 2005; McLachlan et al., 2007). Empirical evidence suggests that animal translocations tend to be unsuccessful and costly (Fischer and Lindenmayer, 2000). Despite these real problems, we did not find discussion of the feasibility of such programs. Climate change adaptation strategies would likely necessitate moving at least some species outside of their current range, an action that has rarely been pursued thus far. To fully evaluate the feasibility of translocations would require stronger understanding of best available methods, potential risks, and policies for regional coordination to avoid situations in which different conservation objectives are put in conflict (McLachlan et al., 2007).

## 5. Site-scale action

Many land managers feel that there is little they can do about climate change beyond what they are already doing, such as trying to maintain basic ecosystem functioning and mitigate other threats like invasive species and pollution. To a certain extent, recommendations we reviewed validate this perspective. A number of “business as usual” recommendations rank high in their frequency in the literature, e.g. mitigating current threats, such as invasive species and habitat loss (Rank 2), increasing or continuing basic monitoring programs (Rank

7) or managing populations for natural disturbance dynamics (Halpin, 1997; Noss, 2001; Shafer, 1999). Franklin et al. (1992) describe how in forest ecosystems mature trees slow the effects of climate change because they tolerate a wide range of temperatures, while seedling establishment is far more sensitive. Under climate change, removal of long-lived trees will therefore act to intensify and speed-up the rate at which forest ecosystems change compared to intact forests. Restoration and greening efforts function as proactive management to mitigate local-scale warming (Halpin, 1997; Mulholland et al., 1997; Wilby and Perry, 2006). Mulholland et al. (1997) point out that restoration of riparian vegetation, needed to secure wildlife populations and ecosystem services now, will also function to decrease stream temperatures in the future. Wilby and Perry (2006) highlight how green building and landscaping techniques, such as planting green roofs, neighborhood trees, and water structures, will help to counter increasing problems of urban heat-island effects.

Other authors point out that business as usual is probably not enough in many cases. Peters and Darling (1985) suggest that managers consider rescue measures such as adding irrigation or drainage systems to secure sensitive populations. Buckland et al. (2001) anticipate that soil fertility in some grasslands may require manipulation to impede species invasions under warmer conditions. Advice to incorporate a broader range of species and genotypes in restoration and forestry than prescribed based on local provenance was common (Rank 11). This type of strategy would depart significantly from the preference for local genotypes prevailing in restoration and forestry practice to date (Millar and Brubaker, 2006; Millar et al., 2007; Scott and Lemieux, 2007) and warrants increased experimentation to better understand potential costs and benefits (Harris et al., 2006; Rice and Emery, 2003).

### 5.1. Resilience versus resistance

A first step for managers will be to wrestle with the question of whether and when they will attempt to resist biotic change, such as by adding irrigation if precipitation declines, rather than try to build resilience to change, such as by facilitating population adaptive capacity through introduction of a wider range of genotypes. In theory resistant strategies attempt to bolster a system’s defenses to rapid environmental change, while resilience strategies attempt to bolster a system’s ability to absorb rapid environmental change. More recommendations advocate resilience than resistance strategies (Fig. 4d). However, intensive management actions to protect historical species in their current distributions are widely advocated (Rank 4). The latter align best with a fixed-reserve approach focusing on local species precedence, an approach that will be increasingly costly and challenging to maintain as directional global changes accelerate.

For some species and systems, options other than intervention might not exist. Resistance approaches designed to maintain the status quo are nevertheless risky – they may leave systems vulnerable to total collapse if interventions are not maintained or compromise other system components (Harris et al., 2006; Walker et al., 2002). For example, the removal of invasive species has sometimes resulted in unpredicted and negative impacts to ecosystem structure and

function (Zavaleta et al., 2001). Managing for resilience (sensu Holling, 1973) on the other hand explicitly focuses on increasing the flexibility and ability of systems to adapt and self-organize in response to change. To build resilience to climate change into systems, however, may require radical shifts in perspective for many conservation stakeholders and re-evaluation of conservation goals (Rank 10). Land managers might need to view a broader range of ecosystem states as desirable, such as novel or dynamic local assemblages that maintain functioning and trophic complexity but not necessarily species identity (Hulme, 2005), or to re-evaluate operational definitions and guidelines, such as what constitutes an invasive species or when a species can be added to a risk list (Scott and Lemieux, 2005; Scott et al., 2002).

Examples of broad perspective shift are found in the restoration literature. Millar and Brubaker (2006) emphasize the use of paleo-ecological perspectives to guide restoration goals and interventions. They ask that managers and restoration practitioners “make friends with physical and climatic change,” arguing for instance that which species are deemed ‘natural’ or ‘invasive’ depends on the spatial and temporal resolution of data used to inform perspective. For example, Monterey pines (*Pinus radiata*) are considered native to a small region of California in which they were found at the time of European colonization. The species has since naturalized widely in California from landscaping plantings and is targeted for removal as an unwanted exotic in these regions. Paleo-ecological records of *P. radiata* reveal strong climate-driven dynamics in range, with widespread distribution during favorable periods and retreat during unfavorable periods. Millar and Brubaker (2006) suggest that naturalized populations be restored rather than removed in locations where *P. radiata* thrived when the climate was similar to the present or predicted future. Pearsall (2005) describes an experimental landscape-scale project in North Carolina, USA designed to test a range of restoration options for combating peat-land loss as a result of rising sea level. Options include oyster bed formation, dune formation, native plant establishment, as well as nonnative plant establishment. The experiment is scheduled to run for 25 years with regular evaluation intervals. Bradley and Wilcove (in press) imagine a “transformative restoration” in which the plant species used to repopulate restoration sites are determined by future climate conditions rather than historical presence. For example, based on results of bioclimatic envelope models, areas in the Great Basin ecoregion of the Western US may be restored best with plants introduced from the Mojave Desert, a more arid, neighboring biome. These projects share a broad, long-term and pragmatic perspective on acceptable restoration outcomes, one that may be necessary to tackle climate change.

A key strategy for building the adaptive capacity of systems is to enhance diversity at various scales. Diverse populations tend to be more adaptable, placing a premium on protecting and managing for high genetic diversity (Rank 13). Capturing the full range of bioclimatic variability within preserves and across landscapes and designing high species, structural, and landscape diversity into constructed and managed systems are also recommended (Rank 9). Pockets of outlier vegetation, areas of high endemism, ecotones, and refugia that protected species during climate shifts in the past

are anticipated to be important sources for species re-colonization and radiation in the future, as well as provide retreats for migrating or translocated species (Rank 12). Willis and Birks (2006) discuss methods that combine genetic and paleo-ecological evidence to identify sites with distinctive patterns of genetic diversity that resulted from past geological events and refugial isolation.

Resistance and resilience strategies are not mutually exclusive. Very special communities or organisms that are of high conservation value may warrant highly invasive, intense and costly management regimes to maintain them. Regimes for intensive management are likely to be implemented through existing threatened species management frameworks, such as recovery plans. For more widespread populations, communities and ecosystems, which often provide important ecosystem services, a focus on resilience might be most appropriate. At the site-scale, managers need to address a host of practical issues such as the cost and cost-effectiveness of adaptation options, their compatibility with existing regulatory and institutional constraints, and their likely effectiveness in the absence of coordination with adjoining private lands.

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## 6. Adapting existing conservation plans

The existing literature does provide an array of actions for managers to build on and consider incorporating into existing conservation plans. A practical first step to climate change adaptation planning is to evaluate the likely outcomes for biodiversity of continuing current management and conservation directions. Most conservation policies and management plans do not yet explicitly consider climate change (Chambers et al., 2005; Groves et al., 2002; Hannah et al., 2002; Scott and Lemieux, 2007). A consistent theme in the literature is at the very least to immediately appraise current conservation and management practice in the context of climate change (Rank 2) with the goal of developing and adopting specific climate change adaptation policies in the near future (Rank 11). The literature here contained some suggestions for how to do this. A few articles emphasized the use of models to guide evaluation and adaptation of existing practices. For example, Christensen et al. (2004) used a simulation model to investigate a coupled system of plants and grazers in the Inner Mongolia Steppe under different climate scenarios. They determined that grasslands were likely to undergo a state-transition to shrublands if existing grazer densities are maintained, and they advocate reducing grazers in this area as well as in other semi-arid managed grassland systems. Hulme (2005) provided a general overview of how mathematical models can integrate long-term demographic and climate data to set climate change-appropriate harvest or stocking schedules or to forecast pest outbreaks.

Some authors highlight existing efforts that are well-suited to tackle climate change and warrant increased funding and research. Donald and Evans (2006) argue that agri-environment incentives and easement programs in the US and the EU, which are growing due to shifts in farm policies, warrant increased funding priority because of their potential to improve habitat availability and landscape connectivity across managed ecosystems. They discuss how these policies

could be modified to tackle climate change directly. Site-specific climate conditions and biotic responses could be mapped on to landscapes and used to prioritize locations for farm diversification. Similar gains could be made by targeting other private landowner biodiversity enrichment programs, like the USDA Forest Legacy Program (<http://www.fs.fed.us/spf/coop/programs/loa/flp.shtml>) or the National Wildlife Federation's Urban Backyard Wildlife Program (<http://www.nwf.org/gardenforwildlife/>).

6.1. Holistic strategies

Issues that currently challenge conservation practice may need to be addressed before the added stress of climate change complicates them further. Communities of local users are often in conflict with conservation objectives (Chan et al., 2007; Suffling and Scott, 2002). Identifying opportunities for reduced conflict and increased synergy between conservation and local communities will become more important as climate changes. A number of authors warn that conservation policies must create positive economic outcomes for local peoples to buffer them against potentially dramatic shifts in livelihoods that will accompany climate shifts (Rank 9). Adaptation requires community buy-in and participation (Chapin et al., 2006). To this end, conservation policies that foster learning and participation (Ramakrishnan, 1998) and provide options that are culturally and economically appropriate, such as those that honor traditional management systems and do not rely on expensive technologies, are more likely to be embraced and implemented (Rank 14). McClanahan et al. (2008) argue that climate-informed conservation planning necessitates site-specific understanding of environmental susceptibility and societal capacity to cope and adapt. They illustrate this process for five western Indian Ocean countries with respect to coral reef conservation. Locations with high environmental susceptibility and low adaptive capacity will be most difficult to secure effectively in the future, while those with low environmental susceptibility and

high adaptive capacity will be easiest. Locations with low environmental susceptibility and low adaptive capacity are good candidates for biodiversity investment, but to be effective these locations also require investments in human infrastructure, livelihood diversification and social capital.

Climate change is acting in concert with multiple other drivers of biodiversity loss including habitat degradation, soil loss, nitrogen enrichment, and acidification. Strong policies must simultaneously address more than one issue (Watson, 2005) or risk exacerbating environmental problems in the process of trying to combat them. Emission reduction programs are a significant push for many governments, organizations and individuals. They warrant an important place in any climate change combat strategy (Rank 13). A number of authors in this review urge, however, that emissions reduction programs and the Clean Development Mechanisms (CDMs) in the Kyoto Protocol be implemented in ways that simultaneously address carbon sequestration, biodiversity conservation and human livelihoods, rather than carbon sequestration in isolation (Rank 11).

Finally, climate change provides a much-needed impetus to evaluate how conservation policies respond to change in general. Climate change is only one of several global environmental trends to which biodiversity and its conservation must respond. Uncertainty in the climate change arena and about the future in general should not limit action to strengthen existing conservation strategies, with a focus on enhancing the ability of ecosystems to absorb and recover from rapid and unpredictable change.

7. A complete strategy

Climate change challenges conservation practice with the need to respond to both rapid directional change and tremendous uncertainty. Climate change adaptation therefore requires implementation of a range of measures, from short- to long-term and from precautionary and robust to more risky or deterministic, but specifically anticipatory (Fig. 6). To cer-

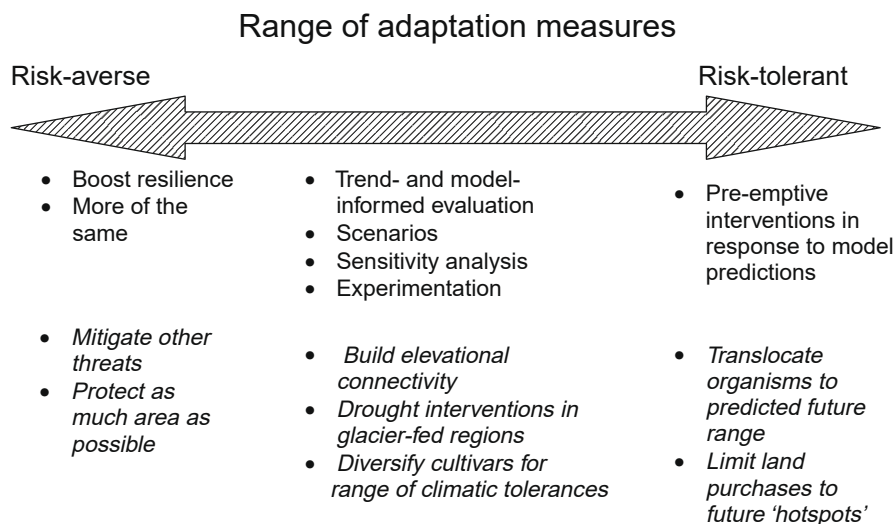


Fig. 6 – Adaptation measures classified along a risk continuum. Under each risk category are examples of general approaches followed by examples of specific adaptation measures. A complete strategy should span a risk continuum.

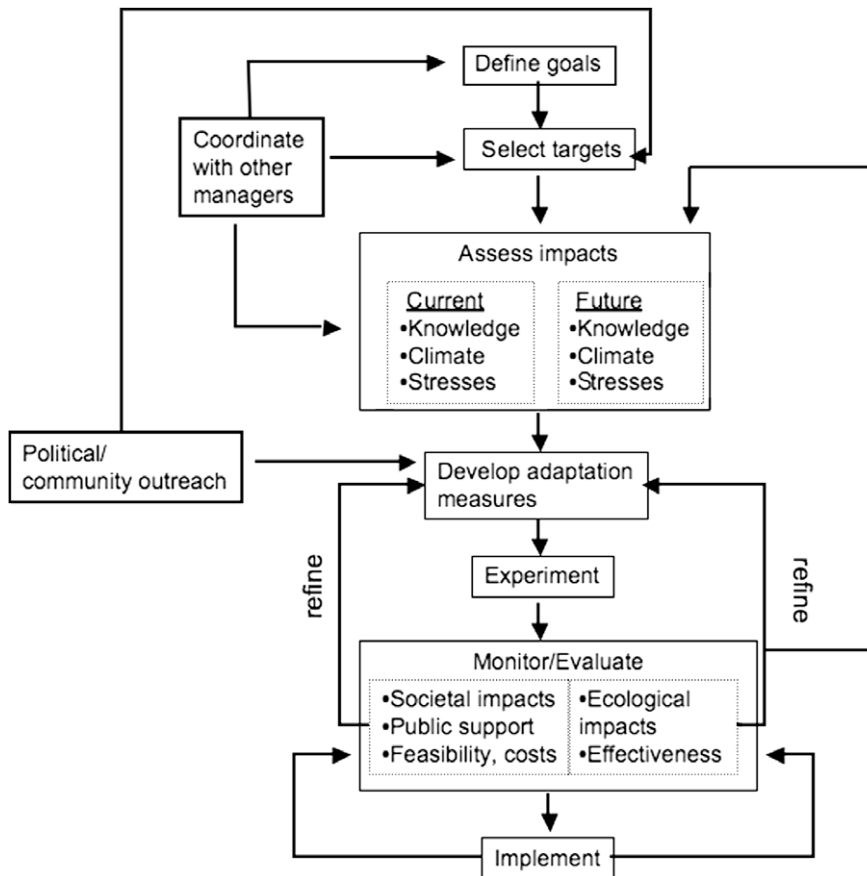
tain degree, risk tolerance of individual actors will guide strategy selection. Millar et al. (2007) discuss how managers must proactively decide whether to adopt deterministic or indeterministic approaches.

Each type of approach has benefits and drawbacks. Precautionary measures such as restoration, increased monitoring of species distribution, and increased investment in reserve protection do not necessarily require highly certain and precise climate change predictions, but such precautionary steps will help managers respond to current biodiversity threats as well as threats that emerge in the future. Precautionary measures alone, however, will not expand our ability to absorb and respond to rapid directional changes in climate, nor do they capitalize on available predictive information and efforts. In worst-case climate scenarios, over-reliance on betting measures may spread resources too thin or prove insufficient to help biodiversity weather the rapid changes underway. On the other hand, forecast-interventions bear significant risks if they are too deterministic, not robust to alternative futures or have negative unanticipated consequences (Suffling and Scott, 2002). They could also deliver great rewards and should be weighed with sensitivity analyses and scenarios, tested in pilot programs, and implemented initially at small scales (McLachlan et al., 2007). Scenario building – done in ways that are amenable to local data limitations

and useable by policymakers and managers – is particularly apt for exploring the range of magnitudes and direction of possible futures and trends without commitment to specific forecasts (Brown, 2006; Millar et al., 2007).

While the range of recommendations in the literature is great, four consistent, broad themes emerge in this review for conservation stakeholders to apply to climate change planning and adaptation: (1) the need for regional institutional coordination for reserve planning and management and to improve landscape connectivity; (2) the need to broaden spatial and temporal perspective in management activities and practice, and to employ actions that build system resilience; (3) the need to incorporate climate change into all conservation planning and actions, which will require increased research and capacity to forecast future conditions and species responses and to deal effectively with unavoidable uncertainty; and (4) the need to address multiple threats and global change drivers simultaneously and in ways that are responsive to and inclusive of diverse human communities and cultures. Action along each of these fronts will involve difficult tradeoffs, barriers to implementation, and collaboration across diverse actors.

Action will also require an adaptation planning process or series of processes appropriate for various scales and applications. Most of the literature to date fails to distinguish adap-



**Fig. 7 – Adaptation planning involves at least a few key steps, each complex and requiring collaboration among actors such as land managers, the public, scientists, funders and lawmakers. Recommendations reviewed here address aspects of these steps, but without specifying where they fit in relation to one another.**



tation from climate change impact assessment, or adaptation planning from implementation. These are distinct steps in an as-yet largely undefined process that the recommendations we survey could inform. We propose a series of general steps that should be modified, elaborated, and tailored to specific needs (Fig. 7). Key to any adaptation planning process will be to follow the principles of adaptive management (Rank 7), in which later steps inform earlier steps in an iterative and on going process.

## 8. Conclusions

Widespread calls exist for immediate action to adapt conservation practice to ongoing climate change in order to ensure the persistence of many species and related ecosystem services. However, the majority of recommendations in the published journal literature lack sufficient specificity to direct this action. Over the last 22 years, general recommendations have been reiterated frequently without the elaboration necessary to operationalize them. Greater effort to increase the availability and applicability of climate change adaptation options for conservation—through concrete strategies and case studies illustrating how and where to link research agendas, conservation programs and institutions—is badly needed.

Recommendations to date also largely neglect social science and are overwhelmingly focused on ecological data (Fig. 4c). This bias is alarming given the obvious importance of human behavior and preferences in determining conservation outcomes (Watson, 2005) and the increasingly important role of multi-use public and private lands in conservation practice. A holistic landscape approach to conservation, driven by a vision of humans and other species co-mingling across reserves and developed lands, has gradually gained prominence over the last 20 years. In their seminal paper, Peters and Darling (1985) provided a number of recommendations that continue to be widely advocated (Table 1), but they did not address the roles of conservation and restoration in human-dominated landscapes. These ideas emerge strongly in more recent literature highlighting a need to integrate ecology with other disciplines and approaches that explicitly address the roles of institutions, policy, politics and people in successful conservation strategies.

Finally, few resources or capacity exist to guide an adaptation planning process at any scale (Hannah et al., 2002; Scott and Lemieux, 2007; Welch, 2005). Such a process would place the sea of adaptation ideas and recommendations in framework and provide practitioners with tools, roles and a structure to evaluate what ideas might be useful and feasible for particular situations. Large-scale adaptation efforts that incorporate many of the recommendations found in this review are currently underway, including governmental efforts such as by Parks Canada or DEFRA in England, and by international non-governmental organizations such as The Nature Conservancy and the Wildlife Conservation Society. Well-documented case studies that focus not only on the outcome but also on the development process of adaptation plans are a promising avenue. These efforts can best enhance and encourage more widespread climate change adaptation, particularly at smaller scales, by capturing what they learn and disseminating it widely.

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## Spatial risk assessment of eastern monarch butterfly road mortality during autumn migration within the southern corridor



Tuula Kantola<sup>a,\*</sup>, James L. Tracy<sup>b</sup>, Kristen A. Baum<sup>c</sup>, Michael A. Quinn<sup>b</sup>, Robert N. Coulson<sup>b</sup>

<sup>a</sup> Department of Forest Sciences, University of Helsinki, P.O. Box 27, FI-00014 Helsinki, Finland

<sup>b</sup> Knowledge Engineering Laboratory, Department of Entomology, Texas A&M University, 2475 TAMU, College Station, TX 77843-2475, USA

<sup>c</sup> Department of Integrative Biology, Oklahoma State University, 501 Life Sciences West, Stillwater, OK 74078-3052, USA

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## ABSTRACT

Road mortality may contribute to the population decline of eastern monarch butterflies (*Danaus plexippus* L.). We estimated autumn monarch roadkill rates within the primary Oklahoma to Mexico southern migration corridor (i.e., Central Funnel). Dead monarchs were surveyed along Texas roadsides during four weeks of autumn migration in 2016 and 2017. Roadkill averaged 3.4 monarchs per 100 m transect, reaching 66 per 100 m in a roadkill hotspot in southwestern Texas. Extrapolations of Central Funnel roadkill based on survey data and road types were 3.6 and 1.1 million in 2016 and 2017, respectively. Spatial distribution of roadkill across the Central Funnel was projected from Texas survey data using 30 m resolution MaxEnt niche models. Highest roadkill probability was linked to arid climate and low human population density. The latter variables may not be directly related to roadkill, but instead represent indirect correlates of increased densities of monarchs where the migration corridor narrows southwards. The higher roadkill projected in southwest Texas and Mexico by MaxEnt models agrees with previously reported monarch roadkill hotspots. MaxEnt-based 2016–2017 projections for annual roadkill rates throughout the Central Funnel averaged 2.1 million. This figure is similar to the result by simple extrapolation, and represents about 3% of the overwintering monarch population for these years. Mitigation at roadkill hotspots in the Central Funnel could reduce monarch roadkill mortality during migration and contribute towards conservation efforts for the monarch butterfly.

### 1. Introduction

Wildlife-vehicle collision is the most widely acknowledged impact of roads on wildlife, and can contribute to the decline of species of conservation concern (Tok et al., 2011; Visintin et al., 2016; Bennett, 2017), including globally declining pollinator insect species (Baxter-Gilbert et al., 2015). Roadkill can result in high mortality and lower abundance for species with large area requirements, pronounced migratory movements, small population sizes, and slow reproduction rates (Seiler and Helldin, 2006; Fahrig and Rytwinski, 2009). Wildlife-vehicle collisions are often spatially and temporally aggregated and substantial annual and inter-annual variation has been associated with environmental factors and traffic volume (Seiler and Helldin, 2006; Shilling and Waetjen, 2015). This tendency for high spatio-temporal variability in roadkill can be difficult to interpret based solely on the mapping of field survey data. Accordingly, there is a trend to use predictive spatial models to account for the variability in investigating the impacts of roads on wildlife mortality (Bennett, 2017). Typical roadkill

niche models use a combination of environmental and anthropogenic variables and are often restricted to small areas (Visintin et al., 2016). Species distribution modeling has previously been used to project roadkill risk of mammals (Grilo et al., 2009; Roger and Ramp, 2009; Visintin et al., 2016, 2017) and owls (Gomes et al., 2009). Spatial models for insect roadkill have not yet been developed.

Only five out of 215 roadkill studies (2%) between 2011 and 2015 were specifically focused on invertebrates (Bennett, 2017). Despite this taxonomic bias in the literature, roadkill may be a substantial threat to certain insect populations. Baxter-Gilbert et al. (2015) projected that hundreds of billions of pollinating insects are lost annually to roadkill across North America. Although relatively few studies exist on butterfly road mortality, researchers have suggested that butterflies are one of the most common insect orders killed by vehicles (McKenna et al., 2001; Rao and Girish, 2007). Despite the high numbers of road-killed butterflies, the risk of Lepidopteran roadkill has been estimated as low to moderate (Baxter-Gilbert et al., 2015; Muñoz et al., 2015). Several studies have estimated butterfly roadkill numbers and examined

\* Corresponding author.

E-mail address: [tuula.kantola@helsinki.fi](mailto:tuula.kantola@helsinki.fi) (T. Kantola).

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contributing factors (Munguira and Thomas, 1992; McKenna et al., 2001; Ries et al., 2001; Rao and Girish, 2007; Skórka et al., 2013), but most of these studies concentrate on local, relatively sedentary butterfly populations and their utilization of roadside habitats rather than migratory butterflies. Migratory danaine butterflies (Nymphalidae: Danaeinae) may be especially susceptible to roadkill during migration (Her, 2008; Taiwan Environmental Protection Administration [EPA], 2010; Santhosh and Basavarajappa, 2014), including the monarch butterfly (*Danaus plexippus* L.) in the United States (McKenna et al., 2001) and Mexico (Correo Real, 2015).

Significant population decline of the eastern migratory monarch butterfly has been observed at the overwintering sites in Central Mexico during the past two decades (Vidal and Rendón-Salinas, 2014; Thogmartin et al., 2017). Consequently, the persistence of the migratory phenomenon of the eastern population may be endangered (Brower et al., 2012). The long-distance migration of monarchs is unique among butterflies. Mortality during the autumn migration (often referred to as fall migration) has been suggested as a contributing factor to the decline (Badgett and Davis, 2015; Ries et al., 2015a; Inamine et al., 2016; Agrawal and Inamine, 2018). Road mortality may significantly affect monarch survival during migration, especially where monarchs become highly concentrated as the migration narrows in Texas and northern Mexico (Badgett and Davis, 2015). Only McKenna et al. (2001) have previously evaluated monarch butterfly roadkill. They reported monarchs as the second-most killed butterfly species during six weeks of autumn in Illinois. They estimated that > 500,000 monarchs were killed statewide along interstate highways during one week in early September 1999 (McKenna et al., 2001). There are several unpublished citizen-science reports of locally high monarch roadkill occurrence in West Texas and northern Mexico during the autumn migration, with observed roadkill reaching 5.7 monarchs per meter near Monterrey, Mexico (Correo Real, 2015; Journey North, 2017). Incidences of high monarch road mortality in northern Mexico have led to the placement of road signs along portions of highways in to reduce speed in the presence of monarchs (Vangaurdia, 2016).

Monarch roadkill has yet to be quantified in relation to an overall population estimate. Seiler and Helldin (2006) point out that any sustained mortality factor, such as roadkill, can be especially damaging for species that are either approaching or are in an annual population decline, such as the monarch. The extent of monarch roadkill needs to be assessed to estimate its potential contribution to the population decline and support conservation planning. Our goal was to develop MaxEnt niche models for monarch road mortality during the autumn migration within the main migration pathway in Texas. The MaxEnt algorithm has been employed before to spatially investigate vehicle-animal collisions of birds and mammals (Ha and Shilling, 2017). The roadkill models were also projected throughout the Central Funnel, which is the identified main southern autumn migratory pathway within the Central Flyway for monarchs from Oklahoma to Mexico (Tracy, 2018; Tracy et al., 2018a). This study includes the first analysis of monarch roadkill data outside of Illinois, and the first development of a spatial roadkill model for an insect. Our specific objectives were to (1) conduct monarch roadkill field surveys within the Central Funnel in Texas, (2) develop MaxEnt niche models for roadkill within the Texas survey area, and project these models throughout the Central Funnel, (3) estimate monarch roadkill numbers within the survey area and the Central Funnel using both simple field survey-based and model-based extrapolation techniques, and (4) discuss the results in the context of monarch conservation and potential applications to other species of conservation concern.

## 2. Methods

### 2.1. Study species

The monarch autumn migration is uniquely accomplished by one

generation. Adults begin migrating in late August to September from the summer breeding grounds, traveling to overwintering grounds in Central Mexico (Brower, 1995; Calvert and Wagner, 1999). Most migrants usually reach Oklahoma and North Texas in late September or early October (Calvert and Wagner, 1999; Monarch Watch, 2018a) and arrive at the overwintering grounds in November (Brower et al., 2006). There are two main migration routes, the Central Flyway and the Eastern or Coastal Flyway (Calvert and Wagner, 1999; Howard and Davis, 2009). The Central Flyway through the Great Plains is the most heavily traveled route (Howard and Davis, 2009), which narrows into the Central Funnel from Oklahoma southwards (Tracy, 2018; Tracy et al., 2018a).

Autumn migrants fly during the day and stop at night and during inclement weather to nectar and roost in trees and shrubs (Brower, 1996). These roosts may comprise a few individuals to several thousand individuals and may last one to several days (Davis and Garland, 2004; Howard and Davis, 2009). In the morning, roosting monarchs either resume migration or search for nectar. These behaviors are influenced by wind patterns or lipid levels (Brower, 1996; Davis and Garland, 2004). During unfavorable southerly winds, monarchs may roost for several days (Schmidt-Koenig, 1985). Migrating monarchs are observed to nectar in a variety of locations, including in right-of-ways (Brower et al., 2006), where they may be vulnerable to vehicle collisions. Brower et al. (2006) suggested that monarchs shift their behavior upon reaching Texas and spend more time nectaring to accumulate lipids for the winter and re-migration in the spring. Migrating monarchs regularly fly at high altitudes, around 300–500 m (Gibo and Pallett, 1979; Gibo, 1981, 1986), but may fly close to the ground, especially when facing headwinds or during overcast weather (Gibo, 1986; Brower, 1996), exposing them to road mortality. Citizen science observations also include reports of low flying fall migrating monarchs over roadways (Correo Real, 2015).

### 2.2. Monarch roadkill surveys and simple roadkill extrapolation

Monarch roadkill field surveys were conducted during the main autumn migration through the Central Funnel in Texas (Fig. 1). Four four-day surveys were conducted in each of the autumns of 2016 and 2017, between 10th October to 4th November and 3–27 October, respectively. The survey area was divided into four north to south sections, with surveys timed to generally occur after the dates of average peak migration (Journey North, 2017; Monarch Watch, 2018a) to allow time for the accumulation of road-killed monarchs. Observed monarch roadkill densities most likely represent accumulations of dead migrating monarchs over a period of one or two days to a few weeks during the main migration pulse through an area (Munguira and Thomas, 1992). Surveyed road types included (1) highways, (2) primary roads, and (3) secondary roads. Each survey location comprised at least a single 100 m by 1 m transect along the grassy edge of one side of the roadway. To assess if the side of the road surveyed influenced the number of dead monarchs, additional transects were surveyed across multiple edges of single and divided-lane highways at some sites. Transects were located using a handheld GPS device (accuracy up to  $\pm 3$  m). Roadkill transects were spaced according to travel and survey time constraints at about 30 to 100 km intervals along the primarily east to west pre-planned survey routes, with additional surveys in 2016 in the southwestern portion of the study area where high monarch roadkill was found (Fig. 1).

All dead monarchs or parts of monarchs were collected to estimate the total number and sex ratio of dead monarchs along transects. A similar spring monarch roadkill survey was conducted in Texas during April to May of 2017 (Fig. A.1; for details, see Appendix A, section 1.1). The boundary of the background evaluation extent for our roadkill study was defined by a 10 km buffer around a convex hull polygon formed using un-thinned 2016 to 2017 monarch roadkill survey data (Fig. 1). We extrapolated the mean roadkill counts for the three road



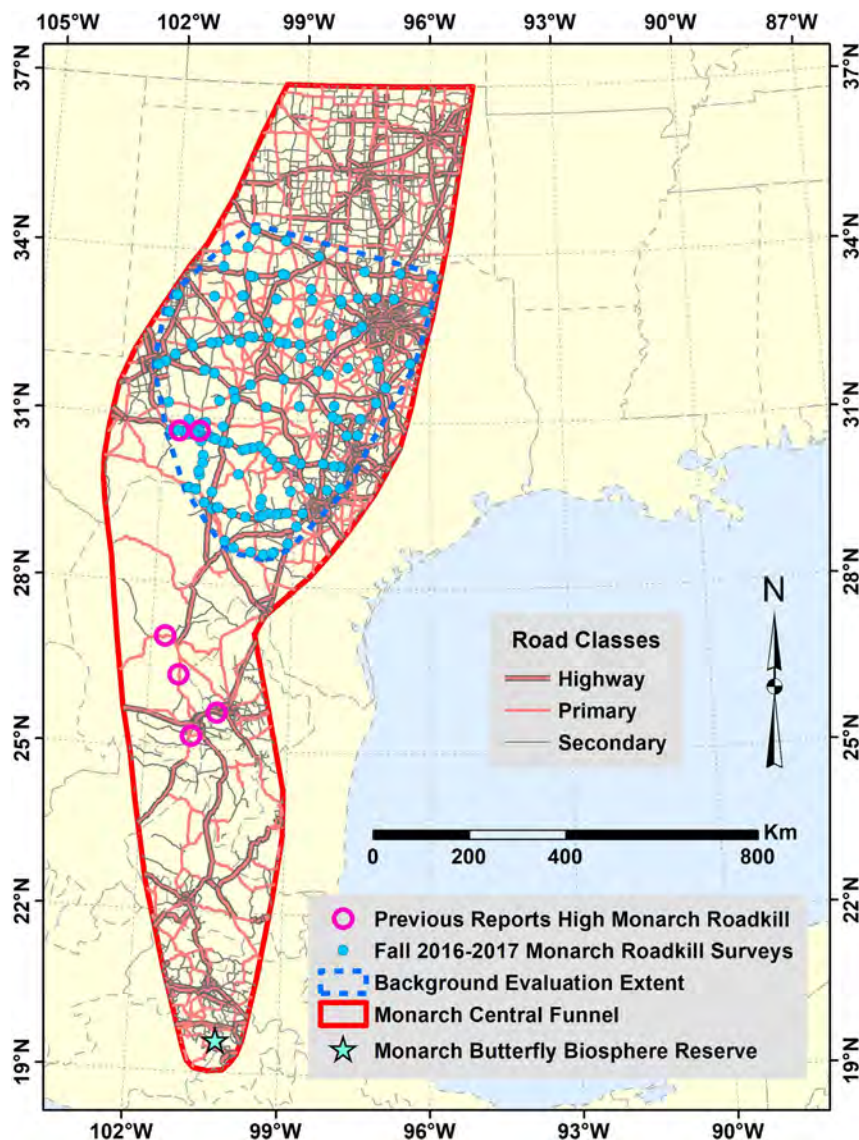


Fig. 1. Monarch roadkill survey 100 m transects for autumn 2016 and 2017 along three major road classes within the monarch Central Funnel in Texas.

types over the background evaluation extent and Central Funnel in a manner similar to that of McKenna et al. (2001). Roadkill rates in areas of locally high monarch roadkill (hotspots) can vary greatly between years and highly differ from other areas. Consequently, roadkill rates in hotspots can bias roadkill rates in larger areas if they are disproportionately represented in the sampling. Therefore, in some extrapolations, hotspot roadkill rates were considered separately for each year from non-hotspot locations. This separation allowed us to understand the importance of the roadkill hotspots within a year, and compare the hotspot differences between years. We also made roadkill extrapolations including hotspot roadkill rates with non-hotspot data and thinning the hotspot data in 2016 to be in proportion to the sample effort in non-hotspot locations (for details, see Appendix A, section 2.1).

### 2.3. Environmental variables

Thirty environmental variables were initially screened for use in the roadkill modeling (Table A.1, Fig. A.2). These variables were selected for their value in previous roadkill niche models and for their use in characterizing the environment of the study area. The variables consisted of nine topographic indices (including four stream indices), eight land cover indices, six road indices, three human population indices,

and four climatic indices. All indices were either calculated at 30.8 m spatial resolution or resampled with bilinear interpolation to the 30.8 m resolution, to match the resolution of the base layer of 1 arc sec Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) data obtained from USGS Earth Explorer (<https://earthexplorer.usgs.gov/>). The high spatial resolution of 30.8 m facilitated modeling of roadkill along individual surveyed roadways over a broad area (see more details in Appendix A, section 7).

### 2.4. Monarch roadkill models

Preliminary MaxEnt model runs indicated that there was not enough data from 2017 to obtain good accuracy statistics for both single year models. Consequently, we combined 2016 and 2017 roadkill presence data, which were randomly spatially thinned to 2 km to reduce spatial autocorrelation. Ten thousand background points were randomly generated within the road mask evaluation area. We calculated background/presence versions of the area under the curve statistic ( $AUC_{bgp}$ ) and true skill statistic ( $TSS_{bgp}$ ) using R software (R Core Team, 2018) and the PresenceAbsence package (Freeman and Moisen, 2008). In the same manner, we calculated a presence/absence version of AUC ( $AUC_{pa}$ ) and TSS ( $TSS_{pa}$ ) using transects with no observed monarch

roadkill as absence data, although we acknowledge roadkill may have occurred in these absence locations as well. We adjusted the MaxEnt beta regularization value to two and used only quadratic and hinge features to reduce model complexity and overfitting for improving model generalization (Jiménez-Valverde et al., 2008; Warren and Seifert, 2011; Tracy et al., 2018b).

Roadway rasters served as a mask for analysis of environmental variables. The original set of 30 environmental variables was decreased to 20 variables. We dropped nine variables exhibiting zero or negative testing gain of  $AUC_{bgp}$  from a MaxEnt threefold jackknife run (Table A.1, Fig. A.3). We also dropped traffic volume because data were not readily available for Mexico. Traffic volume was utilized in preliminary niche models for the Texas background evaluation extent. Preliminary runs indicated that no substantial gain in model performance was achieved with > 10 of the 20 variables, and that employing fewer variables (three) substantially increased undesired high spatial variability in roadkill among models. Consequently, final MaxEnt roadkill models were developed from ten random sets of ten of the 20 variables to represent model variability due to variable selection. The absolute Spearman rank correlation of variables within random variable sets was limited to < 0.7 using the multiple randomized sequential forward selection procedure within the random subset feature selection algorithm (RSFSA) of Tracy et al. (2018b). The final MaxEnt models were calibrated to binary presence/absence format using a threshold of maximum TSS<sub>pa</sub> (Liu et al., 2013) and combined using frequency consensus to form a feature subset ensemble. We also created presence/absence niche models for monarch roadkill using linear and quadratic binomial logistic regression with the R *Glmnet* package (Friedman et al., 2010) for the same ten random sets of ten of 20 variables. These presence/absence models produced lower  $AUC_{bgp}$  values and similar  $AUC_{pa}$  values compared to MaxEnt models, and these models were not investigated further (results not shown).

### 3. Results

#### 3.1. Monarch roadkill survey and simple roadkill extrapolation

We surveyed 16.1 km of roadsides (161,100 m transects), 8.8 km in 2016 and 7.3 km in 2017. We found 581 dead monarchs in 59 locations (102 absence locations) for an average of 3.4 monarchs per transect. We found 546 dead monarchs in 2016 and 35 in 2017 (for raw survey count data, see Appendix A, section 3.1). Of the 546 monarchs in 2016, 499 (91%) were located along or near IH-10 between Sonora and Sheffield (23 of 95 transects) (Fig. 2). This area was defined as a single large 2016 hotspot area extending 95 km along Interstate Highway (IH) 10 from Sonora to 24 km east of the Pecos River. This hotspot included a portion of Texas state highway (SH) 163 extending from 7.6 km south of Ozona to 5 km north of Ozona and a 2 km section of SH-137 extending west from the junction with SH-163. The hotspot was bounded along IH-10 in the west and east by counts of 15 and 10 roadkill per 100 m, and included counts of 21 and 6 roadkill per 100 m on SH-137 and SH-163, respectively. About 93% (466/499) of the dead monarchs in the 2016 hotspot occurred in 14 transects ranging from 10 to 66 per 100 m (Fig. A.4). A total of 257 monarchs were sexed in 2016–2017, of which ca. 38% were female ( $n = 98$ ). The portion of females was 41% in 2016 (132 males, 91 females) and 21% in 2017 (27 males, 7 females). After the 2 km spatial thinning for spatial modeling, the field survey data consisted of 151 transects (53 presence and 98 absence) and 249 individual dead monarchs. Only two road-killed male monarchs were found among 54 transects in our spring 2017 roadkill survey (Fig. A.1).

Southern edges of roadsides contained 43.8% ( $\pm 36\%$  SD,  $n = 13$ ) of the roadkill found in the northernmost edge for both single and divided-lane roads. This relationship was used to estimate roadkill across all two to four edges per roadway when extrapolating roadkill per km per year (for details, see Appendix A, section 5). Estimated roadkill per

km ranged from 6.15 to 645 monarchs per km depending on year, road type, and location in relation to the hotspot area (Table 1). In 2016, mean estimated roadkill per km along highways was significantly higher within the Sonora-Sheffield hotspot (645.38; SD = 446.92;  $n = 15$ ) compared to outside the hotspot (12.64; SD = 22.30;  $n = 22$ ) ( $P = 0.00008$ ; Welch *t*-test). Between years, the estimated roadkill per km generally varied widely among road types, and there was no evidence of any hotspot in 2017 (Table 1). Estimates of roadkill within the hotspot area in 2016 and 2017 ranged from about 74,000 to 5000, representing about 10% and 1% of the entire mortality within the Texas background evaluation extent. Using the field survey data from the whole area, including the randomly thinned hotspot data, the estimated roadkill for the Central Funnel in 2016 rose to over 3.5 million monarch butterflies (Table 1). The estimate for 2017 was 1.1 million road-killed monarchs. Combining the data from both of the years yielded an annual estimate of 2.1 million road-killed monarchs. When the hotspot data were separated from the survey data, total estimated annual roadkill rates in 2016 and 2017 were about 1.6 million and 1.0 million monarchs, respectively. In 2016, about 47%–49% of the roadkill within the Central Funnel was projected to occur within the Texas background evaluation extent, of which 5% was projected to occur in the Sonora-Sheffield hotspot area. In 2017, only about 0.3% of the roadkill within the Central Funnel was projected within the hotspot area, and the percent roadkill in the background area ranged from 31% when hotspot data were analyzed separately to 48% when data from the hotspot area were included (Table 1, Appendix A, section 2).

#### 3.2. Monarch roadkill model

The feature subset ensemble of ten MaxEnt roadkill niche models provided excellent discrimination of roadkill presence locations from background locations within the background evaluation extent, with  $AUC_{bgp}$  values ranging from 0.82 to 0.88 ( $0.86 \pm 0.02$ , mean  $\pm$  SD). The models provided marginally poor discrimination of roadkill presences from absences observed in the field, with  $AUC_{pa}$  values ranging from 0.60 to 0.67 ( $0.64 \pm 0.02$ , mean  $\pm$  SD). Among the top eight variables with the highest permutation importance in the MaxEnt models (Table 2) were three human population density indices and two climatic indices. Other top ranked variables included elevation (m), road density over a 3 km radius ( $\text{km}/\sim 28 \text{ km}^2$ ), and percent cover of artificial surfaces within a 500 m radius. Traffic volume (annual average daily traffic, AADT) ranked third in permutation importance in preliminary models but was not available for Mexico, precluding its use in our final models.

The MaxEnt response curves for population density indices all indicated that lower human population densities had higher association with monarch roadkill (Fig. 3A, E). The climatic indices indicated that roadkill was associated with more arid climates (Fig. 3B, C). Lower road densities and lower percent cover of artificial surface were also associated with higher monarch roadkill (Fig. 4F, G). The response curve for traffic volume, which was not used in the final models, indicated that the highest roadkill was associated with lower traffic volume. The traffic volume response curve was very similar to that of percent cover of artificial surface (Fig. 3G, H), with which it was moderately correlated ( $r_s = 0.58$ ).

The proportion of MaxEnt models projecting monarch roadkill generally increased from northeast to southwest within both the background evaluation extent and Central Funnel (Fig. 4; see Appendix Section 5 for embedded zipped shapefile of MaxEnt consensus model). The highest number of models projected roadkill within much of southwest Texas and Mexico in the Central Funnel. None of the MaxEnt models projected monarch roadkill over most of the northeastern Central Funnel, including the Dallas/Fort Worth metroplex and most of eastern Oklahoma.

Roadkill extrapolations for each of the ten individual MaxEnt models were made across each year and both years combined.



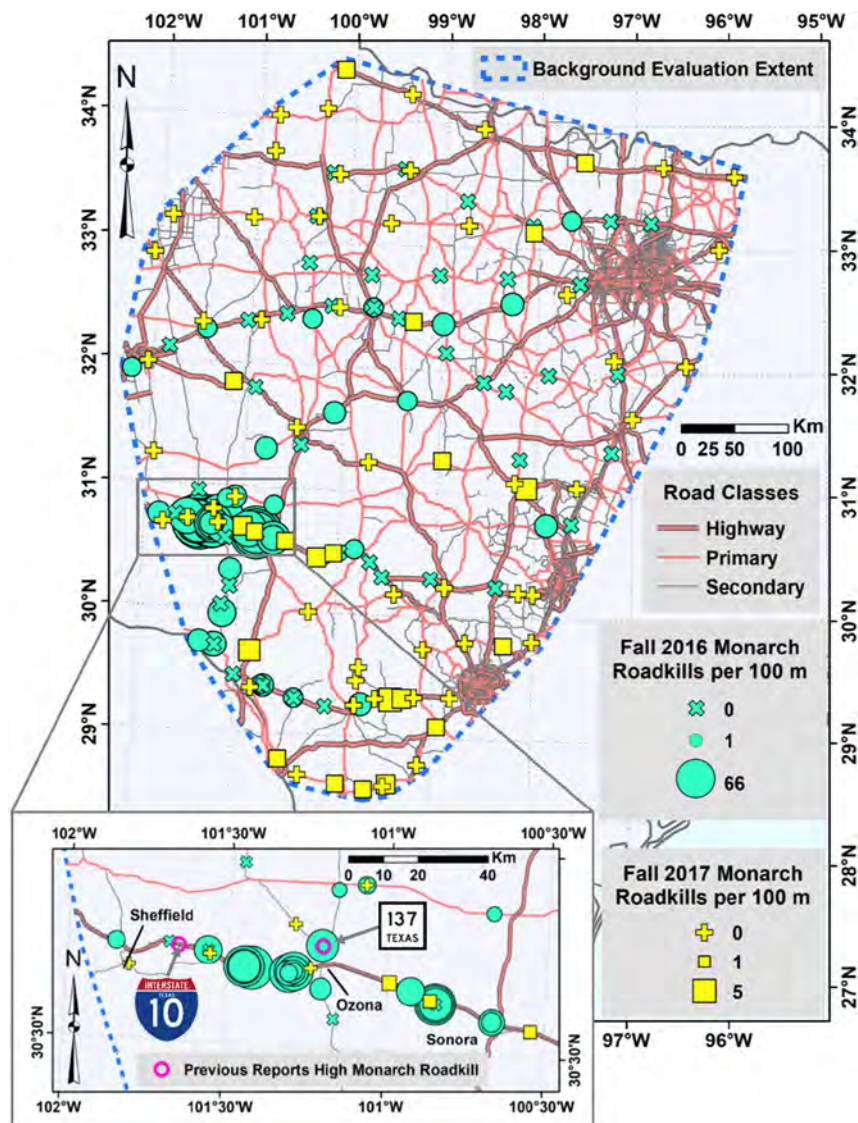


Fig. 2. Monarch roadkill autumn 2016 and 2017 survey results for 100 m transects along major road classes within the background evaluation extent in the monarch Central Funnel in Texas, including previously reported locations of high monarch roadkill.

Extrapolations were based upon roadkill rates per km for presence-only transects (no zero roadkill data) of each road type that were multiplied by the MaxEnt model predicted lengths of roadkill presence for the road type. Roadkill rate calculations for extrapolations included data from hotspot transects that were thinned for 2016 as done for simple extrapolations (for details, see Appendix A, sections 2.1, 5). Extrapolating roadkill rates across the Central Funnel, we estimated averages of  $3.0 \pm 0.7$  and  $1.1 \pm 0.3$  million (mean  $\pm$  SD) road-killed monarchs for 2016 and 2017, respectively (Tables 1, A.2). Combining roadkill data across both years for the Central Funnel yielded annual roadkill rates of  $2.1 \pm 0.5$  million. The mean projected percentage of road-killed monarchs in the Central Funnel that occurred within the Texas background evaluation extent ranged from 67% to 68% in 2016 and 2017 (Tables 1, A.4).

## 4. Discussion

### 4.1. Monarch roadkill survey

In our 2016 roadkill survey (but not 2017), we found a Sonora-Sheffield, Texas, monarch roadkill hotspot that corresponds to the only two previous citizen-science reports of monarch roadkill hotspots in the

US (Fig. 2). It is unclear why hotspots have repeatedly occurred in this area. The hotspot location may be partly related to higher densities of migrating monarchs in more southern areas of the Central Funnel. In addition, local stochastic weather events probably influence the occurrence of roadkill hotspots, such as unfavorable winds that may induce lower monarch flight patterns or extended roosting and nectaring behavior close to the ground in the vicinity of roadways. More research is needed to evaluate how frequently roadkill hotspots occur in this region. It is possible that one or both years represent an outlier, and that hotspots may occur in additional areas.

The variation in roadkill rates observed between the two years of our survey was consistent with other roadkill studies (Seiler and Helldin, 2006). Our overall roadkill rates varied from 6 to 646 dead monarchs per km depending on year, road type, and location (Table 1). This range falls within previous reports for monarchs of from 1.3 to 11.9 butterflies per km per week in Illinois (McKenna et al., 2001) to a very high number of 115 road-killed monarchs within a 20 m stretch along toll highway 40D southwest of Monterrey, Mexico in October 2015 (Correo Real, 2015; see Appendix A, section 8 for data). Reported roadkill rates for other butterflies have ranged from 0.45 to 80 per km per day in North America, Asia, and Europe (Rao and Girish, 2007, De la Puente et al., 2008, Yamada et al., 2010, Skórka et al., 2013, Baxter-

**Table 1**  
Monarch roadkill estimates per year for 2016 to 2017 over the Sonora-Sheffield roadkill hotspot, Texas background evaluation extent (BEE) and the Central Funnel (Figs. 1–2) from the field data by road type using simple extrapolation or MaxEnt model projections.

Year	Millions of monarch roadkill <sup>a</sup>						
	Simple extrapolation				MaxEnt model extrapolations $\bar{X} \pm SD$ (n = 10) <sup>b</sup>		
	Hotspot data separated			Hotspot data included		Hotspot data included	
	Sonora-Sheffield hotspot	Texas BEE	Central Funnel	Texas BEE	Central Funnel	Texas BEE	Central Funnel
2016							
Millions of dead	0.074	0.768	1.570	1.663	3.554	2.050 ± 0.760	3.041 ± 0.743
% Overwintering population <sup>c</sup>	0.09%	0.90%	1.82%	1.93%	4.03%	2.36 ± 0.86%	3.46 ± 0.82%
% Texas BEE mortality	9.58%						
% Central Funnel mortality	4.69%	48.95%		46.78%		66.48 ± 14.79%	
2017							
Millions of dead	0.005	0.492	1.042	0.533	1.131	0.738 ± 0.272	1.084 ± 0.258
% Overwintering population <sup>c</sup>	0.01%	0.79%	1.67%	0.86%	1.81%	1.19 ± 0.43%	1.73 ± 0.41%
% Texas BEE mortality	1.02%						
% Central Funnel mortality	0.32%	31.34%		47.16%		68.86 ± 14.18%	
2016–2017							
Millions of dead	0.058	0.561	1.138	0.995	2.118	1.460 ± 0.540	2.119 ± 0.510
% Overwintering population <sup>c</sup>	0.09%	0.91%	1.82%	1.59%	3.33%	1.96 ± 0.71%	2.82 ± 0.66%
% Texas BEE mortality	10.25%						
% Central Funnel mortality	3.66%	35.75%		27.99%		67.90 ± 15.08%	

<sup>a</sup> Mean roadkill rates (roadkill/km/year) (Table A.2) by road type for extrapolations are calculated from transects in the Texas BEE and incorporate estimates for all road edges. Roadkill rates are multiplied by length of road in various areas to obtain extrapolations (see Table A.3 for road lengths used in simple road type extrapolation) (for all calculations, see Appendix A, section 5).

<sup>b</sup> See Table A.4 for individual MaxEnt model estimates.

<sup>c</sup> Based on 84.61 (2016) and 61.4 (2017) million overwintering monarchs (Monarch Watch, 2018b). Estimated from 21 million monarchs per hectares overwintering (Thogmartin et al., 2017).

Gilbert et al., 2015).

The observed sex ratios of roadkill monarchs were also consistent with previous studies. About 38% of the dead monarchs in our autumn field surveys were females, ranging from 21% in 2017 to 41% in 2016. These figures generally match two separate citizen science observations on the percentage of female monarch roadkill in Mexico of 27% and 36% in October 2015 (Correo Real, 2015). They also are within the range reported from the other roadkill study (McKenna et al., 2001), as well as studies of sex ratios during migration (Borland et al., 2004) or on the overwintering grounds (Steffy, 2015). Davis and Rendón-Salinas

(2010) found a decreasing trend (~10%) in percent female monarchs at the Mexican overwintering sites from 1976 to 2008, which they suggested could reflect female biased mortality due to the protozoan parasite *Ophryocystis elektroscirrha*.

While our estimates of monarch roadkill are likely conservative, carcass persistence is not likely to be a major source of bias. However, we did not evaluate persistence in our study, which could vary based on various factors, such as region, time of year, and weather conditions.

Munguira and Thomas (1992) placed butterfly specimens on roadsides and found that only one of their 50 specimens disappeared during

**Table 2**  
MaxEnt model variable permutation importance for 19 variables used in ten random sets of ten of the 20 variables in monarch roadkill models.

Variable <sup>a</sup>	Abbreviation	Permutation importance <sup>b</sup> , mean ± SD
Human population density per km <sup>2</sup> in 9 km radius (population/254.47 km <sup>2</sup> )	popden9kr	44.2 ± 3.8 (3)
Autumn quarterly mean monthly actual evapotranspiration/potential evapotranspiration × 1000	etr_autq	41.7 ± 23.3 (2)
Annual mean monthly rainfall (mm)	prec_ann	36.4 ± 15.6 (4)
Human population density per km <sup>2</sup> in 3 km radius (population/28.27 km <sup>2</sup> )	popden3kr	30.1 ± 0.0 (1)
Elevation (m)	elev	27.9 ± 5.5 (4)
Distance to urban areas (areas with ≥300 humans per km <sup>2</sup> ) (km)	urbdist	27.1 ± 10.8 (4)
Road density, km road in 3 km radius (km/28.27 km <sup>2</sup> )	roadden3kr	19.6 ± 2.4 (2)
Artificial surfaces % cover in 500 m radius	artsur_500mr	13.4 ± 3.2 (3)
Autumn quarterly mean monthly maximum temperature (°Celsius)	tmax_autq	10.5 ± 9.8 (3)
Distance to highways (m)	hwydist	10.4 ± 2.5 (7)
Latitude (decimal degrees)	latitude	6.4 ± 4.3 (3)
Grasslands % cover in 500 m radius	grslnd_500mr	5.6 ± 3.4 (9)
Autumn mean quarterly wind speed (m/s)	wndsp_autq	5.6 ± 5.4 (4)
Distance to secondary roads (m)	secrddist	5.1 ± 2.9 (8)
Shrublands % cover in 500 m radius	shrub_500mr	4.5 ± 3.4 (9)
Distance to primary roads (m)	primrddist	2.3 ± 3.0 (4)
Road density, km road in 500 m radius (km/0.79 km <sup>2</sup> )	roadden500mr	2.2 ± 3.8 (5)
Distance to high flow accumulation areas (> 60,000 ~km <sup>2</sup> upslope grid cells) (m)	strnhiflodist	1.2 ± 1.0 (5)
Topographic Position Index (TPI), 3 km radius	tpi3kr	1.0 ± 0.2 (5)
Cultivated land % cover in 500 m radius <sup>c</sup>	cult_500mr	0.0 ± 0.0 (0)

<sup>a</sup> See Table S1 for sources of variables. Variables ordered from highest to lowest mean permutation importance.

<sup>b</sup> Permutation importance of the variable in the MaxEnt models, number of models in which the variable was used out of the 10 random models in parentheses.

<sup>c</sup> Cultivated land layer was initially included in all 10 random models, but it was not included by MaxEnt in calculating any of the models.

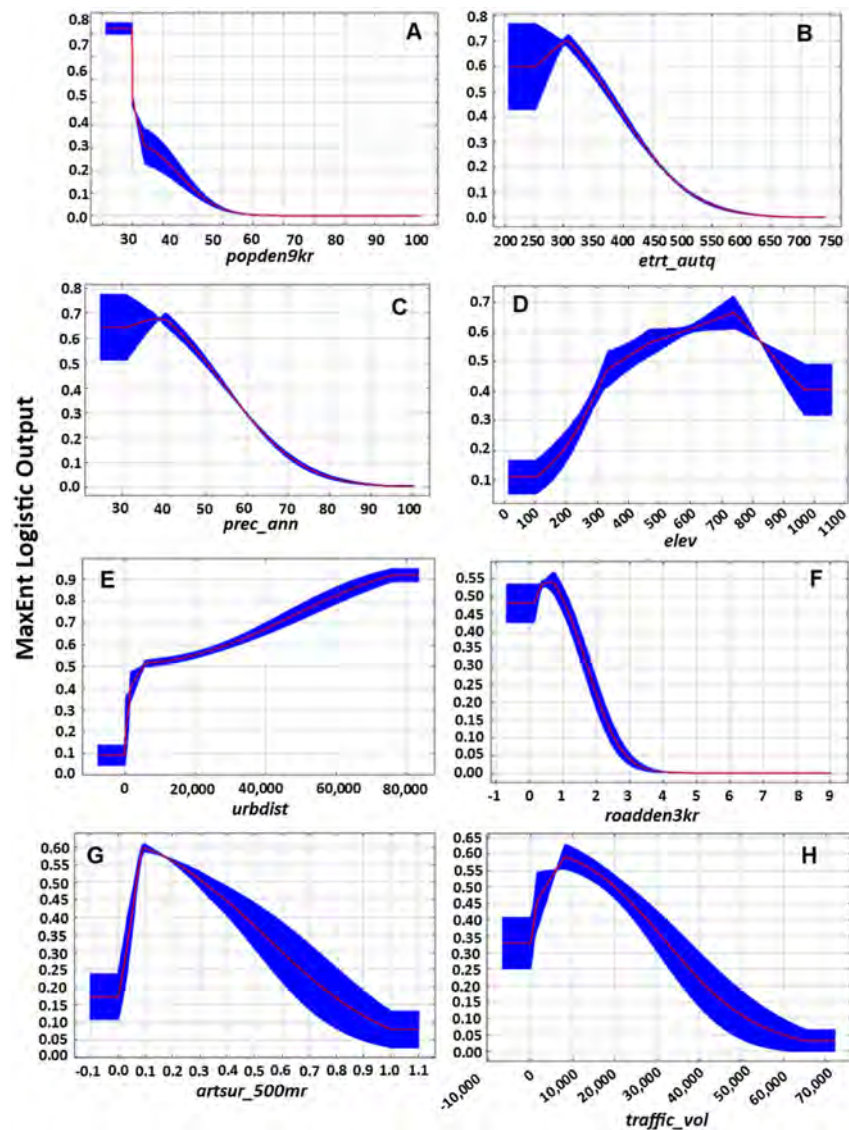


Fig. 3. MaxEnt variable response curves (logistic output probability of presence vs. variable) representative of the final ten models (A–G) and for a 30-variable model (H): (A) popden9kr, (B) etrt\_autq, (C) prec\_ann, (D) elev, (E) urbdist, (F) roadden3kr, (G) artsur\_500mr, (H) traffic\_vol (traffic volume for 2015) (see Table 2 for abbreviations and permutation importance).

two weeks (daily loss rate of 0.15%). Several factors contribute to the conservative nature of our estimates, including the difficulty in detection of dead monarchs, especially in taller vegetation, shredding of dead monarchs by roadside mowing, and a portion of the monarchs remaining attached to the colliding vehicles (McKenna et al., 2001; Seiler and Helldin, 2006). However, several studies indicate that road killed butterflies are mostly blown to the roadside edge, with individuals rarely trapped in car grills (Munguira and Thomas, 1992; Ries et al., 2001). The overall agreement of our roadkill results with previous studies in terms of the range of roadkill rate variability and sex ratios supports the reliability of the data for extrapolating monarch road mortality according to road types and spatial modeling.

## 4.2. Monarch roadkill models

### 4.2.1. Roadkill projections

Most of the MaxEnt models projected monarch roadkill from the southwestern portion of the Central Funnel from West Texas to Mexico (Fig. 4). Our MaxEnt consensus projection agrees with all seven of the previously known citizen science reports of monarch roadkill hotspots in North America (Fig. 4), including two hotspots in West Texas

(Journey North, 2017) and five hotspots in northern Mexico (Correio Real, 2015; Rogelio Carrerra, Universidad Autonoma de Nuevo Leon, Nuevo Leon, Mexico, personal communication).

Our annual MaxEnt based roadkill estimates for monarch mortality throughout the Central Funnel was 3.0 to 1.1 million for 2016 and 2017, respectively. These MaxEnt roadkill estimates were similar to those based on simple roadkill extrapolation by road type when hotspot data were included (3.6 and 1.1 million, respectively). Most of the roadkill projected by MaxEnt models outside of the study area occurred in Mexico, indicating that more MaxEnt models are projecting roadkill along the sparser road network within the Central Funnel over northern and central Mexico than in the northern parts of the funnel (Fig. 4). As the autumn migration pathway narrows in the South, migrating monarchs become more concentrated in the Central Funnel. This higher concentration may contribute to higher roadkill densities in the southern parts of the Central Funnel in Mexico, where most previous reports of monarch roadkill hotspots originate (Fig. 4). Although our models project some increased southward mortality risk, additional data are needed to assess the extent of this risk in Mexico. The extrapolations including the hotspot data with other roadkill data and projecting higher annual roadkill of up to 3.6 million in the Central Funnel



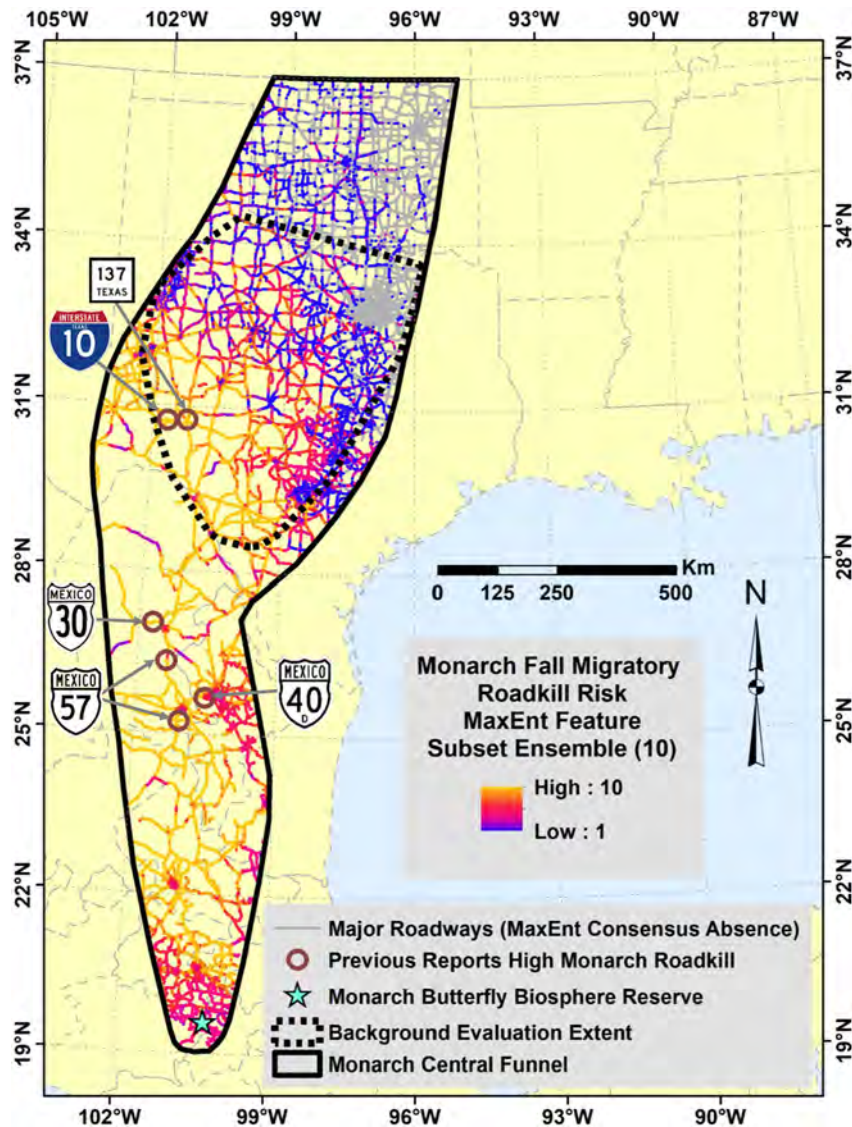


Fig. 4. MaxEnt frequency consensus for feature subset ensemble of ten models developed from random subsets of ten of 20 variables correlated  $< 0.7$  (see Appendix Section 5 for embedded zipped shapefile of MaxEnt consensus model).

should be more realistic considering the occurrence of multiple roadkill hotspots in Mexico of higher density than seen in Texas. The MaxEnt models project little to no roadkill in the northeastern part of the funnel area, including the Dallas/Fort Worth area and eastern Oklahoma. However, some roadkill likely does occur in this area, but possibly at a lower rate than in the more southern areas of the Central Funnel. Further research and field surveys are needed to verify roadkill rates outside of our survey area in the southern and northern parts of the Central Funnel. Additional data may allow effective use of roadkill density models, rather than presence only MaxEnt models used in this study. Roadkill density models can better reveal regional roadkill patterns useful in refining projections, especially for northern Mexico where roadkill could be much higher than in Texas. Roadkill field surveys from other parts of the autumn migration pathways could improve estimates for the total impact of roadkill on the monarch population.

#### 4.2.2. Factors affecting roadkill

MaxEnt projections of monarch roadkill within the Central Funnel were generally associated with more arid climate and less densely populated areas (Fig. 3). These conditions generally describe those for the seven previous monarch roadkill hotspots reported from Texas and

Mexico, with the possible exception of the roadkill hotspot in the vicinity of Monterrey, Mexico (Fig. 4). This could be related to a variety of factors. For example, autumn migrating monarchs have been observed to spend additional time flying lower to the ground during the afternoon in desert areas, perhaps to seek shelter from the heat or find nectar (Journey North, 2018). Monarchs may need to spend more time searching for nectar in arid environments, although this has not been evaluated. Finally, the increased roadkill rates may simply reflect the increased number of monarchs in more southern areas of the Central Funnel. This southern locality factor cannot be associated with most of the predictors, with the exception of latitude, but it may have the highest influence. Local climate, weather patterns, and geography affect monarch movement and behavior, and they all are likely important contributors to road mortality. Wind patterns (direction, duration, and speed) may especially be more important than anthropogenic factors, but short-term weather events could not be incorporated in the models. Occurrence of these weather events is also highly variable and difficult to predict.

Traffic volume has been noted as one of the most important variables in previous roadkill studies (Bennett, 2017). Traffic volume ranked high in importance in our preliminary roadkill models, but we found that model accuracy (AUC) was not significantly affected by its

removal. Other variables that were correlated with traffic volume likely compensated for its absence, including human population density, artificial surface cover, distance to urban areas (km to population  $\geq 300/\text{km}^2$ ), and road density. In our models including traffic volume, the highest roadkill was associated with fairly low AADT values, similar to the study by McKenna et al. (2001). In general, higher roadkill has been associated with higher traffic volume due to increased probability of vehicle collisions (Seiler and Helldin, 2006; Skórka et al., 2013). Samways (1994) suggested that roads with high traffic volume serve as corridors for high butterfly mortality. In our study, low traffic volume, along with related anthropogenic variables, is correlated with locations of monarch roadkill hotspots, but may not be directly related to the roadkill mortality. As the human population grows, traffic volume should increase, including in the lower traffic volume monarch roadkill hotspot areas, likely leading to higher roadkill rates (Bennett, 2017).

#### 4.2.3. Spatial and temporal variation

Over 70,000 monarch roadkill were estimated in the Sonora to Sheffield, Texas hotspot in 2016, compared to about 5000 in 2017. This illustrates the high spatio-temporal variability of roadkill and the potential contribution of hotspots to the monarch road mortality. The timing of our field surveys relative to the peak migration in those years may have varied among transect locations and years, which could have influenced our results. If peak migration occurred after our field surveys in one or both years, we may have underestimated roadkill numbers. For example, the autumn migration in 2017 was later than usual due to unusually hot summer (Agrawal and Inamine, 2018). Few other studies have identified roadkill hotspots for butterflies (but see Samways, 1994, Her, 2008). Monarch roadkill hotspots may vary from year to year and may be difficult to locate or may not occur in some years.

We observed much higher monarch road mortality during autumn migration than in the spring (Fig. A.1), indicating that seasonality is a factor contributing to monarch roadkill rates. However, the monarch spring migration is more spatio-temporally dispersed making comparisons difficult. Temporal variability can occur between years, within the migration phase, or even within a day. For example, monarch behavior, such as flying low in the mornings (McKenna et al., 2001), probably affects the risk of roadkill at different times of day. Temporal patterns affecting monarch roadkill should be investigated further. Other sampling methods may be effective in detecting additional roadkill hotspots, such as adaptive cluster sampling, which was developed for inventorying scattered and clustered phenomena (Thompson, 1990). More frequent samples in a given location can also be critical for detecting roadkill hotspots (Santos et al., 2015).

#### 4.3. Implications and impacts in relation to monarch conservation

##### 4.3.1. Autumn migration mortality

Butterfly roadkill is a density independent mortality factor (Rodewald and Gehrt, 2014) with the incidence of roadkill being subject to high variability. Consequently, roadkill percentage of the migrating population is very unpredictable in any given year. We estimated a conservative annual percentage of migrating monarchs subject to road mortality in the Central Funnel by dividing a roadkill estimate by the sum of overwintering populations and roadkill estimate (overwintering cohort). The size of the overwintering populations is calculated by multiplying the hectares of roosting monarchs at the Mexican overwintering sites from Rendón-Salinas et al. (2018) by the value of 21.1 million monarchs per ha suggested by Thogmartin et al. (2017). Based on these amounts, the estimated annual roadkill rates from our combined years of 2016–2017 MaxEnt models in the Central Funnel represent an average of 2.8% (2.1 million) of the overwintering cohort. In 2016, roadkill within the Central Funnel may have represented about 4.0% of the overwintering cohort (Table 1). The corresponding roadkill for 2017 ranges from 1.5% to 1.8% of the overwintering cohort. In contrast, the projection of 500,000 road-killed monarchs by McKenna

et al. (2001) in Illinois during one week in 1999 represents only 0.26% of the overwintering cohort that year (191 million, 9.05 ha), indicating potentially lower roadkill rates for areas north of the Central Funnel in some years.

The actual monarch population decline within a given year can be much higher than the differences in overwintering cohort sizes from year to year, since it includes the unknown quantities of butterflies recruited, or not recruited due to habitat loss, during spring and summer breeding. Mortality at the Mexican overwintering sites due to occasional winter storms can produce very high mortality, estimated at around 75% in 2002 (Brower et al., 2004) and > 40% in 2016 (Brower et al., 2017). Average monarch overwintering mortality is around  $36\% \pm 21\%$  ( $n = 7$ ; range 4–55%) based on data from Ries et al. (2015b; see their Fig. 24.7). Lowered recruitment due to loss of milkweed habitat has been identified as the primary factor in monarch population declines (Pleasants, 2017; Thogmartin et al., 2017), with losses of milkweed resources in Iowa estimated at 76% from 1999 to 2014 (Pleasants et al., 2017). Other studies place more importance on mortality during the autumn migration in the decline of monarchs (Badgett and Davis, 2015; Inamine et al., 2016; Agrawal and Inamine, 2018). Consequently, it is complex to evaluate the relative importance of roadkill to other factors in the monarch population decline, but it is probably lower compared to the factors of milkweed habitat loss and overwintering mortality. Northward expansion of the monarch summer breeding range is anticipated with climate change (Batalden et al., 2007; Lemoine, 2015), making the southward autumn migration route even longer, increasing both exposure to traffic and associated road mortality (Badgett and Davis, 2015). Monarch roadkill during autumn migration should be further evaluated in the context of other mortality factors along the migration path (Baxter-Gilbert et al., 2015).

Brower et al. (2012) fitted an exponential decline curve to the estimated monarch overwintering populations (ha) in Mexico from 1995 (winter 1994–1995) to 2011 ( $P = 0.015$ ,  $R^2 = 0.336$ ). Inclusion of seven additional years of data through 2018 (Vidal and Rendón-Salinas, 2014; Monarch Watch, 2018b) strengthens fit of an exponential curve ( $y = ae^{bx}$  Fig. 5) ( $P = 0.0009$ ; adjusted  $R^2 = 0.486$ ; ZunZun.com, 2018). A concave exponential curve represents the most serious form of species population decline, indicating constant proportional negative pressure on the population (Di Fonzo et al., 2013). A standard geometric population growth curve, fit to the modeled exponential curve,

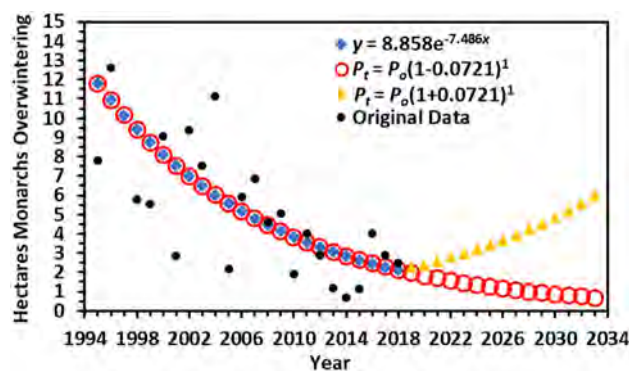


Fig. 5. Annual monarch population in hectares in Mexican overwintering sites from 1995 to 2018 (original data, black circles; Vidal and Rendón-Salinas, 2014; Monarch Watch, 2018b) with fitted exponential curve,  $y = ae^{bx}$  (adjusted  $R^2 = 0.49$ ;  $P = 0.00009$ ; blue diamonds), and corresponding geometric population growth equation curve,  $P_t = P_0(1 + r/n)^t$ , where  $P_t$  is the final hectares (2.11),  $P_0$  is the initial hectares (11.79),  $t$  is the number of years (23),  $n$  is the number of sub-periods (1), and  $r$  is the population growth (or decline) rate (derived population decline of 7.21% per year; open red circles). Fifteen years to restore 6 ha of overwintering monarchs based on totally reversing the current decline to 7.21% growth per year (gold triangles). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

reveals an average – 7.21% annual population decline over the last 23 years associated with an overall 82% population reduction (for details, see Appendix A, section 8). In comparison, a fitted exponential curve until 2011, as used by Brower et al. (2012), yielded a slightly lower annual decline rate of 6.46%. The updated results indicate that the decline rate may have increased or at least has not slowed down. Continuance of the 7.21% rate of decline would result in an average of 0.24 ha of overwintering monarchs occurring in 29 years (by 2046–2047), greatly increasing the chance of extirpation of eastern migrating monarchs by an extreme winter storm mortality event as the overwintering population crosses below the 0.25 ha quasi-extinction threshold (Semmens et al., 2016). A total reversal of the 7.21% annual monarch decline, coupled with an annual 7.21% population increase (net change 14.4%), would be needed to restore the size of the overwintering population to current conservation goal of six hectares (Thogmartin et al., 2017) over the next 15 years. A 0.5% annual reduction in migrating monarch mortality through roadkill mitigation could significantly contribute to a reversal in the long-term 7.2% annual exponential decline in monarch populations (Fig. 5).

#### 4.3.2. Roadkill mitigation

While some major factors in the monarch decline are difficult to reduce, such as overwintering mortality, the opportunity for reducing road mortality is possible through roadkill mitigation (see Rytwinski et al. (2016) for a review on mammal roadkill mitigation). The potential ability to locate re-occurring monarch roadkill hotspots could facilitate more effective mitigation. Scattered and unpredictable monarch roadkill would be more difficult to mitigate. A variety of roadkill mitigation measures have been implemented for danaine migratory butterflies. In Taiwan, a four-meter high net was placed along a 400 m section of bridge on National Freeway 3 to successfully induce spring migrating purple crow butterflies (*Euploea* spp.) to fly over and above the traffic, reducing on site roadkill from around 2.5% to 0.5%. In addition, an outer traffic lane was closed when > 500 butterflies per minute were crossing (Her, 2008; Taiwan EPA, 2010). In response to heavy autumn migratory monarch roadkill observed in Coahuila state of Mexico, traffic signs were posted in 2015 limiting the maximum speed to 60 km per hour (37 mph) in the presence of monarchs (Miranda, 2015). Police have been observed slowing traffic in Nuevo Leon state in Mexico to reduce monarch mortality along a highway south of Monterrey (Dr. Orley R. Taylor, personal communication). Additional research is needed to test and assess the effectiveness of these types of butterfly roadkill mitigation strategies for monarch roadkill hotspots in west Texas and Mexico.

## 5. Conclusions

Our study represents a novel approach for projecting roadkill of a migratory insect through ecological niche modeling. Annual monarch roadkill rates during autumn migration varied substantially. We found close agreement between two methods of estimating monarch roadkill rates, simple extrapolation by road type and MaxEnt roadkill model projections. We project about 1.0 to 3.6 million road-killed monarchs per year during autumn migration over the Central Funnel, which could represent 2–4% of the Mexican monarch overwintering population. MaxEnt model roadkill projections also aligned with several previously known monarch roadkill hotspots, which suggests MaxEnt models could be used to identify additional monarch roadkill within the Central Funnel. Roadkill rates may differ throughout the Central Funnel compared to those observed in the Texas survey area, and should be further investigated. Monarch road mortality should also be investigated along the Coastal Funnel, especially from Texas to Mexico. We recommend more detailed investigation into the spatial and temporal variability in monarch road mortality in the Central Funnel, including how local and short-term weather events, especially related to wind, influence monarch roadkill hotspots. With the new information on monarch road

mortality in the Central Funnel, conservation efforts could be implemented to mitigate mortality at monarch roadkill hotspots. Reducing roadkill rate over the Central Funnel for the eastern monarch population is as an important step towards reversing the continuing decline of this iconic butterfly.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.biocon.2019.01.008>.

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# Permeability of Existing Structures for Terrestrial Wildlife: A Passage Assessment System

WA-RD 777.1

Julia Kintsch  
Patricia C. Cramer

July 2011



Washington State  
Department of Transportation  
Office of Research & Library Services

WSDOT Research Report





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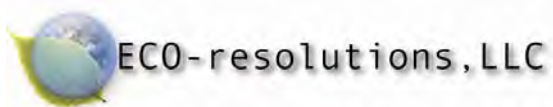


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Julia Kintsch, ECO-resolutions, LLC  
Dr. Patricia C. Cramer, Utah State University



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16. ABSTRACT <b>A Passage Assessment System (PAS) was developed to help the Washington Department of Transportation (WSDOT) evaluate existing transportation infrastructure for its ability to facilitate terrestrial wildlife movement from one side of a roadway to the other. The outcomes of this research provide mechanisms to allow transportation agencies to identify both opportunities and barriers to wildlife passage along roads. The PAS presented in this report provides an assessment process that differentiates – for different types of wildlife – between structures that are currently functional, those that could be enhanced to become more functional, and those that are not functional for wildlife passage. In this manner, the system enables transportation agencies to prioritize these enhancement opportunities for the greatest cost efficiency and identify locations where improved permeability will require new infrastructure investments.</b>  <b>This project involved three steps: 1) a review of the literature and refinement of classification systems for both wildlife and road structures; 2) field research of wildlife use of bridges and culverts across Washington; and 3) the development and refinement of an assessment system to evaluate the ability of bridges and culverts to move a range of wildlife species under or over roads. The study took data from previous research as well as monitoring data from remotely-triggered cameras to produce a system for classifying wildlife into Species Movement Guilds</b>		

based on how the wildlife respond to roads and crossing structures. Structural Functional Classes were also defined to classify road infrastructure, such as bridges, culverts and pipes, to create a common understanding of terminology related to wildlife crossings. The field research was conducted for six months in six locations in central and western Washington with the objective of ascertaining which species of wildlife approached and used different types of structures. The PAS was then developed on the basis of these field data, research on wildlife use of crossings across North America, and the organization provided by the Species Movement Guilds and Structural Functional Classes. The PAS guides practitioners through a series of targeted questions designed to characterize a bridge or culvert relative to its potential to function as a wildlife passage for the full range of wildlife known to occur at a given site. The PAS is intended as an evaluation tool to ensure that biologists ask the right questions in the field and fully document the conditions that may affect passage functionality for the diversity of target species. By answering questions about the structure characteristics, vegetation, land use, roadway, barriers and fencing, the biologist will have a complete passage assessment including preliminary ideas for improving the structure, which can be further refined during the project planning and design processes. The PAS provides an effective mechanism for determining which structures are suitable for enhancements to improve their functionality as wildlife passages or, if no such enhancements are appropriate, identify structure replacement needs for improved highway permeability for wildlife. A Passage Enhancement toolbox is provided to complement the PAS and presents a number of infrastructure adjustments and maintenance actions that may be implemented to help wildlife better move through structures. This toolbox may be used to help guide users in developing site-specific recommendations.

The Passage Assessment System supports timely inclusion of wildlife passage needs from the onset of highway corridor planning, project planning and design. It offers potential cost-savings and minimized project delays by identifying passage modifications that may be significantly less costly than new infrastructure. Where existing culverts and bridges can be shown to pass wildlife, it would help to reduce future construction costs for wildlife crossings in those areas and help to prioritize which areas are lacking in potential crossings and need additional mitigation.

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## EXECUTIVE SUMMARY

State Departments of Transportation (DOT's) are exploring ways to mitigate the negative impacts of roads on wildlife, such as the fragmentation of natural landscapes and the mortality of animals that are hit by vehicles. While new bridges and culverts with fencing specifically designed for wildlife passage (wildlife crossings) offer the greatest opportunity for reducing these negative impacts, they may not always be economically feasible or constructed in a timely manner. Complementing new wildlife crossings, there are also numerous opportunities to enhance existing transportation infrastructure. Hundreds to thousands of culverts and bridges are currently part of the Washington's transportation system and may function to pass wildlife. With small modifications, many of these existing bridges and culverts could be upgraded to provide greater permeability for wildlife and ecosystem processes at lower cost and on shorter time frames than needed for new wildlife crossings.

The purpose of this project was to create an assessment methodology to evaluate existing transportation infrastructure for its ability to facilitate wildlife movement from one side of a roadway to the other. To accomplish this, the research team developed initial criteria for assessing the permeability of existing bridges and culverts for terrestrial wildlife based on the current body of knowledge on how wildlife native to Washington use wildlife crossing structures. The assessment methodology – named the Passage Assessment System (PAS) – was then field tested along Washington roads in linkage areas identified in the Washington statewide habitat connectivity assessment (WHCWG 2010). To complement and validate the field test, the team also conducted wildlife monitoring at seven locations using remote motion-triggered cameras. Data compiled through the monitoring effort served to refine an understanding of how wildlife used select culverts and bridges, which could then be generalized to other locations. The process was then brought to WSDOT biologists in April of 2011 and, through a field test with these future users of the system, the process was further refined. The PAS is a living document, able to be updated to incorporate new understandings of wildlife passage and behavior as they become available, and tailored to address regionally specific wildlife adaptations.

In developing the PAS, it became first necessary to create an explicit process for assessing the characteristics of the various types of bridges and culverts, as well as defining how landscape and structure attributes affect a species' willingness to pass through a structure. To create such an objective standardized process, the researchers began by refining classification systems for wildlife relative to their behavior and perceptions of potential crossing structure, and a second system to provide a common vocabulary for describing the variety of roadway structures that may function as wildlife passages (e.g., culverts, bridges and overpasses). These classification systems were based on a thorough review of the literature base; contributed knowledge from the researchers' concurrent field studies of wildlife and roads in Colorado, Utah, and Montana; and compiled research from colleagues across North America to formulate a more complete understanding of wildlife preferences

and behavior at crossing structures. The wildlife monitoring conducted in Washington as a part of this project further informed an understanding of regional preferences and behavior.

The resulting classification of ‘Species Movement Guilds’ (Chapter 2.2.) categorizes wildlife based on their modes of locomotion and preferred crossing structure characteristics as understood from past and current scientific studies. This is a unique classification designed to facilitate an understanding of ‘what works’ for different types of wildlife. The classification system allows transportation biologists to evaluate the physical and environmental conditions and potential constraints to movement from the perspective of groups of species, and develop mitigation strategies that carefully consider the behavior and preferences of each target species. The Guilds facilitate an understanding of why certain species have specific requirements and allow generalizations to be made across species in a given Guild thereby streamlining project planning and design processes.

Eight Species Movement Guilds are defined (Table 1): Low Mobility Small Fauna, Moderate Mobility Small Fauna, Adaptive High Mobility Fauna, High Openness High Mobility Carnivores, Adaptive Ungulates, Very High Openness Fauna, Arboreal Fauna, and Aerial Fauna. These Guilds provide a classification for mitigating impacts to wildlife whose habitat or movement paths are bisected by a transportation corridor. Interested biologists may not know if a particular species has been studied relative to the effectiveness of various mitigation strategies. By placing that species within its respective Species Movement Guild, generalizations can be made as to which mitigation solutions could be implemented for that species. The Species Movement Guild classification represents the best gathering of the current state of the science of wildlife and transportation in the United States and Canada.

Table 1. Species Movement Guilds

<b>Movement Guild</b>	<b>Typical Species of That Guild</b>
Low Mobility Small Fauna	Invertebrates, frogs, toads, some salamanders
Moderate Mobility Small Fauna	Squirrels, raccoons, hares, weasels
Adaptive High Mobility Fauna	Black bear, bobcat, coyote, lynx
High Openness, High Mobility Carnivores	Grizzly bear, mountain lion, wolf
Adaptive Ungulates	Deer, moose, mountain goat
Very High Openness Fauna	Elk, bighorn sheep, pronghorn antelope
Arboreal Fauna	Flying squirrels, some bats
Aerial Fauna	Songbirds, raptors, bats

The second classification scheme, ‘Structure Functional Classes’ (Chapter 2.3) provides a breakdown of the types of road crossing structures that can provide passageways for wildlife under or over a roadway (i.e., small underpasses, medium underpasses, large underpasses, extensive bridges, wildlife overpasses, specialized culverts and canopy bridges), and the types of wildlife that may use these structures.

The term ‘wildlife underpasses’ connotes many different structures from the smallest culverts that may pass a salamander, to the space under a highway viaduct. A classification of transportation infrastructure into defined Structure Functional Classes provides a definitive set of conditions for four different underpasses, the overpass, and two distinct designs for passages (Table 2). The critical dimensions for breaks among the four classes are based on heights and widths of structures, which are dictated by engineering design constraints as well as the characteristics that define individual species’ willingness to move through a structure. This classification of structure types can help transportation planners, biologists and engineers to relate wildlife passage needs to a specific structure type or types using a common vocabulary.

Table 2. Structure Functional Classes

<b>Class Type</b>	<b>Class Name</b>	<b>Typical Species the Structure Type is Known to Pass</b>
Class 1	Small Underpass	Amphibians, small mammals
Class 2	Medium Underpass	Coyote, bobcat
Class 3	Large Underpass	Deer, elk, black bear
Class 4	Extensive Bridge	Most wildlife – wary species
Class 5	Wildlife Overpass	Most wildlife, including birds
Class 6	Specialized Culverts	Reptiles & amphibians
Class 7	Canopy Bridges	Flying squirrels, arboreal rodents

Combined, the Species Movement Guilds and the Structure Functional Classes lay the foundation for evaluating the permeability of existing structures for wildlife. The team then developed initial structure evaluation criteria based on research in other states supplemented with published research and correspondence with colleagues to determine the factors that appear to influence wildlife passage and how they should be parameterized. These factors include structure dimensions, passageway substrate, vegetation cover, landscape attributes and human use, among other considerations.



A field research component of this project was conducted in conjunction with the development of the Passage Assessment System (PAS). This field component was carried out to better inform the knowledgebase specific to the use of transportation infrastructure by wildlife in Washington. Motion-triggered trail cameras were placed at seven sites across Washington. These sites were selected to best represent different geographic areas, roads with variable number of lanes and different traffic volumes, and different types of structures. Sites were monitored along US 101 in southwestern Washington, and I-90 in west-central Washington. At each site a camera was positioned at each end of the structure to best monitor all animal approaches and passes through the structures.

Monitoring information can help WSDOT determine which species will use certain structures more readily than others. Detailed summaries of the results are provided in the Appendices of this report. In general, every structure monitored passes either mule deer (East of Snoqualmie Pass) or black-tailed deer (western part of the state). These structures included bridges which were expected to pass these deer, and concrete box culverts less than five feet high, a surprising result, perhaps due to a local adaptation necessitated by high traffic volumes on I-90. Photographic data from the Mosquito Creek culvert under US 101 (milepost 76.5), and the double box culvert under I-90 at Tucker Creek (milepost 73) showed a surprising amount of black-tailed deer using the Mosquito Creek/US 101 culvert, and mule deer using the Tucker Cree/I-90 box culvert. The Mosquito Creek culvert is only seven feet (2.1 m) high, less than 16 feet (4.9 m) wide in span, and 138 feet (42 m) long. The I-90 double box culverts at Tucker Creek are less than five feet (1.5 m) high, nine feet (2.7 m) in span, and 58 feet (17.7 m) long for each of the two culverts under opposing lanes of traffic. These culvert heights are typically considered too small for more than occasional mule deer passage. The data from these cameras continue to inform our ideas of how deer will adapt to structures and suggest a need for additional research into the factors that affect passage use, such as traffic volumes, local adaptation, and habitat drivers, among others.

Research throughout the western United States has documented elk's reluctance to pass through confined spaces such as culverts or small, restricted bridges. This study documented elk use of two large bridged structures under I-90, one at the South Fork Snoqualmie River near milepost 33, the other at the Cle Elum River near milepost 79. This research project demonstrated elk movements under bridges that were wide, but less than 10 feet (3.1 m) high where the elk pass under the bridge. This new insight that elk may be willing to use low bridges so long as they are sufficiently wide helped inform the requirements quoted for elk in the Species Movement Guilds description (Section 2.2.1-6) and may help WSDOT and other agencies to better design cost-effective bridges suitable for elk.

Black bear were photographed using a set of large culverts near the town of North Bend, to navigate under I-90. The culverts are 12 feet (3.7 m) high and 29 feet (8.8 m) in span and are tied in to wildlife fencing in both directions. These culverts appears to be among the most successful black bear crossings in the western U.S., as demonstrated by 31 black bear observations during five months of study. In comparison, study sites in two states

combined (Montana and Utah) have tallied less than 12 successful black bear crossings over the course of two years. While the passage is very successful for black bear, only three bobcats approached and crossed through the structure, and seven of 19 approaches by coyotes were repelled. This may explain the low numbers of deer using it. It may also support the idea that in an area of high species diversity, multiple crossings may be necessary for prey, predator and even competitor species.

This compilation of nationwide and local monitoring information was incorporated for the development of a systematic process for evaluating existing transportation infrastructure. The Passage Assessment System (PAS) guides practitioners through a series of targeted questions designed to characterize a bridge or culvert relative to its potential to function as a wildlife passage. The PAS is one of several complementary tools to assist WSDOT in identifying important connectivity areas and design mitigation solutions to improve or restore permeability for native wildlife. While the Washington Wildlife Habitat Connectivity Analysis (WHCWG 2010) offers a broad-scale perspective of connectivity across the state, the PAS allows WSDOT biologists to assess permeability at the site scale, for example along targeted stretches of roadway identified as bisecting these landscape connections.

To begin the assessment process, it is necessary to first select the roadway segments of interests before conducting the PAS in the field. These may be areas that are identified connectivity zones; areas with high levels of animal-vehicle collisions, as determined from carcass removal data; areas that are slated for upcoming projects in short-term (3-5 year) planning or longer term (5-15 year) corridor planning; or, preferably, a combination of the above. The next step before taking the PAS into the field is to identify the species of interest whose habitat is bisected or adjacent to the roadway, and for which movement from one side of the road to the other may be of concern. In general, target species include those that are of danger in animal-vehicle collisions, such as deer, elk and moose; species of concern such as forest carnivores and threatened and endangered species; and other species that are sensitive to the barrier effect of roads. The Wildlife Habitat Connectivity Analysis identified 16 focal species for the connectivity analysis. These species, if they occur in the geographic area of interest, should be included as target species. Appendix A identifies target species and associated Species Movement Guilds for each ecoregion in the state.

The assessment questions that compose the PAS were derived from a similar assessment system used in Colorado (Kintsch et al. 2011) and were further refined through a field test in Florida conducted by one of the researchers (Cramer). Following an additional series of refinements in collaboration with WSDOT, the researchers conducted a one-week field test, visiting 17 sites in southern and central Washington, including sites representing multiple bioregions and a range of structure types (pipe culverts, box culverts, arch culverts, small bridge underpasses and large bridge underpasses) as well as road types (from two to six lanes, including both divided and undivided highways). See Appendix D for complete site summaries. Final refinements to the PAS were made based on monitoring results and feedback an April 2011 workshop where the PAS was presented to WSDOT biologists from across the state.

The PAS is composed of three sections: General Questions, Undivided Highway, and Divided Highway, as well as a User's Guide provided for additional reference. For each structure that is being evaluated the user will complete 1) the General Assessment Questions, and 2) either the Divided or Undivided Highway Assessment Questions, depending on whether the structure of interest is located on a divided or undivided highway. Each of the questions in all three sections is fully clarified in the User's Guide. The complete PAS is available in hardcopy format in Appendix B of this report, or a digital copy is available from the Fish and Wildlife page of WSDOT's intranet. It is recommended that two biologists conduct the PAS together to capture a more comprehensive picture of a structure's passage characteristics.

The General Assessment Questions record general information about the site, including a milepost, GPS point, a unique location code, the Structure Functional Class Type, the Species Movement Guilds present at that site, and whether the highway is divided or undivided. The answer to this last question – divided or undivided highway – will determine which form the user completes next, either the Divided or Undivided Highway Assessment Questions. While the questions posed are the same for a divided or undivided highway, they must be posed independently for each structure at a divided highway site.

At the start of the form the user is asked to respond to a set of preliminary questions. These are a collection of targeted questions designed to determine if there is a 'fatal flaw' with the structure relative to the Species Movement Guild(s) of interest. Each question should be considered relative to the Species Movement Guilds indicated. If a fatal flaw is identified, then the user need not complete the remaining PAS questions as the fatal flaw renders the structure unsuitable for enhancement; a redesigned and reconstructed structure is required to pass wildlife at that location. Fatal flaws may be specific to some or all Guilds and include situations where a culvert is too long for the target species to pass through or where there is a lack of visibility from one end of a structure to the other.

If no fatal flaws are identified, the user then continues with the remaining questions, which are divided into distinct sections to guide the evaluation process. The assessment questions address the structures size and shape, lanes of traffic, other nearby structures, inlet and outlet features, water flow, visibility, vegetation, nearby land use and fencing, evidence of wildlife use and any human use. Throughout the PAS, users are encouraged to take a number of photos from multiple directions to fully capture a visual record of the structure and its attributes.

Finally, the user is instructed to document their general impressions regarding the functionality of the structure for each of the Species Movement Guilds of interest. For each Guild, the user is instructed to rank the structure such that an A rank means that animals could pass through the structure as is or with small modifications; a C rank means that the structure could be functional with modest modification; and an F rank means that the structure cannot be enhanced to function as a wildlife passage. This section is a subjective assessment and responses should be based on the user's overall impression having completed the full PAS. Users are then asked which features could be changed to make the structure more functional for any Species Movement Guild of interest given an A or C rank.

This question offers an opportunity for the user to suggest potential improvements. These may be amended and refined later, but this evaluation is helpful for capturing preliminary ideas and impressions while still in the field.

Upon completing the PAS the user will be equipped to answer the question: ‘can this structure be improved to accommodate passage for the target species present in this area?’ It is possible, in some cases, that a given structure may be enhanced to accommodate one or several of the target species, but cannot be suitably improved to accommodate all target species.

Having determined that a structure *can* be enhanced for wildlife passage, biologists are then confronted with the question of *how* to enhance the structure to facilitate passage. Given the unique characteristics of every structure and the specific permeability objectives at each site, there is no simple answer to this question, however a number of commonly encountered situations are addressed in the Passage Enhancement Toolbox (Appendix C). The toolbox addresses a number of situations and provides examples of each. The user is encouraged to consider the range of possible enhancements and how they could be implemented at each site being assessed.

The Passage Assessment System supports timely inclusion of wildlife passage needs from the onset of highway corridor planning, project planning and design. It offers potential cost-savings over new structures and minimizes project delays by identifying passage modifications that may be significantly less costly than anticipated. If existing culverts and bridges can be shown to pass wildlife, it would help to reduce future construction costs for wildlife crossings in those areas and help to prioritize which areas are lacking in potential crossings and need immediate mitigation. The PAS can also be used to identify areas where maintenance and daily operations activities could significantly improve existing infrastructure for wildlife movement outside of projects. PAS should be considered a living document as new research reveals how passage characteristics affect permeability for different types of species.

There are a number of ways in which the PAS may be enhanced over time to facilitate the assessment process and guide the design of appropriate mitigation enhancements. Notably, while the PAS is currently available as hard copy data forms for use in the fields, it is also ready to be programmed into handheld GPS-data collection units. Two such units are currently being beta-tested by the USDA Forest Service (contact: S. Jacobson). These units provide a streamlined mechanism for collecting and compiling field data. Both the hard copy forms and the programmable units may be easily updated and refined as needed.

In addition, ongoing and new monitoring studies that help deepen our understanding of wildlife responses to crossing structures may also further inform and refine the PAS over time. With the deployment of field research cameras across Washington, WSDOT will be better equipped to record species’ responses to transportation infrastructure and traffic. These data will greatly assist WSDOT in developing wildlife crossing structures and enhancements to existing structures that will improve the permeability of the state’s road network for all wildlife.

As the knowledgebase of what works and doesn't work for different species evolves, DOTs will be increasingly equipped to design effective new wildlife crossing structures and improve the functionality of existing structures. Targeted monitoring where permeability enhancements have been implemented will create a positive feedback loop for maximizing the effectiveness of future improvements. Tools such as the PAS can help DOTs direct transportation dollars for maximum effectiveness and cost efficiency.



## CHAPTER 1. INTRODUCTION

The science and practice of transportation ecology is concerned with the effects of transportation on the natural world and the measures necessary to help avoid, minimize and mitigate those effects. In a world largely dependent upon motorized transport of people, goods and services, the negative consequences to individual plants and animals and entire ecosystems is inevitable. Both the road footprint and vehicular traffic pose threats to intact ecosystems and wildlife by creating barriers to movement of individuals and natural processes, fragmenting natural communities, and causing numerous vehicle collision-related deaths. At the heart of the practice of transportation ecology is the belief that new transportation projects should first avoid natural areas and crucial wildlife core areas and corridors; second, plans should minimize those effects; and lastly, mitigate for the effects of a project on wildlife, natural habitat and ecosystem processes. In the case of existing transportation infrastructure that is still in use, mitigation is the only option available for improving roadway situations to accommodate multiple wildlife species and their movements across the landscape, thereby promoting wildlife permeability.

The negative effects of roads including the fragmentation of natural landscapes and the mortality of animals that are hit by vehicles can be partially mitigated through improvements to existing infrastructure to enhance permeability for wildlife. While new crossing structures designed specifically for wildlife passage offer the greatest opportunity for reducing the negative impacts of roads on wildlife, such large infrastructure projects are often not economically feasible or constructed in a timely manner. Hundreds to thousands of culverts and bridges are currently part of the state's transportation infrastructure and may function to pass wildlife. With small modifications, many of these existing bridges and culverts could be upgraded to provide greater permeability for wildlife and ecosystem processes.

Efforts are underway nationwide to better plan new transportation projects and upgrades to existing transportation infrastructure in ways that help to minimize the negative effects of roads on the natural environment, natural process and wildlife movement. Such integrative planning efforts begin at the long-range planning stage, where initial environmental needs and mitigation costs are assessed. To properly inform these long-range planning efforts there is a need to assess existing infrastructure for its current and potential ability to function as passageways for different types of wildlife. Inclusion of wildlife permeability needs at the outset of project planning effectively promotes landscape connectivity to help minimize transportation impacts in a cost-effective fashion.

While there are many studies documenting individual species' preferences for crossing structures across the continent and the globe, until this research project, there has not been a complete analysis of functional crossing structure characteristics for diverse wildlife species. In addition, while transportation agencies across North America and Europe have instituted various types of enhancements to existing infrastructure to promote permeability for wildlife at a number of locations, a clear process for understanding and defining the structural and landscape characteristics that enhance or impede movement through a structure for diverse types of wildlife has been lacking.

Consequently, the Washington State Department of Transportation (WSDOT) has been without a means for understanding how transportation infrastructure currently functions to support or impede connectivity for terrestrial wildlife. In supporting this research, WSDOT identified a concrete need for protocols for evaluating existing structures – bridges and culverts – with regards to their potential to pass different types of wildlife. The outcomes of this research provide these mechanisms, allowing transportation agencies to identify both opportunities and barriers to wildlife passage. The Passage Assessment System (PAS) presented in this report provides an assessment process that differentiates – for different types of wildlife – between structures that are currently functional, those that could be enhanced to become more functional, and those that are not functional for wildlife passage. In this manner, the system enables transportation agencies to prioritize these enhancement opportunities for the greatest cost efficiency, and identify locations where improved permeability will require new infrastructure investments.

The Passage Assessment System supports timely inclusion of wildlife passage needs from the onset of highway corridor planning, project planning and design. It offers potential cost-savings over new structures and minimizes project delays by identifying passage modifications that may be significantly less costly than anticipated. If existing culverts and bridges can be shown to pass wildlife, it would help to reduce future construction costs for wildlife crossings in those areas and help to prioritize which areas are lacking in potential crossings and need immediate mitigation. The process also assists in ecological considerations because it targets priority areas where functional passages do not currently exist. The PAS, in conjunction with Washington's recently completed statewide Wildlife Habitat Connectivity Analysis (WHCWG 2010) and the statewide carcass removal database, form the basis for targeting mitigation dollars and incorporating wildlife needs early in the transportation planning process to inform infrastructure designs prior to project development and thereby help minimize delays. The PAS can also be used to identify areas where maintenance and daily operations activities could significantly improve existing infrastructure for wildlife movement outside of projects.

## **1.1. History of Landscape Permeability in Washington State**

Since 1991 WSDOT has managed a cooperative program to inventory, prioritize, and correct fish passage barriers along state roads. More recently, WSDOT has recognized the need for creating an analogous process for identifying and assessing connectivity needs for terrestrial wildlife across state roads, of which this Passage Assessment System is a step.

In July 2007, Washington State Secretary of Transportation Douglas MacDonald signed Executive Order 1031 'Protections and Connections for High Quality Natural Habitats', which directs the agency to protect ecosystem health and preservation of biodiversity through the road and highways programs. This order directs WSDOT to protect aquatic and terrestrial connectivity for fish and wildlife. As part of WSDOT's actions to fulfill this order, WSDOT and its partners in the Washington Wildlife Habitat Connectivity Working Group released the statewide Washington Wildlife Habitat Connectivity Analysis (WHCWG 2010). This document provides maps based on scientific analyses of how 16 target species of wildlife may need to move across the state through connected networks and where the most intact connected landscapes occur throughout the state. This connectivity assessment, in combination with other information, will influence road corridor plans and highway improvement projects, and will help to prioritize highway segments for receiving funds for wildlife-friendly improvements.

With these multiple approaches to identify and maintain terrestrial and aquatic connectivity across Washington roads, it is a logical next step to create a method to assess how well existing infrastructures passes terrestrial wildlife. The results of this assessment method could then in turn be used to improve existing structures in small and large ways to assist wildlife and natural process movement, such as the flow of water. It is an important step in the process of "protecting connections for high quality habitats" as directed by Executive Order 1031.

## **1.2. The Science of Wildlife Use of Transportation Infrastructure**

Designing wildlife crossings – new structures as well as enhancements to existing infrastructures – is based on research documenting how different species and taxonomic groups of wildlife have used wildlife crossings in past and current studies. In addition, more general information about the behavioral characteristics and habitat needs of that species can be used to further inform crossing designs, particularly where little or no research has been conducted on an individual species' use of crossings. Improving roads for wildlife permeability has been studied since

1975 when Colorado's first mule deer culvert under Interstate 70 was monitored for mule deer use (Reed et al. 1975). Since that time many states have benefited from the several dozen studies monitoring wildlife use of culverts and bridges across the continent. While the first wildlife crossings were constructed for a specific target species, such as deer or Florida panther, biologists soon learned that designing wildlife passages for the full suite of species found in an area can benefit all of the wildlife present in that area and can help maintain ecosystem processes, such as hydrologic flow (Foster and Humphrey 1995). It is now common, though perhaps not standard practice, to design new wildlife passages for suites of animals. Designing crossings and improving existing infrastructure therefore requires understanding how multiple species may perceive and, subsequently, use a passage. For example, a passage designed primarily for large ungulates can be modified to also accommodate smaller animals and aquatic species. As transportation agencies move towards incorporating more wildlife-friendly practices in their designs, construction and operations, such multi-species considerations are prudent.

### 1.2.1. Types of Wildlife Passages

A wildlife crossing is a structure that allows wildlife to pass over or under the road. A wildlife crossing structure is designed and built specifically or in part to assist in wildlife movement (Bissonette and Cramer 2008) and include both overpasses and underpasses. Overpasses are built to allow wildlife to move over the flow of traffic to get to the other side of the roadway (Fig.1). Underpasses are much more common and entail two different types of structures, culverts and bridges, both of which allow wildlife to move under the roadway. Bridged wildlife passages can be single span bridges where the structure rests on abutments with no intermediate support columns (Fig. 2). Multi-span bridges are on abutments as well but also have one or more intermediate support columns between abutments (Fig. 3). Culvert underpasses are conduits for wildlife under the road that have an embankment around the entire perimeter. Typically either



Figure 1. Wildlife overpass over Highway 93, MT © P. Cramer



Figure 2. Single span bridge wildlife crossing in Utah, under US 6 © P. Cramer

concrete box culverts (Fig. 4) or corrugated steel plate arch culverts are used (Fig. 5). More recently, a new arch design for wildlife passages that is intermediate between bridges and culverts has been constructed. An arch crossing consists of pre-fabricated six foot-wide arch spans that rest on abutments and are fastened together to form an arched passageway beneath the road. There is some soil at the sides of the arches, but the abutments are large enough that there are two to one slopes coming off of them to the passage area, making the entrance appear more like a bridged structure than a culvert (Fig. 6)



Figure 3. Multi-span bridge functioning as a crossing under I-70, Colorado © Center for Native Ecosystems, ECO-resolutions, LLC & CDOT



Figure 4. Concrete culvert under US 101 in Washington with black-tailed deer doe and fawns © P. Cramer, J. Kintsch, & WSDOT



Figure 5. Black bear entering a multi-plate steel arch culvert “game crossing” under I-90 in Washington (built in 1976) © P. Cramer, J. Kintsch, & WSDOT



Figure 6. Arch span wildlife crossing in Utah under I-70 © P. Cramer



### 1.2.2. Overview of Factors Affecting Wildlife Use of Crossings

There are many interrelated factors that affect an individual animal or a population's decisions to use crossings. The two main factors that affect these decisions can be grouped into characteristics of the external environment and internal motivations based on the biology of the species. Understanding why animals behave the way they do and their basic biological needs is an essential component to help planners, biologists and engineers design suitable wildlife crossings and enhance existing infrastructure that considers both the internal and external factors motivating animals to use or avoid a given structure.

Biological factors important to wildlife movement include the following (note that not all of these factors are of equal importance for all species):

- Mode of locomotion, i.e., crawling animals move differently than running animals and may spend more time in a crossing structure;
- Predator avoidance strategies, i.e., the need for prey species to feel safe using a crossing structure;
- Defense strategies, i.e., skunks stop to spray a threat, while porcupines back up to it, and rabbits and deer may run in a zigzag fashion;
- Herd mentality versus solitary movement;
- The need to access basic resources such as food and water;
- The need to find mates;
- The need to migrate to meet basic biological needs such as breeding, calving, egg laying, or access to winter and summer habitats;
- The need to escape human pressures such as development or recreational activities;
- The need to disperse to establish new territories;
- The need for specific types of habitat such as a semi-aquatic condition.

Environmental factors that affect how wildlife perceives structures for potential passage include (note that not all of these factors are of equal importance for all species):

- The presence of natural area or specific habitat on both sides of the road;
- The presence of human development or disturbance nearby or within the structure;
- Vegetative cover leading to the structure;
- Vegetative or woody debris cover within a structure;
- Visibility through the structure and at the approaches to the structure;
- Light contrast inside and outside of the structure;
- Elevation gradients that may affect water flow or large gradients that may affect an animal's approach to a structure;

- Traffic noise that is present outside the structure and that may be amplified inside or changed in pitch inside or beneath the structure;
- Traffic volumes, i.e., heavy traffic volumes may deter animals from coming near the road, and crossing through a structure, while low traffic volumes may encourage animals to cross at-grade rather than use structures unless they are otherwise prevented from doing so with fences or other funneling devices;
- Similarity of the conditions in, under or on a structure relative to the natural environment in which it is located;
- The feel of openness (rather than confinement) for an animal crossing through a structure.

Openness ratio has been a much-discussed and frequently misused metric for assessing the functionality of crossing structures for wildlife, and for this reason it is briefly addressed here. Openness ratio – defined as (height x width)/length, in meters – was originally derived as a threshold measure for comparing the relative openness of various box culverts for use by mule deer, given their preference for a clear line of site through a structure (Reed et al. 1979). This measure has since been extrapolated beyond its intended use and applied to all kinds of structure shapes, leading to confusion in how to measure structures other than boxes, and has been applied to a variety of species, with different minimum thresholds indicated for different species. Other complications in relying on openness ratio as a measure of structure functionality include how the ratio – which is unit-specific – is calculated; how skylights and grates affect the length metric; and a failure to differentiate between the value of height (rise) vs. width (span) in affecting the likelihood of animal using a structure (Jacobson and Jacobson 2007). While researchers agree that the concept of structure openness is an essential factor influencing passage functionality for some types of species, such as deer and elk, Clevenger et al. (2002) noted that openness may become a less important variable influencing culvert use as animals become familiar with particular structures, versus animals that are encountering a structure for the first time, in which case openness may play a greater role. For these reasons, it is not advised to use openness ratio to calculate thresholds for evaluating the functionality of a given structure, and it is not included in the Passage Assessment System.

Jacobson and Jacobson (2007) provide alternative measures to openness ratio for white-tailed deer that consider predator avoidance strategies. These include aspect ratio, a measure of structure length and height at the level of a deer's head; cross-sectional area, a measure of structure shape relative to a deer's perception of openness; brightness, a measure of perceived distance to safety; and presence of a ledge, which can influence an animal's willingness to pass through a structure. While these measures have not been tested or refined for other species, concepts such as

these were used in the development of the Passage Assessment System presented in this report.

Past and current research projects are typically designed to measure one or several of these factors and how they influence passage for a given species. Rarely have all of these factors been studied relative to the full suite of species present at a study location.

## **CHAPTER 2. RESEARCH APPROACH**

The purpose of this project was to create an assessment methodology to evaluate existing transportation infrastructure for its ability to facilitate wildlife movement from one side of a roadway to the other. To accomplish this, the research team developed initial criteria for assessing the permeability of existing bridges and culverts based on the current body of knowledge on how wildlife native to Washington uses wildlife crossings. The assessment methodology – named the Passage Assessment System (PAS) – was then field tested along Washington roads in linkage areas identified in the Washington statewide habitat connectivity assessment. To complement and validate the field test, the team also conducted wildlife monitoring at seven locations using remote motion-triggered cameras. Data compiled through the monitoring effort served to refine an understanding of how wildlife used select culverts and bridges, which could then be generalized to other locations. The process was then brought to WSDOT biologists in April of 2011 and, through a field test with these future users of the system, the process was further refined. It is a living document, able to be updated to incorporate new understandings of wildlife passage and behavior as they become available, and tailored to address regionally specific wildlife adaptations.

To create the PAS, it was first necessary to develop an explicit process for assessing the characteristics of the various types of bridges and culverts as well as how landscape and structure attributes affect a species willingness to pass through. Taking a synthesis approach, the team reviewed the current literature base and complimented this with knowledge gleaned from our concurrent studies in Colorado, Utah, and Montana and from research colleagues across North America to formulate a more complete understanding of wildlife preferences and behavior at crossing structures. The wildlife monitoring conducted in Washington as a part of this project further helped to develop a more definitive understanding of regional preferences and behavior.

Using this base of information, the team developed two interrelated classification schemes. The classification of ‘Species Movement Guilds’ (Chapter 2.2.) categorizes wildlife based on their modes of locomotion and preferred crossing structure characteristics as understood from past and current scientific studies. This is a unique classification designed to facilitate an understanding of ‘what works’ for different types of wildlife. The classification system allows transportation biologists to evaluate the physical and environmental conditions and potential constraints to movement from the perspective of groups of species, and develop mitigation strategies that carefully consider the behavior and preferences of each target species.

The classification ‘Structure Functional Classes’ (Chapter 2.3) provides a breakdown of the types of road crossing structures that can provide passageways for wildlife under or over a roadway (i.e., small underpasses, medium underpasses, large underpasses, extensive bridges, wildlife overpasses, specialized culverts and canopy bridges), and the types of wildlife that may use these structures. Combined, the Species Movement Guilds and the Structure Functional Classes lay the foundation for evaluating the permeability of existing structures for wildlife. The team then developed initial structure evaluation criteria based on research in other states supplemented with published research and correspondence with colleagues to determine the factors that appear to influence wildlife passage and how they should be parameterized. These factors include structure dimensions, passageway substrate, vegetation cover, landscape attributes and human use, among other considerations.

The Passage Assessment System is a tool for transportation biologists to evaluate existing bridges, culverts and overpasses relative to their functionality as potential wildlife crossings. The PAS does not and cannot provide a definitive answer as to how to modify existing infrastructure to better accommodate terrestrial wildlife passage; instead, the PAS guides the user through the thought process of identifying the characteristics that impede or promote wildlife passage for different types of species, ensuring that all the relevant factors are fully considered, from a species perspective. In combination with other resources, such as the Passage Enhancement Toolbox provided in Appendix C, users are provided with a framework for identifying if a structure can be modified to accommodate the target wildlife and, if so, which modifications are warranted.

## **2.1. Previous Roadway Infrastructure Evaluation Studies**

Across the country, DOTs are increasingly integrating permeability for terrestrial and aquatic wildlife into transportation projects to mitigate transportation impacts

or, in many cases, restore connectivity that has been lost. Efforts to evaluate permeability needs range from informal field visits to detailed manuals for enhancing aquatic connectivity through culverts (e.g., Washington Department of Fish and Wildlife 2000). While a number of states, particularly in the west, have conducted wildlife habitat connectivity assessments of varying levels of analysis and detail, to date, no states have a complete inventory and assessment of transportation infrastructure as it relates to identified wildlife connectivity zones for terrestrial wildlife. In-the-field assessments of potential modifications to existing infrastructure can be conducted well in advance of transportation planning schedules, allowing planners to incorporate wildlife permeability considerations into project designs and budgets. In addition, such assessments may reveal small modifications that can be made outside of project planning through ongoing operations and maintenance, with great benefits to wildlife movement, for example, by removing fencing blocking culvert entrances, clearing debris blocking passage through culverts, or by adding soil over riprap under bridges to create a dry, stable pathway for wildlife to cross over.

In Colorado, a three-year study of the Interstate 70 corridor developed a basic framework for evaluating existing bridges and culverts. This study was supplemented by camera monitoring at select locations in an effort to identify key segments of roadway for wildlife connectivity and to develop recommendations for improving permeability in these areas (Kintsch et al. 2011). The evaluation processes conducted on I-70 directly informed the development of the Passage Assessment System created for this research project.

The Massachusetts Department of Transportation published a report that presents considerations for evaluating existing structures at freshwater streams and offers best practices for accommodating wildlife passage at these road-stream crossings (Massachusetts Department of Transportation 2010). This evaluation system provides a simple field assessment for rating road-stream crossings for terrestrial and aquatic passage on a scale from 0 (severe barrier) to 10 (meets optimal standards). The rating system considers only three factors influencing terrestrial passage – the presence of barriers, openness ratio and minimum clearance – and does not distinguish among the diversity of wildlife species. In contrast, the PAS presented here includes a number of variables that influence the likelihood of successful passage and provides guidelines for assessing how crossing characteristics may affect different species differently.

Field-based assessments of existing transportation infrastructure in other states have occurred on an ad-hoc basis or, in the case of Utah, limited to a broad-scale and subjective evaluation of barriers to connectivity across specific highway corridors (Utah Department of Transportation 2007).



## 2.2. Species Movement Guilds

The Species Movement Guilds (Table 1) are a classification of terrestrial wildlife species based on their responses to roads and crossing structures – behavior that is largely influenced by predator detection and avoidance strategies, as well as an animal’s size and capacity for locomotion. Traditional species classifications are based on taxonomic groupings based on biologic similarities among species. In contrast, the Species Movement Guilds classification was developed specifically for the purpose of designing species-specific wildlife crossings and evaluating the influential characteristics that render a structure functional or non-functional. Previous studies in road ecology have proffered similar classifications more closely tied to taxonomic classifications (e.g., Grillo et al. 2010), or based on body size (Clevenger and Kociolek 2006) and how species respond to habitat fragmentation (Cavallaro et al. 2005). Clevenger and Huijser (2009) developed a size-based classification that considers fragmentation impacts as well as species area requirements.

The Species Movement Guilds presented in this report are intended to be a refinement of these previous classifications, including an in-depth discussion and justification for the groupings. The guilds categorize wildlife based on body size – which puts a physical limit on the structures that a given species can use – how they move, how they respond to roadway traffic or potential threats such as predators, and the crossing structure characteristics, such as vegetation cover, ambient conditions and visibility, that may affect their willingness to use different structures to move under and over roads. The guilds facilitate an understanding of why certain species have specific requirements and ‘what works’ for different types of species. Predator avoidance is a key factor for most wildlife. As different species have different detection and avoidance strategies, crossing structures must address the strategies of the target wildlife at a given location. In addition, some species are limited by their movement capacity (slow vs. fast-moving), by their mode of travel (ground, water, air), or by their need for consistent environmental conditions (e.g., some amphibians); these specific habitat requirements also need to be addressed. The type of preferred habitat that an animal lives in within an ecoregion also affects how they use a crossing. Populations of the same species may be more willing than others to use a crossing based on its similarity to the landscape it is placed in. A population’s experience with humans and other factors can also affect how they use a crossing; where some wildlife populations may be adapted to human presence, for others it causes a fear or avoidance reaction. The Species Movement Guilds are based on generalizations across populations and provide broad guidance for application within the context of the landscape and specific situations at hand. The guilds were developed with careful review of published and grey literature in wildlife and transportation ecology as well as the author’s and other colleagues

combined experience with wildlife movement and roads across the U.S. and Canada; pertinent references are included in the discussion of each of guild in the following section.

The purpose of Species Movement Guilds classification scheme is to provide a user-friendly framework for transportation biologists to determine how well the movement needs of target species are accommodated by existing transportation infrastructure and whether post-construction improvements could improve wildlife passage at a given location. This process allows biologists to better understand the permeability of the transportation network for different types of species. Although the classification was designed specifically with regards to improving bridges, culverts and overpasses, it could also be applied to the design of shoulder and median barriers, fences and related roadway infrastructure. By combining an understanding the movement needs of each Species Movement Guild with the situational and structural attributes that render a structure functional for those guilds, biologists are better positioned to evaluate suitable enhancement options at a given location or, if no such option is available, advise the design for a new, effective wildlife crossing. Developed in collaboration with a colleague at the U.S. Forest Service, the Species Movement Guilds were compiled with reference to the best available research and monitoring information (including the concurrent monitoring project in Washington), and were further validated and refined during the field test of the structure evaluation system.

Further conditions for defining Species Movement Guilds included culvert and bridge minimum size requirements and structure characteristics such as substrate, cover, openness, ambient conditions, lighting, lines of sight, sound buffering, shape, approach conditions, amount of human use/development, etc. Typically, when designing passage structures the movement needs of multiple types of species must be addressed as opposed to a single species or guild. Intuitively, large structures may be designed to accommodate smaller species, whereas small culverts cannot accommodate larger wildlife species. However, the specific design characteristics required by each target Species Movement Guilds must be individually addressed; a larger structure will not automatically accommodate small animals if it does not provide appropriate cover or other necessary attributes. This species classification offers a useful mechanism for an initial assessment of needs and opportunities. In all cases additional analysis is required to determine the best options for accommodating multiple species or regional variations in species preferences due to the presence or lack of predators, human activity, resource availability or other considerations.

**TABLE 1:** Terrestrial Species Movement Guilds. A functional categorization of terrestrial wildlife based on body size, predator avoidance strategies, and species behavior relative to road infrastructure, traffic and crossing structure characteristics. Developed by the authors in collaboration with Sandra Jacobson, U.S. Forest Service.

<b>Species Movement Guild</b>	<b>Species Examples</b>	<b>Species Attributes</b>	<b>Preferred Passage Attributes</b>	<b>Preferred Structures</b>
Low Mobility Small Fauna (LMSF)	Invertebrates, frogs, toads, some salamanders, some ground insects	Small, slow-moving species that require specific ambient conditions (including possibly moisture and light) to survive and disperse. Some species in this group may take several generations to move across a structure. Completely enclosed structures may interfere with directional movements for some species that navigate by reference to celestial features.	Crossings must provide species-specific habitat and consistent outside environmental conditions throughout the entire structure, including natural substrate, light, temperature and moisture. Species in this category may be found adjacent to water, but probably prefer dry pathways or pathways without flowing water through culverts.	<i>Extensive bridges, wildlife overpasses, trench drains</i>
Moderate Mobility Small Fauna (MMSF)	Ground squirrels, shrews, rabbit, hare, chipmunk, vole, mice, skunk, raccoon, some salamanders, lizards, turtles, snakes, badger, marmot, weasel, pika, fox, marten, fisher, river otter, beaver, mink, muskrat, some ground birds	Small animals that are fairly adaptable to different types and sizes of structures. Almost all of these species are prey for larger species and require some hiding cover for protection. Some may require a natural substrate or moisture to survive in structures, and most prefer natural substrates.	Functional crossing structures include a variety of structure types and sizes. A non-submerged pathway is almost always preferred and usually required by species in this guild. They may also use structures with artificial substrate or ramps. Cover provided within larger structures with rocks, vegetation or smaller pipes is usable.	<i>Small, medium or large underpasses (culverts and bridges), extensive bridges, wildlife overpasses</i>
Adaptive High Mobility Fauna (AHMF)	Black bear, bobcat, coyote, lynx	Medium-sized mammals that naturally use enclosed spaces for dens, and can tolerate a limited amount of enclosure in underpasses. Minimum crossing structure size is proportional to species body size.	Species in this group may use a variety of structure types and prefer to have suitable habitat directly adjacent to the structure entrances.	<i>Small, medium or large underpasses (culverts and bridges), extensive bridges, wildlife overpasses</i>
High Openness High Mobility Carnivores (HOHMC)	Grizzly bear, mountain lion, wolf	Highly mobile species that prefer good visibility. Typically larger animals that have a larger minimum structure size requirement than Adaptive High Mobility Fauna. These species range widely across the landscape and may need to cross multiple highways.	Open structures that provide good visibility but can be tolerant of longer structures (>100'). Species in this group tend to prefer more open structures than Adaptive High Mobility Fauna but are more tolerant of enclosed structures than Very High Openness Fauna.	<i>Large bridge underpasses, extensive bridges, wildlife overpasses</i>

<b>Species Movement Guild</b>	<b>Species Examples</b>	<b>Species Attributes</b>	<b>Preferred Passage Attributes</b>	<b>Preferred Structures</b>
Adaptive Ungulates (AU)	Mule and white-tailed deer, moose, mountain goat	Medium and large-sized ungulates that require good visibility on a horizontal plane and a moderate amount of cover. These animals prefer a natural substrate and adjacent cover, but may also use concrete-bottomed culverts. Ungulates in this group use structures in approximate proportion to their body size (i.e., deer can use smaller structures than moose).	Passages that have good visibility within and around the structure and clear lines of sight from one end of a crossing structure to the other. Preferred structures are wider than they are tall and are less than 100' in length. Mule deer may prefer more open structures than white-tailed deer.	<i>Medium or large underpasses (culverts and bridges), extensive bridges, wildlife overpasses</i>
Very High Openness Fauna (VHOF)	Elk, pronghorn, bighorn sheep, open habitat grouse	Ungulates in this group are particularly wary of predators and require very wide vistas and clear lines of sight. They tend to prefer a moderate amount of hiding cover that does not infringe on their ability to detect or escape predators. Structure size is dictated primarily life history attributes such as predator avoidance or maneuverability.	Large passages with wide openings (at least 15') that are less than 100' long, excellent visibility within and around the structure, and clear lines of sight from one end of a crossing structure to the other. Bridge underpass structures with natural earthen side slopes are preferred to those with concrete or metal walls. Features that may encourage passage include a natural substrate, and noise and light contrast moderating features.	<i>Large culvert or bridge underpasses, extensive bridges, wildlife overpasses</i>
Arboreal Fauna (ArbF)	Flying squirrels, some bats, arboreal voles	Species that move primarily through the canopy rather than on the ground surface.	Features for these species provide a continuous canopy-level structure across the roadway.	<i>Treetop rope bridges, towers, or modified wire or metal structures.</i>
Aerial Fauna (AerF)	Songbirds, raptors, bats, flying insects (including butterflies)	Species whose primary mode of movement is flying.	Features for these species aim to divert flying species out of the path of traffic.	<i>Diversion poles, extensive bridges, wildlife overpasses</i>

## **2.2.1. Research Summary of Species Preferences and Behavior**

This section provides an overview of each of the Species Movement Guilds and the research on individual species that informed the categorization scheme. For each guild, a discussion of the trends found in transportation ecology is presented and specific conditions preferred by different species are noted. This discussion is presented with the understanding that a given crossing may be constructed for suites of species rather than a single target species, in which case crossing designs should draw from the 'preferred characteristics' listed for the suite of species present at that site. There is no perfect crossing structure, as any structure is mitigation – at best, adequate compensation for the natural landscape connectivity that has been lost. As such, the potentially conflicting needs of multiple species must be balanced at any given site. Additional research and information sharing across states and countries will help to further improve crossing designs of the future.

### **2.2.1-1. Low Mobility Small Fauna**

Members of this guild include small, slow-moving animals that require specific ambient conditions (for example, moisture or light) through the length of a crossing structure, such as frogs, toads, some salamanders, invertebrates and some ground insects. Structures for these species may be open at the top to permit moisture and light to enter the structure and to allow navigation with respect to celestial navigation. The structures may be enclosed as well, thus protecting the animals from road pollution and traffic noise. Some species in this guild may take several generations to move the length of a crossing structure, such as insects. Species in this category are found across the spectrum of natural areas including near water (such as frogs and salamanders), dry upland areas (toads and tortoises), and even those amphibians willing to travel over snow to breed, such as long-toed salamanders. As a result of this extreme diversity in preferences of areas of movement, crossings must provide species-specific habitat and consistent outside environmental conditions throughout the entire structure, including natural substrate, light, temperature and moisture. These structures could be small culverts, or large bridges that provide natural substrate beneath them for contiguous movement.

### ***Specific Considerations for Amphibians and Reptiles***

#### **Salamanders and Frogs**

The first amphibian crossings in the United States were a pair of salamander crossings placed under a road in Amherst, Massachusetts in 1987. These tunnels were placed 200 feet (61 m) apart and connected with a system of 12-inch (30.5 cm) high drift fences to direct the salamanders towards the tunnels. Jackson (1996) found that salamanders need light to see inside the tunnel, and once artificial light was provided, the time it took for salamanders to enter and pass through the tunnels was dramatically reduced. Salamanders need moisture in their passages, and crossings designed for these species should include some mechanism for



allowing rain to enter and moisten the substrate within the underpass. Jackson (1996) suggests when considering more than two lane highways for tunnels, take into account animals freezing along the way and either minimize the length of the passage, or provide island-stop over habitat that could serve as half-way points for migrating amphibians.

A typical amphibian crossing is circular or rectangular; generally less than 1.6 feet (0.5 m) in cross section; as short as possible; and with a floor lined with a natural soil substrate (Aresco 2005, Jackson 2003). Specific guidelines for designing amphibian crossings include the following considerations:

- The tunnel should be open at top and fitted with iron grate flush with road surface to allow ample light, rain, and air to circulate (Jackson 2003). Brehm (1989) further notes that grated passages play an important role in providing aeration and equilibrium of ambient temperatures and moisture conditions.
- Because some amphibians and reptiles use olfactory cues to assist them in their movements, Jochimsen et al. (2004) suggest allowing for a layer of detritus and leafy substrate to remain undisturbed along the length of passages.
- Tunnels should be situated so that they can be easily accessed and not prone to flooding (Puky and Vogel 2004).
- Maintenance of amphibian tunnels is also extremely important for functional crossings; tunnels should be cleaned on an annual basis before the start of the migration period (Puky and Vogel 2004).
- Wing walls should angle out from each end of tunnel at approximately 45 degrees (Jackson 2003) and continue outward as guide fencing. This fencing can be plastic (polythene mesh) or concrete (Grillo et al. 2010), or even fashioned from metal guard rails stacked vertically.
- The height of the vertical guide walls can vary from 18 inches (45.7 cm) to over 3.3 feet (1 m; Fig. 7; Aresco 2005, Jackson 2003). The length should extend from the wing walls for 100-300 feet (30-90 m) on both sides of the road. The tops of these walls should be angled away from the road to prevent climbing organisms from getting over the fence. Jackson and Tyning (1989) also suggest that the drift fences should be sunk into the ground 2.5-4 inches (6-10 cm; Figure 8). Some animals do not follow fences. Jackson and Tyning (1989) found that wood



Figure 7. Amphibian and reptile barrier wall at Paynes Prairie State Preserve, along US 441 in Gainesville, Florida © P. Cramer



*Figure 8.* Drift fencing to funnel turtles under the highway to get to other side of Lake Jackson, Tallahassee, FL © P. Cramer

- frogs have been hesitant to move along the fencing.
- Crossing structures should be spaced within 200 feet (61 m) of one another (Jackson 2003); Puky and Vogel (2004) found a maximum spacing distance of 260-328 feet (80-100 m) to be adequate, but recommend determining the spacing between crossing structure on the basis of the migration radius of the target species under normal conditions.
  - Locate crossings in the center of migration routes rather than at the edges. To find these migration routes, the species need to be studied for at least two years because routes vary from year to year (Puky and Vogel 2004).
  - The authors conclude that close cooperation between engineers and biologists specializing in amphibians is of utmost importance to finding mutually acceptable solutions (Puky and Vogel 2004).

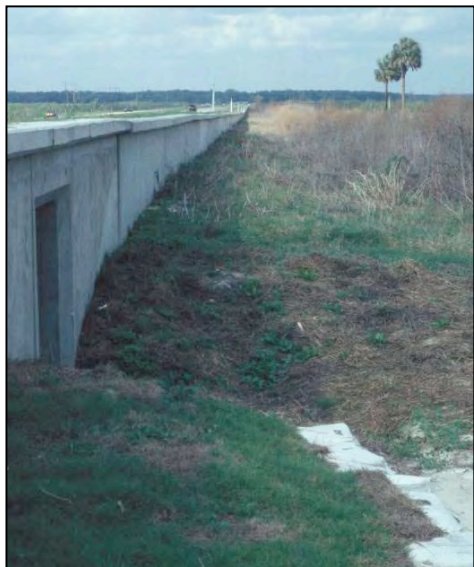
Drainage culverts and culverts designed to allow the flow of water can be modified to pass amphibians and reptiles via the installation of shelves or floating docks inside the culvert (Jochimsen et al. 2004). Jackson (1999) suggests channelizing the water through the culvert to create an extended bank area, although this action should be conducted only with careful consideration of aquatic connectivity needs through the culvert. Dry culverts can be enhanced with the placement of natural substrate inside the culvert to provide a suitable movement surface for amphibians. The addition of cover in the form of vegetation, logs or rocks inside the culvert can also improve conditions for these prey species.

While keeping the top of a culvert open allows for moisture, light, and a view of the night sky, it also allows for road runoff to enter the crossing. This may expose the moving animals to heavy metals such as copper, zinc, and lead, as well as petroleum derivatives. Further research is needed that helps in the design of crossings for this small fauna group. Perhaps multi-chamber designs could be created where outside chambers of a three-chambered culvert would catch the pollutants running off the road, while the middle third chamber is open and aerated but free of road runoff. Another idea would be to find a way to deliver moisture to the culvert from more pure sources outside of the road-right-of way, thus avoiding the need to deliver moisture from the road.

For further information on mitigation solutions for wildlife at locations with road-stream crossings, readers may reference a recent publication from Massachusetts Department of Transportation (Massachusetts Department of Transportation 2010), which offers very instructive recommendations on placing new structures and enhancing older ones to accommodate amphibians and aquatic species in a stream environment.

**BOX 1: Paynes Prairie Ecopassages**

Some of the most successful amphibian (and reptile) crossing structures and fencing are located in Florida. The Paynes Prairie ecopassages (concrete box culverts) and accompanying concrete wall have worked very successfully (Fig. 9; Dodd et al. 2004), with a 93% reduction in total numbers of animals killed one year post-construction. The wall which kept the animals off the road is a one meter high concrete wall with a 6 inch (15.24 cm) lip that faces toward the wild lands away from the road. The concrete is composed of a very smooth mix, so it would be difficult for animals to climb up. There are 8 box culverts along 2 miles of a four lane divided highway. The culverts are approximately 8 feet by 8 feet (2.4x2.4 m), but with natural sedimentation in the culverts, the heights have decreased somewhat over time. At all times there are at least two box culverts with running water, and two culverts at the edges of the wet prairie that are dry. The remaining culverts vary in water depth according to conditions. The greatest weakness of this system at this time is the lack of regular maintenance to clear vegetation growing near the concrete wall. Because plants can grow up and over the wall, tree frogs and other climbing species have been able to access the roadway in this manner. A United States Geological Survey (USGS) website is dedicated to the project (United States Geological Survey 2011).



*Figure 9. Paynes Prairie Ecopassage and amphibian and reptile wall, shortly after construction © P. Cramer*

### Turtles, Tortoises, Snakes and Lizards

Many of the considerations for amphibians are identical for reptiles. The Paynes Prairie ecopassages mentioned above for amphibians have worked for lizards, alligators and snakes, but no turtles were recorded using the culverts. However, in a study of painted turtle movement Jackson and Marchand (1998) found that a 2'x2'x20'<sup>1</sup> (6x6x37 m) tunnel made of wood with 131 feet (40 m) of drift fence at both ends was successfully used by painted turtles, though no road was involved in this study. In this study, the authors caution that clear lines of sight along the drift fencing as well as at the tunnel entrances were an important variable for successful through-passage.

The more recent Lake Jackson crossings and ecopassages along Lake Jackson north of Tallahassee, Florida were installed in 2010. Prior to the installation of the wall and culverts for turtle movement, Aresco (2005) was able to temporarily reduce the high mortality of moving turtles with a drift fence to an existing culvert, and conducted monitoring of the stretch of road for 44 months. A website (Aresco 2011) gives a thorough review of the entire process of identifying a deadly stretch of road for turtles, and raising public awareness and agency support, and finally a mitigation system that includes culverts and a concrete wall like those along Paynes Prairie, Florida (see Box 1).

Overall, research indicates that reptilian species preferences for crossing types and placement are varied among species (Jochimsen et al. 2004, Little et al. 2002), underscoring the importance of local research on the target species of interest to inform the design of mitigation solutions (Woltz et al. 2008). In Portland Oregon, the Port of Portland Authority built turtle culverts for painted turtles, which, although not scientifically studied, appear to work (Figs. 10 & 11).

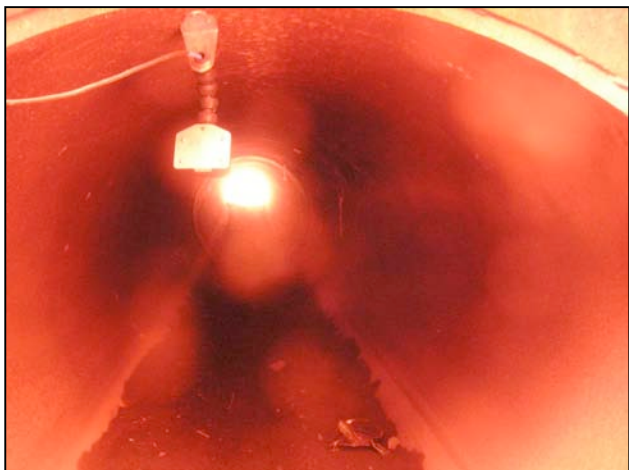


Figure 10. Painted turtle using new turtle crossing culvert in Portland ©Port of Portland



Figure 11. Turtle culvert, wall, and grate ©Port of Portland

<sup>1</sup> All structure dimensions in this document use the format: Height-by-Span-by Length; or if structure length is not being discussed, simply: Height-by-Span.



For further reference, see Jochimsen et al.(2004), which provides an overview of how various structural and ecosystem characteristics effect structure effectiveness at moving amphibians and reptiles. In addition, the Minnesota Department of Natural Resources recently updated a publication on designs and practices for the repair and reconstruction of culverts, bridges, and storm water outfalls (Leete 2010). The document is particularly useful in the design of wildlife benches and curbs for animals of all sizes and shapes, and includes recommendations for using biodegradable materials to replace the use of nylon mesh for erosion control, which is known to trap small animals, such as snakes, frogs, toads, turtles, and ducklings.

### **2.2.1-2. Moderate Mobility Small Fauna**

Moderate Mobility Small Fauna are small animals such as ground squirrels, rabbits, voles, raccoons, snakes, badgers, marmots and weasels that are fairly adaptable to a variety of structure types and sizes (Fig. 12). Members of this guild are typically preyed upon by larger species and, therefore, require protective cover through a structure or, at minimum, at the approaches to a structure (Foresman 2004). Such cover may be vegetative, wood debris, rock, or even artificial cover. While some members of this guild may require a natural substrate through a culvert, others may be tolerant of an artificial surface. Most of the species in this guild prefer a non-submerged pathway through a crossing structure. If there is any flow of water through a structure, passage can be greatly increased with wildlife shelves. Twelve species of mammals that are members of the carnivore and rodent families have been documented using artificial benches created by placing shelves in these culverts (Foresman 2004).

Traffic volume and traffic noise at crossing sites can have mixed effects on these species. Clevenger et al. (2001) found that as traffic volume increased, marten, weasel, snowshoe hare, and red squirrel use of wildlife crossing culverts increased. This could be due to the fact the animals could not find breaks in the traffic that would allow them to cross the road at-grade.

#### ***Specific Considerations***

##### Rodents

Foresman (2004) documented heavy use of culverts by rodents in Montana along U.S. Highway 93. Deer mice, meadow voles, red squirrel, muskrat, ground squirrel, shrews, yellow-bellied marmot, mountain cottontail, wood rat, porcupine, and fox squirrel were photographed in corrugated steel culverts ranging from 3-12 feet (0.9 m to 3.75 m) in diameter. In Vermont, Bellis



*Figure 12. Mountain cottontail using a pipe culvert in Colorado under I-70 © Center for Native Ecosystems, ECO-resolutions, LLC & CDOT*



(2008) live-trapped small mammals on both sides of two wildlife bridge underpasses. In two summers of trapping the only animals he could document using the crossings were deer mice species ( $n=13$ ). Voles, chipmunks, jumping mice, red squirrels, weasels, and ermine were all captured on one side of the road but never recaptured on the opposite side. These structures had recently been constructed and there was little natural vegetation within 50 feet (15.2 m) of the bridges. Bellis noted in his thesis work conducted by McDonald and St. Clair (2004) that found that small mammals, including three species also included in Bellis' Vermont study, had much higher success moving through smaller than larger crossing structures, which they attributed to greater overhead cover in the smaller structures. McDonald and St. Clair (2004) also mention that a lack of natural vegetation at crossing structure limited use among small mammals.

### Small Carnivores

Clevenger et al. (2001) found that weasels, *Mustela ermine* and *M. frenata*, preferred culverts that are higher, but culvert use was negatively correlated with greater culvert openness, apparently preferring high and narrow culverts. In the same Banff study, pine martens preferred culverts with low clearance and high openness ratios, meaning they preferred short and wide culverts. Weasels' use of culverts was also positively correlated with the amount of vegetative cover. Badgers have been recorded using culverts, especially in British Columbia (Klafki 2002, Newhouse and Kinley 2002), which mimic their natural burrows on the landscape (Fig. 13).

Overall, crossings that would promote movement of Moderate Mobility Small Fauna need to have vegetation right up to the crossing structure entrance; be small in size relative to other wildlife crossings; be free of water year round or a shelf structure placed to facilitate small and meso mammal movement (Fig. 14); include a tube built in below the shelf for voles; and be less than 300 feet (91.4 m) in length. All the culverts in the studies mentioned are 200 feet (61 m) or less in length as the animal traverses under the road.

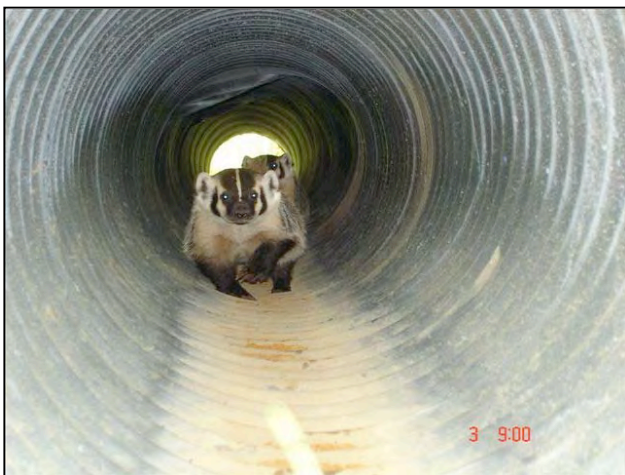


Figure 13. Badgers in culvert in British Columbia © S. Towers



Figure 14. Ermine, or short tailed weasel using wildlife shelf in culvert under US 93, Montana © K. Foresman

### 2.2.1-3. Adaptive High Mobility Fauna

This guild includes medium-sized mammals that are naturally accustomed to enclosed spaces for denning and are tolerant, to a limited degree, of a more enclosed situation in an underpass. Members of this guild include black bear, bobcat, coyote, and Canada lynx. Adaptive High Mobility Fauna may adapt to a variety of structure types, so long as a minimum size requirement is met, proportional to the size of the animal.

#### *Specific Considerations*

##### Black Bear

Black bear have demonstrated an ability to use wildlife crossings in Florida (Foster and Humphrey 1995), North Carolina (McCollister and van Manen 2010), Vermont, Colorado (Singer et al. 2011), Utah (Cramer 2011), Montana (Foresman 2004, and Cramer et al. 2011), Washington (this study), and Alberta, Canada (Clevenger and Waltho 2005). Overall, scientists report black bear will use bridge wildlife underpasses and culverts (McCollister and van Manen 2010, Clevenger and Waltho 2005, Cramer et al. 2011, Singer et al. 2011). Clevenger and Waltho (2005) found black bear tended to use crossing structures that were constricted in space. In Montana, black bear have been photographed using a variety of structures. While Foresman (2004) photographed a black bear using a culvert 3.1 feet (0.95 m) in height, Dr. Cramer's current study on the same stretch of US 93 has revealed black bear using bridge crossings more often than culvert crossings. In Washington, the authors of this report documented 30 black bear passages through a pair of 12'x29'x120-144' (3.7x8.8x37-44 m) arch culverts under I-90 (Fig. 15). Only one of the 31 bear approaches resulted in a repel action. It appears the black bear in the North Bend area of Washington have adapted to this culvert. From the wide geographic span of photos of black bear using structures, it is apparent that they are a highly adaptable species and will use structures they can fit through and feel safe entering. From the data collected in the habitat area around the North Bend, Washington culvert, it also appears that vegetative cover is important to Washington black bears.



*Figure 15. Black bear cubs passing through culvert behind mom, under I-90 Washington © P. Cramer, J. Kintsch & WSDOT*

## Coyote

The coyote is a wide ranging habitat generalist that is known to be quite tolerant of human activity, and is one of the most adaptable and widespread carnivores in North America (Fitzgerald et al.1994). Coyotes almost certainly use culverts and bridges in every state and province in the U.S. and Canada. Coyotes are tolerant of smaller spaces, such as drainage culverts, and can also adapt to bridge crossings. They are also known to cross at-grade over roads. Clevenger et al. (2001) and Foresman (2004) documented multiple coyote passages in culverts ranging from 3 feet (~1 m) up to 12 feet (3.7 m) high. Alternatively, Haas (2000) found coyote use of underpasses in California increased with underpass openness, and that fencing and roadway dividers (shoulder and median barriers) were most effective in encouraging coyote use of underpasses. Lyren (2000) found the same population of coyotes experienced significantly higher mortality by vehicles in areas with no wildlife fencing as compared to areas with wildlife fencing. The volume of traffic appears to also affect coyote use of structures. Lyren (2000) studied the same underpasses Haas (2000) studied in California and found the frequency of underpass use by coyotes appeared to be suppressed by traffic volume. Clevenger et al. (2001) also found that traffic volume was the most important predictive factor in coyote use of culverts in Alberta, with their use negatively correlated with traffic. These findings may indicate an aversion to traffic noise and possible avoidance of human activity (due to persecution).

In Washington, coyotes were photographed in this study at both bridge and culvert structures (Fig. 16). At a large culvert under I-90 near North Bend, coyotes were photographed at the entrance 19 times. They appeared to repel from the culvert on three occasions, and paralleled the structure at least four times. This is one of the highest volume roads in Washington and it is not known if the traffic volume affected the coyotes' use of this and other monitored structures.



Figure 16. Coyote using culvert under I-90, Washington © P. Cramer, J. Kintsch & WSDOT

In general, structures for coyote passage can be quite variable, but coyotes are a wary predator and sometimes behave like a prey species – in part due to the continued hunting pressures from humans in every state – and may be hesitant to use crossing structures. The presence of native vegetation cover at crossing structure entrances (positive correlation), human activity (probable negative correlation), traffic volumes/noise (negative correlation), and the presence of guide fencing (positive correlation) may all affect a coyote's willingness to use a crossing structure.



## Bobcats

Bobcats have been documented using structures in Montana (Cramer et al. 2011, and a study underway on US 93 North of Missoula by the Salish Kootenai Tribe and Western Transportation Institute), Colorado (Singer et al. 2011), California (Haas 2000, Lyren 2000, Ng et al. 2004), Florida (Foster and Humphrey 1995, Dodd et al. 2004), Vermont (Bellis 2008) and in Washington in this study, among others. A common theme among bobcat and wildlife crossing studies was that bobcats were documented with a preference for crossing roads at-grade, even in places where there are wildlife crossing culverts and bridges present (Bellis 2008, Cain et al. 2003, Haas 2000, Lyren 2000, Ng et al. 2004), often becoming victims of vehicular collisions. Cain et al. (2003) also found that bobcats crossed roads most frequently in areas where distance between dense vegetation was shortest. When they do use structures, they appear to prefer larger structures over more confined culverts, although monitoring in Colorado captured photographs of bobcats using pipe culverts as small as 7.4 feet (2.25 m) in diameter, including one partially sediment-filled pipe, and as large as an open span bridge (Fig. 17; Singer et al. 2011). Cain et al. (2003) found bobcat exhibited a preference for structures with high openness ratios. In Florida Foster and Humphrey (1995) recorded some of the first monitoring pictures of bobcats, which were under pairs of bridges on I-75. In this Washington study, bobcats were recorded only at the large arch culvert under I-90 near North Bend. There were three bobcat observations and all appeared to pass through the culvert. In Washington, bobcats may be more prone to using crossing in areas with abundant natural vegetation cover on both sides of the road – as is present at North Bend crossing – and with low levels of human activity (Fig. 18).



*Figure 17.* Bobcat using pipe culvert under I-70, Colorado © Center for Native Ecosystems, ECO-resolutions, LLC & CDOT.



*Figure 18.* Bobcat using large arch culvert under I-90, Washington © P. Cramer, J. Kintsch & WSDOT.

## Lynx

Low population densities, large home ranges and wide-ranging movements across the landscape have made lynx particularly difficult study subjects; consequently, few studies have documented lynx use of crossing structures. Over the course of three years of monitoring at seven different sites across Colorado, researchers did not document a single lynx using the structures, which included two pipe culverts and five box culverts (Crooks et al. 2008). Lynx have been documented using wildlife underpasses and overpasses in Banff, Canada, but lynx are not common around Banff and their use of the structures has been only rarely captured. As of yet, researchers cannot confirm whether lynx will readily use crossing structures in the western United States (Huijser and Paul 2008).

### **2.2.1-4. High Openness High Mobility Carnivores**

The carnivores of this guild, including grizzly bear, wolf and puma, prefer large structures with good visibility. Because of their larger body sizes, members of this guild have a larger minimum structure size requirement than Adaptive High Mobility Fauna such as black bear and coyotes. Species in this group tend to prefer more open structures than Adaptive High Mobility Fauna, but are more tolerant of structures longer than 100 feet (30.5 m) or enclosed structures than members of the Very High Openness Fauna Guild, such as elk.

Few studies have analyzed how the group of carnivores encompassed by this guild use wildlife crossings as a whole. Clevenger and Waltho (2000) analyzed carnivore movement through 11 wildlife underpasses in Banff National Park in Alberta, Canada for 35 months and were able to make some generalizations. They found that grizzly bear, black bear, wolf, and puma use of crossings was more influenced by human activities than by structure variables. The most significant attribute influencing these species' use of the wildlife crossings was underpass distance to town site (positively correlated), followed by human activities such as hiking and human use of the site and horseback riding (negatively correlated). They found the landscape and structure variables were the least significant attributes affecting how the carnivores used the structures. Individual species preferences have been analyzed in more detail in other studies, as described below.

### ***Specific Considerations***

#### Puma (Mountain Lion)

Pumas are habitat generalists, but as highly specialized ambush predators they require good cover or complex terrain for concealment (Sweaner et al.2000). Exurban development and recreational activity in puma habitat in recent decades has led to an increase in human conflicts with this species. Beier (1995) found that while pumas avoided substantially developed areas and the associated noise, lighting, and presence of domestic dogs, they readily used areas with heavily used recreational trails.



Gloyne and Clevenger (2001) reported on puma use of 22 crossing structures in Banff National Park in Alberta. They found a significant positive correlation between passages made by puma through the structures and the passages made by mule deer and white-tailed deer. Contrary to the Clevenger and Waltho (2000) publication just one year earlier for the same study site, they found no correlation between puma and human use of the wildlife crossings. Puma's use of open span bridged underpasses was more than expected. Bridge underpasses spanning creek drainages were used in proportion to their availability, while all other crossing types were used significantly less than expected. The crossings with the highest number of puma passages were those situated close to high quality puma habitat. The general take home message from this study was that puma tended to use underpasses more than overpass structures. Clevenger and Waltho (2005) in a later study of the Banff Crossing structures found puma favored more constricted spaces for crossings. The analysis in this study also found that distance to cover was the most important landscape attribute for successful puma usage of crossing structures, where the greater the distance to cover, the lower the likelihood of successful passage.



Figure 19. Puma (mountain lion) using a box culvert under I-70 in Utah © P. Cramer

Studies in Utah (Cramer 2011) and Montana (Cramer et al. 2011) have recorded puma presence approximately a dozen times. They have shown to be highly adaptable and have been photographed crossing at-grade over U.S. 93 in Montana, and under Interstates in Utah using box culverts (Fig. 19) and bridges and repeatedly over an interstate on a narrow wildlife overpass. Although there is not enough data at this time for statistical analyses in these studies, it appears puma prefer to cross roads in areas with little human development.

#### Other High Openness High Mobility Carnivores

There are few studies that document wolf or grizzly bear use of wildlife passages. Clevenger and Waltho (2005) found grizzly bear and wolf tended to use crossings that were high, wide, and short in length. Given their hesitancy to use crossings, in large part due to their cautious nature with humans, this study is the only one that defines these species preferences and would be the best recommendation for crossing structures that pass these species at this time.

### **2.2.1-5. Adaptive Ungulates**

All ungulates in North America have been recorded using wildlife crossing structures. However, several of these species are significantly more adaptable to a variety of wildlife crossing structures than others – these are the Adaptive Ungulates. This guild includes white-tailed deer, mule deer, moose, and mountain goat. These are species that have minimum requirements for suitable crossing structures, but are not as hesitant to enter the enclosed spaces of culverts or even bridges, as are species in the guild Very High Openness Fauna.

#### ***Specific Considerations***

##### Mule deer

Mule deer (including black-tailed deer, a subspecies of mule deer) is the primary deer species of interest with regards to wildlife-road conflicts in Washington, and is the species this report will focus on most intensely. White-tailed deer are also present in Washington, particularly in the eastern portion of the state. Of the 100-plus wildlife passages nationwide that have been specifically designed for mule deer, nearly all have successfully passed mule deer (Bissonette and Cramer 2008). Mule deer and white-tailed deer are adaptive species and over time can learn to use bridges and culverts as passageways, particularly if eight-foot high guide fencing is present. White-tailed deer have proven to be very adaptive to transportation structures across the U.S. and the preferences for mule deer below can generally apply to them as well.

##### Mule Deer and Culverts

The first mule deer wildlife passage study was in Colorado at a box culvert under Interstate 70 (Reed et al. 1975). This 10'x10'x100' (3x3x30.5 m) box culvert passes some mule deer, but the long, narrow culvert may have a high repel rate (Singer et al. 2011) and in the first years after the culvert was built only a portion of the herd used the culvert in their seasonal migration route, leaving many animals unable to reach their wintering grounds. Subsequent studies (Ford 1980, Gordon et al. 2003, Gordon and Anderson 2003, Rosa 2006) demonstrated that mule deer were willing to use a range of culvert shapes and sizes. Gordon and Anderson (2003) implemented a design in Wyoming where the dimensions of a concrete box culvert under a two-lane road could be manipulated to study the point at which more deer were repelled away from the culvert that used it. The smallest functional dimension for mule deer in this study was 12'x20' (3.7x6 m) under a two lane road where the culvert was 60 feet (18 m) in length. As a result, these dimensions have become the minimum standard for the design of crossing structures for large herds of mule deer rather than just occasional individual animals. Ongoing monitoring of six new similarly-sized culverts connected with wildlife exclusion fencing along the same Wyoming roadway have documented over 13,000 successful mule deer crossings along this migration corridor between October 1 through December 31, 2010 (Sawyer and LeBeau 2011).

Ongoing research in Utah (Cramer 2011) is documenting successful as well as attempted passage at three differently-sized corrugated steel plate culverts (all designed as wildlife crossings), eight concrete box culverts (one designed as a wildlife crossing), as well as three bridges designed specifically for wildlife and four additional existing bridges. While the study is not complete, it appears that a sense of structure openness for culverts, especially, is a very important characteristic for mule deer. The study further demonstrates that longer culverts (greater than 120 feet long [36.6 m]) have higher repel rates (i.e., which are when animals approach a structure and then turn away) than the shorter culverts (ranging in length from 65 to 120 feet long [19.8-36.6 m]). The long culverts pass beneath four lane highways, while the shorter culverts path beneath two-lane roads or two lanes of highway with an open median. Even along interstates, it appears that paired culverts with separate structures for the opposing traffic lanes, and an open median can accommodate mule deer fairly successfully. For example, along I-15 there are two sets of corrugated steel culverts that are shorter (65-75' long [19.8-22.9 m]) and larger (17-20' high [5.2-6 m]) than the other culverts in the study (Fig. 20). These culverts have low rates of repellence (5-6%) compared to rates of repellence of 20 to 35 percent for longer culverts. The study also demonstrated that concrete box culverts 200 feet (61 m) or longer along Interstates 70 and 15 did not function as wildlife crossings for mule deer if there was no wildlife fencing present. Further research will help determine whether deer can be encouraged to use such long structures in areas where wildlife exclusion fencing has recently been placed.



Figure 20. Mule deer moving through culvert under US 91 in Utah © P. Cramer

It appears that mule deer are willing to traverse under two lane roads through culverts that are approximate 100 feet (30.5 m) long and a variety of heights and widths, as long as the height is a minimum of 10 feet (3 m) and the width 20 feet (6 m; Sawyer and LeBeau 2011), with some varying conditions acceptable. When culverts are longer than the width of two lanes of traffic, repellence rates for mule deer increase to 10 to 50 percent of approaches.

Based on these research studies, it is recommended that culvert crossing structures be less than 120 feet (37 m) and most definitely less than 200 feet (61 m) for passing species in the

Adaptive Ungulates Guild. Minimizing culvert length as much as possible is recommended to accommodate the majority of mule deer that approach a culvert. If a culvert must traverse more than two lanes, then opening up the culvert by increasing the height and, in particular, the width of the culvert at eye-level (for a mule deer) is recommended to the extent possible. In addition, two separate culverts placed under opposing lanes of traffic with an open median between the

two culverts can create a more appealing situation for mule deer (as well as a number of other species in this and other guilds) than a single, long culvert (Fig. 21).

*Figure 21.* Black-tailed deer doe and fawns crossing under four lanes of I-90 through a pair of double box culverts, Washington © P. Cramer, J. Kintsch & WSDOT



### Mule Deer and Bridges

Bridges of all kinds and sizes have been shown to function for mule deer. Mule deer have been documented traversing under roads with two to four lanes with span bridges in Idaho (C. Class, personal communication), Utah (Cramer 2011, Rosa 2004), Wyoming (Sawyer and Rudd 2005), Arizona (Dodd et al. 2007b), California (Ford 1980), Colorado (Barnum 2003, Singer et al. 2011), Montana (Cramer et al. 2011) and Washington (this study). The rate of repellence is often not reported in studies or could not be measured. In Utah, rates of repellence at bridges that accommodate two to four lane highways ranges from 2.3 to 20% (Cramer 2011). In the Utah study the higher rates of repellence were related to multiple factors such as structure dimensions, human activity, the presence of livestock fencing tied to the structure base which is hard for young deer to negotiate, and animals still unaccustomed to a new structure during the first year of monitoring.



*Figure 22.* Mule deer using area under the Cle Elum bridge along I-90 © P. Cramer, J. Kintsch & WSDOT

The combined research suggests that any bridge that is a minimum of 10 feet (3 m) high and less than 100 feet long (30.5 m) as the animal traverses under the road has had success in passing hundreds of animals. There are few to no studies of mule deer using bridges that are over 100 feet in length under the lanes of traffic. This is because often, when there are greater than two lanes, opposing traffic is accommodated on two separate bridges or culverts with an open median. In Utah, Utah DOT has been able to accommodate four and five lanes of traffic on bridges less than 100 feet in length as the animals traverse under the road. In



Washington, the Cle Elum River Bridge along I-90 near the WSDOT Bullfrog Facility (milepost 79) is a perfect example of two low height (less than 10 feet [3 m] at the spots where mule deer cross under) bridges accommodating two to three lanes of traffic each, with an open median are sufficient for deer to adapt to using (Fig. 22; see monitoring report, Appendix D).

### Mule Deer and Overpasses

Overpasses that have passed mule deer in the United States exist in Utah, Montana, and Nevada. Constructed in 1975, the Utah passage is the oldest wildlife overpass in North America. Each of a pair of bridges measures 210 feet (64 m) long by 22 feet (6.7 m) wide as they cross over I-15. More than 700 successful mule deer pass have been recorded over the first 18 months of monitoring (Fig. 23; Cramer 2011).

In 2009 in Montana, and 2010 in Nevada, pre-fabricated arch culverts were built around the two lanes of US 93 and dirt was filled over the culverts so wildlife could move over the traffic on wildlife overpasses approximately 100 feet (30.5 m) wide, in both states. Mule deer began using the Nevada overpass within days of completion (L. Bellis personal communication), while in Montana they were using it within weeks (P. Basting personal communication). Culvert overpasses such as these provide a cost-effective alternative (less than 2 million dollars) to wildlife bridges in areas where tunneling traffic is a viable option.

In addition to the research on different types of crossing structures, numerous studies have shown that 8-foot (2.4 m) high wildlife exclusion fencing is an important mechanism for boosting passage rates, preventing at-grade crossings, and helping animals to adapt to the crossing structures (Clevenger et al. 2002, Cramer 2011, Dodd et al. 2009). Wildlife fencing to guide deer towards a structure is recommended for all crossing structures, regardless of type.

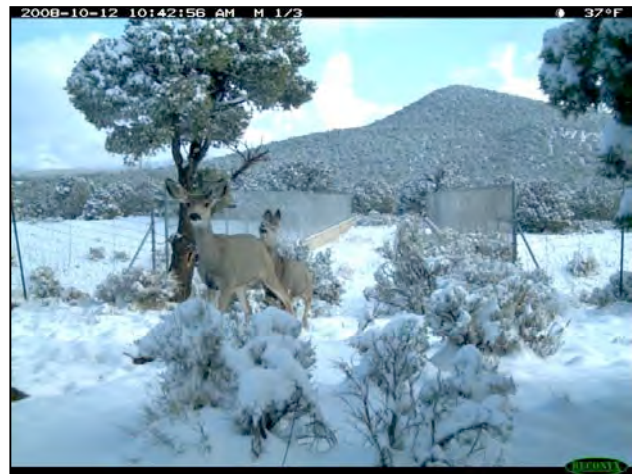


Figure 23. Mule deer using overpass over I-15, Utah  
© P. Cramer

### Moose

Moose exhibit an amazing ability to adapt to small structures. Given their restricted range in the United States, few states have experience in accommodating moose in underpasses. In Utah, moose have been documented using 10'x17' x165' (3x5x50 m) corrugated steel culverts in the northern mountains (Fig. 24; Cramer 2011). Sawyer and LeBeau (2011) have similarly reported moose use of culverts measuring 10'x20'x60' (3x6x18 m) in Wyoming. While this is not the recommended size of structures built for moose, populations have adapted to culverts that have been in place for years. It is believed moose will pass readily under bridges, though





Figure 24. Moose using culvert under US 91 in Utah  
© P. Cramer

there is little documented evidence of such movements and few monitoring studies have targeted or included the study of moose passage. An exception is an Alaska study, which documented moose movement under a specifically designed bridge crossing with a minimum passage height of 10.5 feet (3.2 m) along the length of the bridge and 9-foot (2.7 m) high guide fencing (McDonald 1991).

### Mountain Goats

Mountain goats have shown a willingness to pass under bridges in Montana, just outside of Glacier National Park (Singer and Doherty 1985). This study is the only study known to the authors that documents mountain goat movements through structures explicitly built for them. There is no known research or anecdotal information documenting mountain goats passage through culverts, but there is little to suggest that herds of mountain goats would adapt to moving through culverts.

### **2.2.1-6. Very High Openness Fauna**

Unlike the Adaptive Ungulates Guild, members of the Very High Openness Fauna Guild are particularly wary of predators and require very wide vistas and clear lines of sight through a crossing structure. They tend to prefer a moderate amount of cover at the structure approaches or even inside the structure; however such cover must not infringe upon their ability to detect or escape from potential predators. While largely composed of ungulate species, including elk, bighorn sheep and pronghorn, other predator-wary species, such as grouse, are also included in this guild.

### ***Specific Considerations***

#### Elk

Elk have proven to be very cautious with regards to their willingness to pass through bridges or culverts. In over 35 years of monitoring wildlife crossings in studies across the United States, elk have consistently shown themselves to be



Figure 25. Elk repelling from a long box culvert under I-70 in Utah © P. Cramer

extremely wary of using culverts of all shapes and sizes as crossings (Fig. 25). Regular use of box culverts by elk (a minimum of dozens of passages per year) has been documented at only one location in the United States, along US Highway 30 through Nugget Canyon in Wyoming (Sawyer and Le Beau 2011). Elk use of box culverts at other locations has been largely incidental, with less than five animals per occurrence (e.g., Singer et al. 2011). Prescriptions for wildlife crossings for elk should always involve a bridge. Elk have shown a willingness to use bridged wildlife crossings in Arizona (Dodd et al.

2007a), Utah (Cramer 2011, Rosa 2006), Wyoming (Sawyer and Rudd 2005) Idaho (C. Class personal communication), Colorado (Singer et al. 2011) and Washington (this study). In monitoring conducted for this study, elk showed a willingness to move under paired bridges accommodating I-90 at the Cle Elum and Snoqualmie Rivers. The Cle Elum Bridge is 11 feet (3.35 m) high at the locations elk were photographed grazing under the bridge. The Snoqualmie River bridge is 6.8 feet (2 m) high where elk were photographed traversing under the bridge. In this study, elk exhibited a preference for structures that are wide (over 65 feet [19.8 m]) across from side to side, giving a feeling of openness despite the seemingly low height of the structure. In Arizona, Dodd et al. (2007) found that the openness of the area under the bridge is an important factor influencing elk use of structures. This feeling of openness can be enhanced by angled natural substrate support slopes, as opposed to vertical walls. In the Arizona study, a pair of bridges a few hundred feet apart and almost identical in construction except for the abutment slopes had dramatically different elk usage rates. The structure with concrete walled sides produced significantly higher rates of repulsion than the adjacent structure with sloped earthen sides. Dodd et al. (2007) suggest all bridged wildlife crossings include natural 2:1 slopes under the bridges rather than concrete materials.

Elk appear to be highly willing to use two overpass structures in Banff National Park in Alberta, Canada, where monitoring has documented elk passage numbers in the hundreds to thousands (Clevenger and Waltho 2005). Elsewhere, elk have not been documented in large numbers using overpasses, though, notably, of the handful of wildlife overpasses located in North America, only a few are located in elk habitat. In Utah, elk have been documented using the state's only overpass on only 12 occasions in two years. This overpass is composed of two bridges, each just 21 feet (6.4 m) wide and 200 feet (61 m) long, with a natural median above the level of traffic. All of these passes were made by bull elk. No females have been documented using this structure in over two years of monitoring, even though it has been in

place for over 30 years and has ample tree cover at the entrances and in the median. The limiting factor may well be the narrow nature of the overpass.

An overarching guideline for evaluating existing structures for elk passage is to keep structures as open as possible (Fig. 26). The span of a structure as an elk crosses needs to be much wider than it is tall, as exhibited by the bridges structures along I-90 in this Washington study.

Fencing elk to existing culverts may force individual elk through those culverts, but repeatedly across the western states, herds of elk have refused to use such structures. Bridges are the preferred option for elk passage.

### Pronghorn

Pronghorn are notoriously wary animals and are perhaps the most difficult large mammal for which to design functional wildlife crossings. In a review of pronghorn movements near roads, Sawyer and Rudd (2005) concluded that either very high

and wide bridges or overpasses are suitable structures for pronghorn passage. Little research has been conducted on the crossing features influencing pronghorn passage. According to Sawyer and LeBeau (2011), "U.S. Highway 30 in Nugget Canyon in Wyoming may be the only place where pronghorn have been documented using crossing structures (approximately 12 occurrences)". In this herd, it appears pronghorn learned to use the passage by following mule deer through the structure. Pronghorn overpasses are planned for the Trappers' Point area along US 189 near Pinedale, Wyoming.

### Bighorn Sheep

Bighorn sheep have been studied only in Arizona to ascertain their preferences for crossings. Bristow and Crabb (2008) used radio collars and monitoring cameras to evaluate the effectiveness of three existing bridged underpasses for movement of desert bighorn sheep along Arizona's SR 68. In 25 successful crossing events, only rams used the structures. No marked ewes used the underpasses or crossed over the road at grade. In a separate study along US 93 in Arizona, several bighorn rams were documented using bridged underpasses and ewes and rams crossed across the road at grade (McKinney and Smith 2006). The authors of this study determined that the overpasses were necessary for population-level movement. In November of 2010, three bighorn overpasses, two measuring 50 feet (15 m) wide and one measuring 100 feet (30.5 m) by 202 feet (61.6 m) long were completed over US 93. These overpasses were built much in the spirit of the Utah overpass across I-15;



Figure 26. E Bull elk moving under arched wildlife crossings under I-70, Utah © P. Cramer

they are simple bridges over a four-lane highway. Within days of installing the monitoring cameras, Arizona Game and Fish biologists documented both male and female sheep moving over the overpass<sup>2</sup>.

Based on the monitoring results from Arizona, anecdotal information from other locations, an understanding of sheep's predator avoidance strategies, and the apparent reluctance of ewes to use bridged underpasses, overpasses are the recommended structure type for passing multiple members of both sexes of a bighorn sheep population.

### 2.2.1-7. Arboreal Fauna

Species in this guild move primarily through the canopy rather than on the ground surface, such as flying squirrels, arboreal voles and some bats. The best mechanism for providing safe passages for species in this guild is to construct a canopy-level structure across the roadway, for example, a rope or metal bridge (Fig. 27). A second method that is still under investigation is the placement of tall poles alongside a two-lane road to assist gliders over the road and flow of traffic. In North Carolina, several pairs of these tall poles have been placed along two lane roads with trees on both sides of the road. There are platforms toward the top of these poles that are meant as "launching" pads for the flying squirrels in the area. Cameras mounted on these platforms have recorded successful flying squirrel passage between poles (A. Burroughs NCDOT, personal communication). Researchers in North Carolina are investigating this method further and will make the results public at some point in the future.



Figure 27. Arboreal Crossing, Europe  
© M. Huijser

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<sup>2</sup> A video clip of two rams using the crossing can be viewed at:

<http://www.youtube.com/watch?v=vrKCM26r1FM>.

A February 2011 article from Arizona Fish and Game on the crossings can be found at:

<http://azgfd.net/artman/publish/NewsMedia/First-bighorn-sheep-documented-on-overpasses.shtml>.

### **2.2.1-8. Aerial Fauna**

Aerial Fauna are animals that move primarily by flying, such as songbirds, raptors, bats, and flying insects, including butterflies. As animals in this group are capable of flying over a roadway, the primary concern with regards to connectivity across roads is to divert them from flying into the path of traffic. Several mitigation methods can help minimize collisions and also the effects of habitat fragmentation caused by road infrastructure.

Crossing structures can assist flying fauna to fly below or over the flow of roadway traffic. Large structures that cross high above natural areas allow flying creatures the ability to maintain flight underneath the road. Such structures include causeways, viaducts and expanded bridges. In Europe, vegetated overpasses have also been shown to provide safe crossings for woodland bird species (Jacobson 2005). In this study there were significantly more bird flights over vegetated overpasses compared to passes directly over the road, and in some cases the birds included the wildlife overpasses within their territories.

Directing animals to fly high above or away from the flow of traffic is another alternative. Where bridges cross over waterways or near aquatic areas, birds may use the airflow at the bridge to swoop in and gain lift. This behavior has been documented in areas along the coasts of Texas and Florida. The Departments of Transportation in these states have installed either aluminum fence poles (Texas) or poly vinyl chloride (pvc) pipes (Florida) on such bridges to create the appearance of a larger barrier thereby causing the birds to fly higher over the bridge as well as the traffic (Jacobson 2005).

Predatory birds such as owls are typically killed along roadways when they find a source of rodents within the right-of-way. In Idaho and Oregon along I-84, owl spring migrations occur at the same time farmers are plowing their fields, thus driving out local rodents toward the interstate right of way for cover and forage. While no solutions have been initiated as of yet, it appears the problem could be partially mitigated by keeping rodents out of the right of way, or by preventing owls from accessing the prey through the placement of low fences, or by placing materials that flap in the wind to discourage the owls from approaching the right of way. Another opportunity exists in areas where enough water is present to support the growth of bushes in the median, such as sage brush in this area of Idaho. This would make aerial attacks more difficult from a distance across the lanes of traffic.

In Arizona, the first recorded bird crossing was constructed in Tucson. The burrowing owls nesting along the road were in danger of flying over the road barriers and into traffic. A median area that acted as a planter was placed with fast growing trees and shrubs. This acted as a diversion device to alter the flight of the owls up and over traffic (Fig. 28). Unfortunately, habitat destruction nearby forced the relocation of these birds.



*Figure 28.* Rick Ellis, Pima County Planner in Arizona at an owl crossing, where trees were planted to divert flying owls over traffic flow © P. Cramer



These Species Movement Guilds are meant to better classify an animal of concern near a transportation corridor. Interested biologists may not know if a particular species has been studied for their response to mitigation. By placing that species within its respective Species Movement Guild, generalizations can be made as to which mitigation solutions may work for that species. The overview above represents the best compilation of the current state of the science of wildlife and transportation in the United States and Canada.

### **2.3. Structure Functional Classes**

The term ‘wildlife underpasses’ connotes many different structures from the smallest culverts that may pass a salamander, to the space under a highway viaduct, tens to hundreds of feet above the landscape. This classification of transportation infrastructure into defined Structure Functional Classes, provides a definitive set of conditions for four different underpasses, the overpass, and two unusual designs for passages (Table 2). The critical dimensions for breaks among the four classes are based on heights and widths of structures, which are dictated by engineering design constraints and wildlife characteristics that define individual species’ willingness to move through a structure. These classifications are supported with the information below. This classification of structure types can help transportation planners, biologists and engineers to relate wildlife passage needs to a specific structure type or types with a common vocabulary. This classification was first proposed in the National Academies research ‘Evaluation of the Use and Effectiveness of Wildlife Crossings’ (Bissonette and Cramer 2008) and the accompanying website (Bissonette and Cramer 2006) and has been subsequently updated and modified for this research.

**TABLE 2:** Structure Functional Classes, viewed from a species perspective. Generally, species that use small structures will use larger structures if appropriate cover and other features are provided, but most species cannot use smaller classes. This table is for terminology only and is not intended to be used for structure design. It can be used for generalized discussions early in planning process. It is not intended to be prescriptive since each site requires site-specific planning by qualified biologists and engineers. These structure classes were developed by the authors in collaboration with Sandra Jacobson, U.S.D.A. Forest Service.

<b>Crossing Structure Category</b>	<b>Function</b>	<b>Approximate Dimension Range (Span x Rise)</b>	<b>Passage Examples</b>	<b>Species Examples</b>	<b>Behavioral Attributes</b>	<b>Species Movement Guilds (Potential)</b>
Class 1: Small Underpass	Provides enclosed protection for small animals that require cover.	Metal pipe culverts or small box culverts 1.5 m (5') span or less	Small bridges, dry culverts, and ephemerally flooded drainage culverts. Continually flooded drainage structures have limited functionality for terrestrial species but may function for some aquatics.	Amphibians, reptiles, small mammals and some medium-sized mammals (badger, fox, bobcat). Aquatic species include fish, aquatic amphibians, and invertebrates.	Small animals that prefer cover or do not mind confinement.	Low Mobility Fauna, Mobile Small Fauna, Highly Mobile Adaptive Fauna
Class 2: Medium Underpass	Provides some cover yet more openness than Class 1 structures for animals smaller than deer. If water is conveyed, allows for stream simulation including unwetted natural banks.	Underpasses larger than 1.5 m (5') span, to 2.4 m (8') span x 2.4 m (8') rise	Box culverts, arch pipes and other culvert shapes, small bridges.	Coyote, bobcat, ocelot, lynx and some large carnivores (black bear, puma); alligator.	Medium sized mammals that require some cover and some openness to see through passage.	Low Mobility Fauna, Mobile Small Fauna, Highly Mobile Adaptive Fauna, Adaptive Ungulates
Class 3: Large Underpass	Provides an approximate minimum for ungulates, especially deer, and other species that require visibility, maneuverability, and moderated noise. May allow some natural processes including vegetation growth and stream processes.	Underpasses with minimum dimensions: 6.1 m (20') span x 2.4 m (8') rise, or 3.1 m (10') span x 3.1 m (10') rise, and open span bridges	Box culverts, large arch pipes, bridges including open span bridges. Multiple chambered structures are considered as individual units.	Ungulates use structures in approximate proportion to their size (ie, deer can use smaller structures than elk or moose) although pronghorn require larger structures (minimum 18.3 m span x 5.5 m rise). Large carnivores (wolf, grizzly bear, black bear, puma).	Larger mammals that require structures of a minimum size for passage.	Low Mobility Fauna, Mobile Small Fauna, Highly Mobile Adaptive Fauna, High Openness Mobile Fauna, Adaptive Ungulates

<b>Crossing Structure Category</b>	<b>Function</b>	<b>Approximate Dimension Range (Span x Rise)</b>	<b>Passage Examples</b>	<b>Species Examples</b>	<b>Behavioral Attributes</b>	<b>Species Movement Guilds (Potential)</b>
Class 4: Extensive Bridge (includes Viaducts)	Allows ecosystem processes to permeate highway such as wetland water flow, vegetation growth, and entire floodplains. Provides excellent horizontal visibility for animals requiring openness.	Bridge extending over several spans. Designed for each site so dimensions vary. May allow more sunlight under structure than other types.	Viaducts are long bridges elevated over the landscape in a series of smaller spans, often connecting points of equal height. Typically over wetlands, steep terrain.	Most species including wetland species, birds, pronghorn.	Viaducts are particularly good for wary species including carnivores that may not approach other structures, or low mobility species such as mollusks that require vegetation throughout the structure.	Low Mobility Fauna, Mobile Small Fauna, Highly Mobile Adaptive Fauna, High Openness Mobile Fauna, Adaptive Ungulates, Arboreal Fauna, Aerial Fauna
Class 5: Wildlife Overpass	Provides an open top and expansive visibility of the horizon for animals preferring unenclosed spaces. Allows full sunlight and precipitation for vegetation growth. May allow small, sunlit water features.	Overpass structure for wildlife to pass over roadway, as small as 6.7 m (22') wide, but preferably at least 50 m (164') wide.	Overpasses with soil and plant growth.	All ungulates (pronghorn not proven yet), carnivores (bear, puma, forest carnivores). Songbirds and insects including butterflies.	Any species that requires natural habitat, sunlight or ambient conditions for movement.	Low Mobility Fauna, Mobile Small Fauna, Highly Mobile Adaptive Fauna, High Openness Mobile Fauna, Adaptive Ungulates, Arboreal Fauna, Aerial Fauna
Class 6: Specialized Culvert	Allows outside environmental conditions to occur within the entire structure, including light, temperature and moisture.	Current designs are small culverts less than .5 m (24") span but could be larger structures.	Trench drains and slotted culverts.	Reptiles and amphibians	Reptiles and amphibians that require ambient conditions to survive and disperse, or to orientate during movements.	Low Mobility Fauna
Class 7: Canopy Bridge	Provides an arboreal passage for animals that typically do not descend below tree canopy to ground.	Adequate to cross all traffic lanes. May be connected to trees in the median.	Treetop rope bridges, or modified wire or metal structures.	Squirrels, arboreal rodents, opossum. Potential for insects and plants.	Species that move through the canopy rather than on the ground surface.	Arboreal Fauna



Figure 29. Example of a Class 1 Small Culvert, I-70  
CO © J. Kintsch



Figure 30. Example of a Class 2 Medium Culvert,  
I-90 WA © J. Kintsch & P. Cramer

### Class 1: Small Underpasses

Small passages made of metal or concrete pipes and culverts up to 5 feet (1.5 m) in diameter are typically (but not always) preferred by smaller mammals, amphibians and reptiles, and some medium sized animals such as badger, fox, and bobcat (Fig. 29). These species do not hesitate to enter confined spaces and may need cover and other conditions, such as moisture, that are more typically found in smaller spaces as opposed to larger, more open passages. Such conditions can be replicated in a larger passageway by maintaining woody or vegetative cover through the passage or by laying a small pipe through the larger culvert to accommodate small animal passage. Culverts that accommodate water typically fall into this category. Some species require the moisture present with water courses, such as amphibians. Other species need more dry conditions. It is recommended that even these smaller structures be designed or enhanced to allow some terrestrial movement by installing raised shelves along the sides of these aquatic passages.

### Class 2: Medium Underpasses

Medium passages are underpasses that are larger than 5 feet (1.5 m) in span and up to 8 feet (2.4 m) in span, with an 8 feet (2.4 m) rise (Fig. 30). Height is used as the definitive measure at this level because the majority of existing passages in this size class are culverts where the height is equivalent or similar to the width or span. The definitive height of 8 feet (2.4 m) was used as the upper limit of the height of a crossing this size based on data gathered in the United States and Canada that included the dimensions of 128 existing wildlife crossings (Bissonette and Cramer 2008). Plotting the height of crossings by the number of crossings with that height, the data exhibited a break in groupings between the heights of 8 and 10 feet (2.4 and 3 m; Fig. 31). Eight feet (2.4 m) is also calculated as the upper size limit for medium-sized passages because the majority of mule deer determined to use underpasses in the previously mentioned studies used crossings greater than 8 feet high. By this definition, a 8'x8' standard box culvert (2.4x2.4 m) is the upper limit for

a medium underpass because deer typically do not prefer these passages, fully understanding that, in some instances, deer will use these smaller passages

Also included in this class are small bridges up to 8 feet (2.4 m) high. While still classified as medium underpasses, these bridges are much wider than a culvert of the same height and span, and provide a greater appearance of openness. Medium underpasses are typically used by medium sized animals such as coyotes, bobcat, lynx, black bear, and puma, and smaller low mobility and moderately mobile fauna such as snakes, turtles, marmots, otter, beaver, and some ground birds.

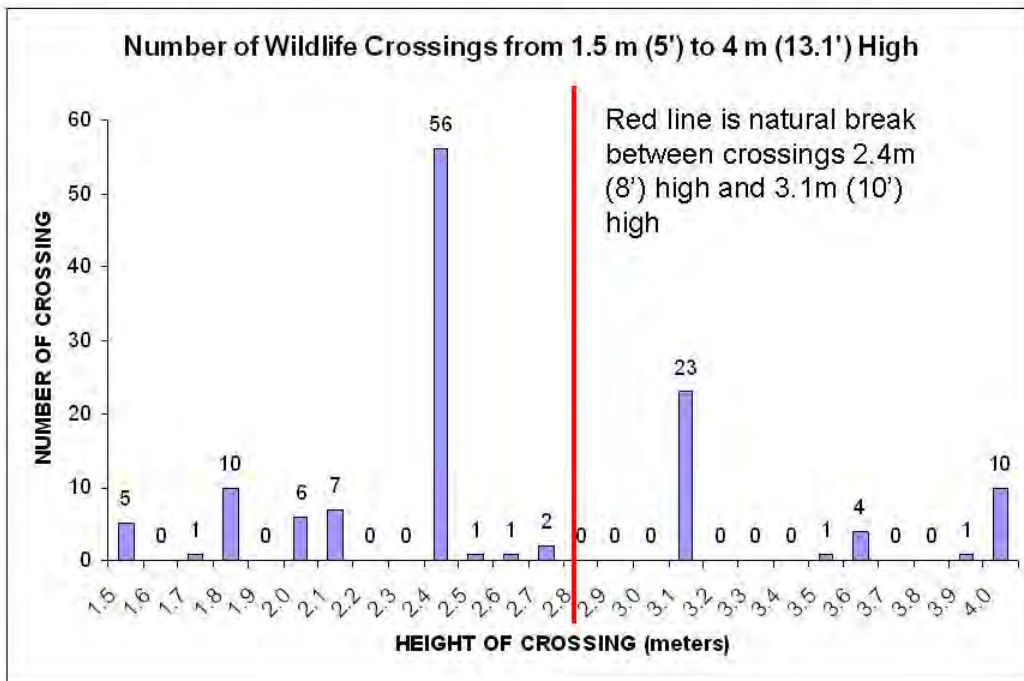


Figure 31. Height of 128 known wildlife crossings plotted versus the number of wildlife crossing structures at that height. These wildlife crossing dimensions were taken from survey participants in the National Cooperative Highway Research Program study, 'Evaluation of the use and effectiveness of wildlife crossings' (Bissonette and Cramer 2008). All crossings included in this graph were specifically built for wildlife.

**Class 3: Large Underpasses**

The minimum dimensions for large underpasses are defined, in part, as passages that can regularly pass deer species (both mule and white-tailed). These passages are defined as having a minimum of a 10 feet (3 m) span by 10 feet (3 m) rise – typically culverts – up to a 20 feet (6.1 m) span by an 8 feet (2.4 m) rise. These values are a reflection of the typical size of prefabricated culverts such as 10 by 10





Figure 32. Example of a Class 3 Large Underpass arch culvert being used by mule deer under I-90 Washington © P. Cramer, J. Kintsch & WSDOT



Figure 33. Example of a Class 3 Large Underpass bridge structure being used by black-tailed deer, SR 6, Washington © P. Cramer, J. Kintsch & WSDOT

feet (3x3 m) culverts, as well as larger arch culverts (Fig. 32). This class also includes all types of bridges, from those that are open span to those with multiple chambers where the individual units fall in this size range (Fig. 33). The smallest passage that has been monitored and verified used by deer is a 10 by 10 feet (3x3 m) culvert in Dowd Junction, Colorado (Reed et al. 1975). Donaldson (2005, 2006) documented limited use of a smaller culvert (10x6 ft [3x1.8 m]) by white-tailed deer in the eastern U.S., but recommends passage height be at least 12 feet (3.7 m). Gordon and Anderson (2003) recommend the minimum dimensions for a deer passage in their study area in Wyoming be at least 8 feet (2.4 m) high and 20 feet (6.1 m) wide. Based on these results and recommendations, the minimum size for a Large Underpass was determined to be either a 8'x20' (2.4x6.1 m) culvert; a 10'x10' (3x3 m) culvert; or a bridge at least 8 feet high and 32.8 feet wide (2.4x10 m). The latter is similar to the 8'x43' (2.4x13.1 m) bridges under Florida's I-75, which are used by white-tailed deer (Foster and Humphrey 1995). Also included in this class are larger structures, such as span bridges, which are typically larger than these dimensions, with spans over 43 feet (13 m). The added width provides greater openness to a passage. These types of passages have been documented passing all kinds of species from Low Mobility Small Fauna, such as frogs, to Very High Openness Fauna, such as elk.

#### Class 4: Extensive Bridges - Viaducts

These passages are areas where the roadbed is elevated high above the landscape over great distances, such that wildlife and ecosystem process can function naturally in the landscape beneath the viaduct. These structures span hundreds of yards (meters) and are typically at least 15 feet (4.6 m) above the ground surface. Most species of wildlife can use these areas, including wetland and riparian species as well as flying animals (Fig. 34).



Figure 34. Example of a Class 4 extensive bridge or viaduct, I-70 Colorado © J. Kintsch



Figure 35. Example of a Class 5 Wildlife Overpass, NV © L. Bellis, Nevada DOT



Figure 36. Mule Deer on top of Nevada overpass © L. Bellis, Nevada DOT

### Class 5: Wildlife Overpasses

Wildlife overpasses have been frequently used in Europe as an effective means for re-connecting habitats over roadways (Bank et al. 2002) and are increasingly being constructed in North America (Figs. 35 & 36). Currently there are only ten overpasses for wildlife in North America, ranging from a 22 feet (6.7 m) wide crossing built for mule deer in Utah; to a 50 feet (15.2 m) bighorn sheep overpasses in Arizona; to 164 feet (50 m) wide overpasses across the Trans-Canada Highway in Banff National Park. Ongoing studies of the two Banff overpasses offer some of the most comprehensive research to date on designing these types of structures. Monitoring has documented use by almost every large and meso-mammal species in the Park, from grizzly bear to elk to lynx (Clevenger and Waltho 2000, 2005; Clevenger et al. 2001). The open design and presence of natural vegetative cover literally extends habitat over the highway, facilitating its use by large carnivores and ungulates as well as small mammals, amphibians, and insects.

Two important design considerations that affect the effectiveness of a wildlife bridge are the width of the structure (Keller 1999; Pfister et al. 2002), and the presence of flat, clear lines of sight across the structure to habitat on the opposite side of the road (Clevenger et al. 2002). Pfister et al. (1997) observed that wildlife behavior was more natural on wider structures, and concluded that structures at least 197 feet (60 m) wide were more effective than those narrower than 164 feet (50 m). A parabolic design, where the structure ends are wider than the middle portion are believed to provide the most effective design for wildlife bridges (Clevenger et al. 2002). With this design, Clevenger et al. (2002) recommends that the narrowest portion of the structure should be approximately 230 feet (70 m) wide and extend out to 295 feet (90 m) at the ends to allow animals approaching from the side a better line of sight across the structure. A straight-line parabolic design is typically more cost-effective than a true hourglass design and provides the same benefits. In both Europe and North America, 164 feet (50 m) is regarded as the absolute minimum width for a multi-species overpass, and 197-230 feet (60-70 m) or more is a generally recommended, depending on other site-specific and engineering considerations (Keller 1999; Clevenger et al. 2002; Pfister et al. 2002). Current research projects in Utah, Arizona, Nevada, and Montana are finding that overpasses with much more narrow widths (less than or equal to 150 feet [45.7 m]) are passing individual species – including mule deer in Nevada and Utah; white-tailed deer in Montana; and bighorn sheep in Arizona – in numbers that are measured by the dozens to hundreds of passes per year. A more thorough review of overpasses in the western United States in the coming years is a necessary action to make better recommendations for the design of future overpasses.

Overpasses have also been built over above ground pipelines, with anecdotal evidence of caribou, moose, black bear and coyote use.

## **2.4. Monitoring Approach**

### **2.4.1. Purpose and Methods**

A field research component of this research was conducted in conjunction with the development of the Passage Assessment System (PAS). Little monitoring had been previously conducted to assess how wildlife in Washington use existing bridges and culverts; this field component was carried out to better inform the knowledgebase specific to the use of transportation infrastructure by wildlife in Washington. This component of the research project helped in refining the PAS and the accompanying Species Movement Guilds and Structural Functional Classes.

In April 2010 motion-triggered trail cameras were placed at six sites across Washington. These sites were selected to best represent different geographic areas, roads with variable number of lanes and different traffic volumes, and different types of structures. Due to funding limitations, sites greater than 200 miles from

Seattle were not selected. In June 2010, six additional cameras were placed at three additional sites. Three sites in the southwestern region of Washington were monitored: a box culvert at Mosquito Creek under US 101; a bridge over the Bone River on US 101; and a bridge over the Willapa River on SR 6. Three sites in central Washington were monitored: a corrugated steel wildlife crossing culvert under I-90 near North Bend; a double concrete box culvert under I-90 near Roslyn; and the Cle Elum River Bridge near Cle Elum. Two of the sites that had cameras placed during April, at North Bend, were pulled due to vandalism that resulted in the theft of two cameras. These sites were at the Snoqualmie trail bridges, and the South Fork Snoqualmie River bridges. They were not monitored longer than several days.

At each site, a camera was positioned at each end of the structure to best monitor all animal approaches and passes through the structures. The cameras were placed inside metal utility boxes and locked to bicycle cables which were embedded in 60 to 120 pounds of concrete on the inside bottom of the utility box. Cameras were checked every two weeks to change the batteries and retrieve photographic data. Data were entered into Excel spreadsheets for analysis. Monitoring activities continued until October 2010. The majority of these cameras are still in use by WSDOT at the writing of this report.

## **2.4.2. Overall Results**

A complete summary of the monitoring results is presented in Appendix D 'Structure Evaluations, Monitoring Results and Recommendations'. The monitoring summaries provide an overview of the data, including the number of deer and elk at the site; whether the animals used the structure or were repelled; seasonal use of the structure by deer; and tallies of all species detected at the site. For each site, six sample pictures of the camera data are displayed to demonstrate wildlife activity at the site. Monitoring information can help WSDOT determine which species will use certain structures more readily than others. The summaries also help support and clarify conclusions drawn during the site evaluations and refine the recommendations provided to enhance the structures for wildlife passage.

Of particular note from the study results is the documented elk use of two large bridged structures under I-90, one at the South Fork Snoqualmie River near milepost 33, the other at the Cle Elum River near milepost 79. Research throughout the western United States has documented the species' reluctance to pass through confined spaces such as culverts or small, restricted bridges. However, photographic evidence compiled through this research project showed elk movements under bridges that were wide, but less than 10 feet (3 m) high. This new insight that elk may be willing to use low bridges so long as they are sufficiently wide helped inform the requirements quoted for elk in the Species Movement Guilds description (Chapter 2.2.1.1-6) and may help WSDOT and other agencies to better design cost-effective bridges suitable for elk.

A very interesting site included in this study was near North Bend, where a pair of corrugated steel culverts crosses under I-90 (milepost 29). These culverts are located in a thickly vegetated area. Judging from the characteristics of the structure itself and the fact the small stream through this crossing was placed underground for half of the crossing; it appears that these culverts were designed specifically for wildlife passage. If wildlife were not considered, the stream could have been shunted underground for the entire length of the passage. In the WSDOT Bridge Engineering Information System records this structure is listed as being built in 1976 and is listed as a game crossing. The structure is tied into an extensive segment of 8-foot (2.4 m) high wildlife fencing. This culvert appears to be among the most successful black bear crossings in the western U.S., as demonstrated by 31 black bear observations during 5 months of study. In comparison, study sites in two states combined (Montana and Utah) have tallied less than 12 successful black bear crossings over the course of two years. While the passage is very successful for black bear, only three bobcats approached and crossed through the structure, and seven of 19 approaches by coyotes were repelled. Our camera technician on several occasions could smell the bear presence in the culverts when she came to check the cameras. This may explain the low numbers of deer using it. It may also support the idea that in an area of high species diversity, multiple crossings may be necessary for prey, predator and even competitor species. A site visit in April 2011 by Dr. Cramer revealed multiple piles of elk fecal pellets on both sides of the highway at this site. This data further supports the idea that multiple species of prey and predators may be at this site, but only a select group (the predators) is predominately using the culvert.

Site visits in 2011 allowed for further examination of wildlife in the areas near the crossings. During site visits in April 2011, Dr. Cramer conducted vegetation and fecal pellet counts along transects that included 25 location points in a grid pattern on each side of the highway at sites where cameras were placed. Preliminary results of pellet counts revealed that the cameras that face the crossings are only capturing a portion of the animals located in the vicinity of the crossings. This was exemplified most strongly at the Mosquito Creek culvert (US 101, milepost 76.5), as well as the large corrugated steel culverts near North Bend (I-90, milepost 29). Only one elk was photographed at the west entrance to the Mosquito Creek culvert, yet there were dozens of piles of fresh elk pellets on that side of the highway in the vicinity of the culvert entrance. The monitoring transects for fecal pellets at the large culverts at North Bend also revealed dozens of elk fecal pellet piles on both sides of the highway. This added information lends further evidence to the theory that elk prefer not to use culverts. These site visits also revealed mule and black-tailed deer use of areas near the crossings. The data have not been analyzed sufficiently at this point to glean trends in the presence of deer and other species photographed in front of the cameras and the correlation to the fecal pellet groups found in these transects.

Deer in the study exhibited a willingness to pass through culverts smaller than the researchers predicted they would. Photographic data from the Mosquito Creek



culvert under US 101, and the double box culvert under I-90 at Tucker Creek (milepost 73) showed a surprising amount of black-tailed deer using the US 101 culvert, and mule deer using the I-90 box culvert. These data had the researchers and WSDOT biologists re-thinking the culvert size limits that deer will navigate through. The Mosquito Creek culvert is only seven feet (2.1 m) high, just under 16 feet (4.9 m) wide in span, and 138 feet (42 m) long. The I-90 double box culverts at Tucker Creek are less than five feet (1.5 m) high, nine feet (2.7 m) in span, and 58 feet (17.7 m) long for each of the two culverts under opposing lanes of traffic. These culvert heights are typically considered too small for more than occasional mule deer passage. While the Mosquito Creek passage mainly passed females with young, and only passed one male, making it very limited as a passage for the deer population, the Tucker Creek culverts under I-90 passed females and young as well as 28 passages of male deer. The data from these cameras continues to inform our ideas of how deer will adapt to structures and suggest a need for additional research into the factors that affect passage use, such as traffic volumes, local adaptation, and habitat drivers, among others.

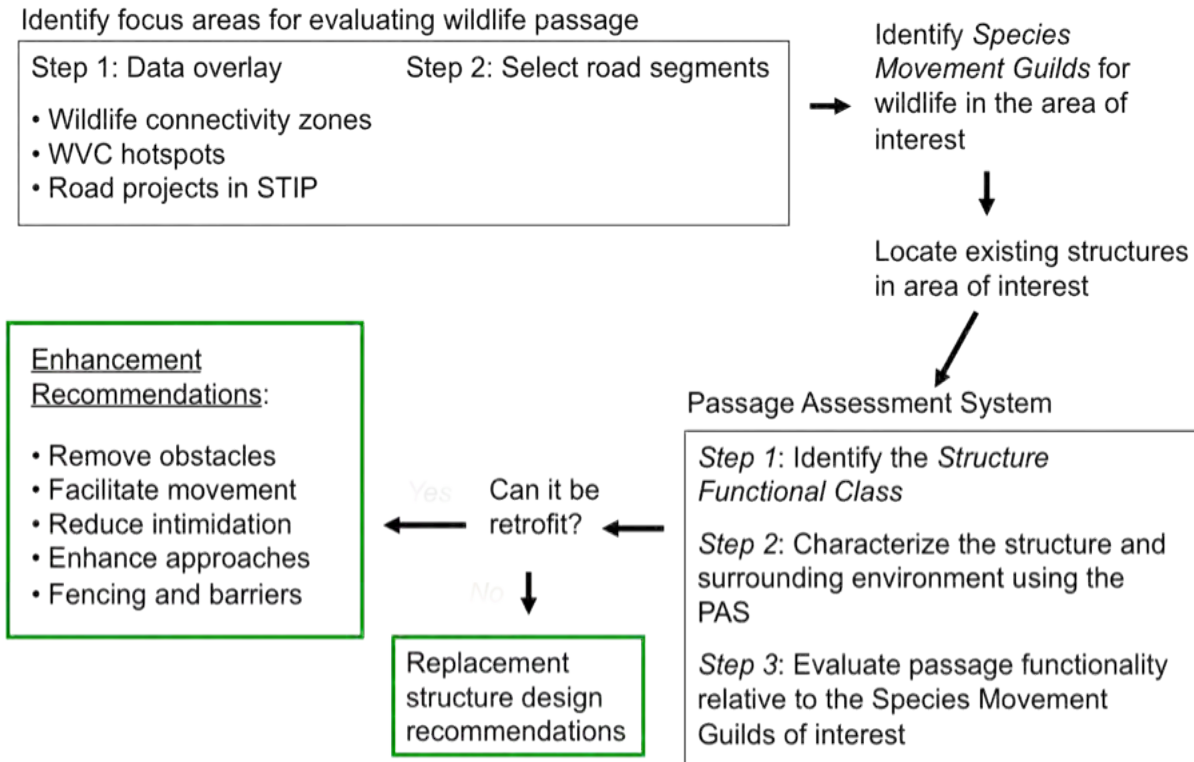
## **2.5. Passage Assessment System**

The Passage Assessment System (PAS) guides practitioners through a series of targeted questions designed to characterize a bridge or culvert relative to its potential to function as a wildlife passage. The PAS is one of several complementary tools to assist WSDOT in identifying important connectivity areas and design mitigation solutions to improve or restore permeability for native wildlife. While the Washington Wildlife Habitat Connectivity Analysis (WHCWG 2010) offers a broad-scale perspective of connectivity across the state, the PAS allows WSDOT biologists to assess permeability at the site scale, for example along targeted stretches of roadway identified as bisecting these landscape connections.

The PAS is intended as an evaluation tool to ensure that biologists ask the right questions in the field and fully document the conditions that may affect passage functionality for the diversity of target species. Upon completion, the biologists will have a complete passage assessment including preliminary ideas for improving the structure, which can be further refined during the project planning and design processes. The PAS provides an effective mechanism for determining which structures are suitable for enhancements to improve their functionality as wildlife passages or, if no such enhancements are appropriate, identify structure replacement needs for improved highway permeability for wildlife. In this way, the PAS can inform project plans and budgets at the earliest stages of the transportation planning and design process. Figure 37 depicts the major steps in identifying and evaluating existing structures for their potential to pass targeted wildlife species.

To begin the assessment process, it is necessary to first select the roadway segments of interests before conducting the PAS in the field. These may be areas that are

## Major Steps in Identifying the Potential of Existing Structures for Wildlife Passage Based on Species Movement Guilds



*Figure 37.* Flowchart identifying the major steps in evaluating the potential for an existing structure to pass native wildlife. In determining where to focus limited dollars, this process may be used at multiple locations along a given stretch of roadway to evaluate each potential safe passage opportunities (culverts, bridges and overpasses) and thereby identify which species guilds are well served by the existing conditions versus those that are underserved in the geographic area of interest.

identified connectivity zones; areas with high levels of animal-vehicle collisions, as determined from carcass removal data; areas that are slated for upcoming projects in short-term (3-5 year) planning or longer term (5-15 year) corridor planning; or, preferably, a combination of the above. A list of existing structures that fall in the roadway segments of interest can then be compiled from WSDOT's structures inventory. The locations identified on this list are where DOT biologists will use the PAS to evaluate existing structures for their functionality to pass target wildlife. Structures that are too old or are unsafe need not be evaluated, as they must be replaced; wildlife permeability considerations should then inform the design of the new structure. Other conditions that may affect whether a structure should be enhanced that are not considered in the PAS include land use and protected status of the lands on either side of a structure; the age or safety of a structure; or situations where an enhancement is not cost-effective relative to the replacement schedule.

The final step before taking the PAS into the field is to identify the species of interest whose habitat is bisected or adjacent to the roadway, and for which movement from one side of the road to the other may be of concern. In general, target species include those that are of danger in animal-vehicle collisions, such as deer, elk and moose; species of concern such as forest carnivores and threatened and endangered species; and other species that are sensitive to the barrier effect of roads. The Wildlife Habitat Linkages identified 16 focal species for the connectivity analysis. These species, if they occur in the geographic area of interest, should be included as target species. Appendix A identifies target species and associated Species Movement Guilds for each ecoregion in the state.

The assessment questions that compose the PAS were derived from a similar assessment system used in Colorado (Kintsch et al. 2011) and were further refined through a field test in Florida conducted by one of the researchers (Cramer). Following an additional series of refinements in collaboration with WSDOT, the researchers conducted a one-week field test, visiting 17 sites in southern and central Washington, including sites representing multiple bioregions and a range of structure types (pipe culverts, box culverts, arch culverts, small bridge underpasses and large bridge underpasses) as well as road types (from two to six lanes, including both divided and undivided highways). See Appendix D for complete site summaries. Final refinements to the PAS were made based on monitoring results and feedback an April 2011 workshop where the PAS was presented to WSDOT biologists from across the state.

The PAS is composed of three sections: General Questions, Undivided Highway, and Divided Highway, as well as a User's Guide provided for additional reference. For each structure that is being evaluated the user will complete 1) the General Assessment Questions, and 2) either the Divided or Undivided Highway Assessment Questions, depending on whether the structure of interest is located on a divided or undivided highway. Each of the questions in all three sections is fully clarified in the User's Guide. The complete PAS is available in hardcopy format in Appendix B of this

report, or a digital copy is available from the Fish and Wildlife page of WSDOT's intranet. It is recommended that two biologists conduct the PAS together to capture a more comprehensive picture of a structure's passage characteristics.

The General Assessment Questions record basic information about the site, including a milepost, GPS point, a unique location code, the Species Movement Guilds present at that site (Chapter 2.2), the Structure Functional Class Type (Chapter 2.3), and whether the highway is divided or undivided. The answer to this last question – divided or undivided highway – will determine which form the user completes next, either the Divided or Undivided Highway Assessment Questions. While the questions posed are the same for a divided or undivided highway, they must be posed independently for each structure at a divided highway site.

At the start of the form the user is asked to respond to a set of preliminary questions. These are a collection of targeted questions designed to determine if there is a 'fatal flaw' with the structure relative to the Species Movement Guild(s) of interest. Each question should be considered relative to the Species Movement Guilds indicated. If a fatal flaw is identified, then the user need not complete the remaining PAS questions as the fatal flaw renders the structure unsuitable for enhancement; a newly designed and constructed structure is required to pass wildlife at that location. Fatal flaws may be specific to some or all guilds and include situations where a culvert is too long for the target species to pass through or where there is a lack of visibility from one end of a structure to the other.

If no fatal flaws are identified, the user then continues with the remaining questions, which are divided into distinct sections to guide the evaluation process. Some questions are repeated to capture conditions on both sides of a structure. The assessment questions include:

- Basic questions about the structure size and shape;
- Number of traffic lanes;
- Presence of parallel infrastructure, such as railroads, frontage roads or recreational paths;
- Questions about the inlet and outlet including specific inlet or outlet features (such as an apron or a perched outlet), the presence of obstructions (such as riprap or debris), vegetation cover, and the predominant land use within the immediate vicinity;
- Questions about the inside of the structure including visibility, water flow, presence of a dry pathway, substrate, noise, vegetative cover, skylights, obstructions, and the presence of a road or trail through the structure;
- Questions about fencing and walls associated with the structure including the type, height and condition of any fencing or walls, and presence of any escape mechanisms such as jump outs or one-way gates;
- Evidence of wildlife use;
- Evidence of human activity.

Throughout the PAS, users are encouraged to take a number of photos from multiple directions to fully capture a visual record of the structure and its attributes.

Finally, the user is instructed to document their general impressions regarding the functionality of the structure for each of the Species Movement Guilds of interest. For each guild, the user is instructed to rank the structure such that an A rank means that animals could pass through the structure as is or with small modifications; a C rank means that the structure could be functional with modest modification; and an F rank means that the structure cannot be enhanced to function as a wildlife passage. This section is a subjective assessment and responses should be based on the user's overall impression having completed the full PAS. Users are then asked which features could be changed to make the structure more functional for any Species Movement Guild of interest given an A or C rank. This question offers an opportunity for the user to suggest potential improvements. These may be amended and refined later, but this evaluation is helpful for capturing preliminary ideas and impressions while still in the field.

While users should answer all questions in the PAS, regardless of which Species Movement Guilds need passage at a given site, when determining whether or not a structure can be enhanced to improve functionality, if the only target species is a toad, for example, then the structure does not need to be evaluated for bears, and vice versa. However, at many sites there is a suite of species – and therefore, guilds – requiring safe passage.

Notably, the time of year at which the passage assessment is conducted can greatly alter perspectives on the functionality of that structure for a given Species Movement Guild, largely, because of differences in water flow through the seasons. In some areas, users may need to visit a site two or more times throughout the year to develop a more complete picture of how passage is affected by changing water levels. If the users can only visit a site once, the visit should ideally occur at a time when water levels are near their highest, and special consideration should be given to how either higher or lower water levels might affect passage through the structure. The length of time that high water flows may affect terrestrial passage should also be considered – if submersion occurs for less than a month or during a season when the target wildlife are not active, there may not be a conflict with wildlife passage. In addition, multiple visits throughout the year can also capture information about how vegetation growth may affect passage or visibility, as well as provide opportunities to detect signs of animal activity at different times of year.

Upon completing the PAS the user will be equipped to answer the question: 'can this structure be improved to accommodate passage for the target species present in this area?' It is possible, in some cases that a given structure may be enhanced to accommodate one or several of the target species, but cannot be suitably enhanced for all target species. The user is encouraged to consider the range of possible enhancements and how they could be implemented at each site being assessed. Chapter 2.5.2 provides guidance for identifying suitable enhancement options once



it has been determined that a structure may be enhanced to improve permeability for the target species.

### **2.5.1. Refining the Passage Assessment System for Local Conditions**

The PAS was developed and designed for Washington’s DOT, however the assessment process is applicable regardless of geography. Once the species present in a given region have been classified according to the Species Movement Guilds, the PAS can be applied to that region. Some evaluation thresholds may need to be adjusted based on local conditions – such as a wildlife population that has adapted to human activity – or as new research becomes available, providing a more refined understanding of the factors affecting species’ use of structures.

The PAS was developed for the purpose of assessing highway infrastructure located in non-urban environments. This evaluation system may also be applied to structures located in urban environments, however, users should be aware that urban wildlife are more adapted to human activity and infrastructure than their non-urban counterparts and may, therefore, have different tolerances for which the user will need to account when developing enhancement solutions.

### **2.5.2. Passage Enhancement Toolbox**

Having determined that a structure *can* be enhanced for wildlife passage, biologists are then confronted with the question of *how* to enhance the structure to facilitate passage. Given the unique characteristics of every structure and the specific permeability objectives at each site, there is no simple answer to this question, however a number of commonly encountered situations are addressed in the Passage Enhancement Toolbox (Appendix C). The toolbox addresses a number of situations and provides examples of each. Enhancement options are organized into six categories:

- Remove obstacles to wildlife passage
- Facilitate movement and create pathways
- Reduce intimidation
- Enhance structure approaches
- Fencing and barriers
- Add or adjust structural features

Some enhancements require investments in maintenance, for example, removing sediment from a culvert or repairing holes in wildlife fencing; others require new investments, such as installing new fencing or guide walls, or constructing a new pathway through a structure. The toolbox is a living document that should be updated as revised as new techniques are tried and tested, providing an ever-

expanding array of enhancement options for DOTs to draw from. These enhancements can be further refined and customized to site-specific conditions during the DOTs project design processes, prior to implementation.

## **CHAPTER 3. CONCLUSIONS AND RECOMMENDATIONS**

### **3.1. Conclusions**

The PAS is an effective tool for evaluating the permeability of existing structures in WSDOT's transportation network. Using the PAS in conjunction with the Washington Wildlife Habitat Connectivity Analysis (WHCWG 2010) will allow biologists to conduct site-specific assessments within targeted high priority connectivity zones and in upcoming project areas as identified in the Statewide Transportation Improvement Program (STIP).

The PAS and all the supporting information that went into its development represents a first-time compilation of research results and theories on wildlife crossings across North America. The refinement of the Species Movement Guilds for this research allows any user of the information to categorize a species of interest to better understand how this species or similar species have been found move and behave with respect to roads and wildlife crossings. This allows for a fast, efficient classification of wildlife based on generalizations of movement behavior for broader categories of wildlife, regardless of known research on the specific species. The Structural Functional Classes, which were also refined for this research, can similarly be applied to all transportation culverts and bridges across North America. With the publication of this research in several different arenas, these classes are positioned to become the standard categorization for the science of transportation ecology. The development of the Passage Enhancement Toolbox is another resource that can be used by multiple users in North America and can be used as a reference for many different ways to mitigate and enhance existing structures along transportation corridors, regardless of locale. Overall, the information gathered in the development of the PAS – in addition to the PAS itself – will benefit the science and practice of transportation ecology as a whole.

The PAS was first introduced to group of WSDOT biologists in April 2011; additional experience using the PAS in the field will hone the biologists' skills in conducting and interpreting passage evaluations as a part of WSDOT's overall efforts to address permeability for wildlife and mitigate the impacts of the transportation network on connectivity for both terrestrial and aquatic wildlife. The PAS should be considered a living document as new research reveals how passage characteristics affect permeability for different types of species.

## 3.2. Next Steps and Recommendations

There are a number of ways in which the PAS may be enhanced over time to facilitate the assessment process and guide the design of appropriate mitigation enhancements. In addition to being available as hard copy data forms for use in the fields, the PAS is also ready to be programmed into handheld GPS-data collection units. Two such units are currently being beta-tested by the USDA Forest Service (contact: S. Jacobson). These and other units are scheduled to be tested in conjunction with a University of California at Davis and Caltrans research project in the summer of 2011. These units provide a streamlined mechanism for collecting and compiling field data. Both the hard copy forms and the programmable units may be easily updated and refined as needed. Continued use of the PAS by WSDOT, CALTRANS and other DOTs will help to inform any such updates.

Ongoing and new monitoring studies that help deepen our understanding of wildlife responses to crossing structures may also further inform and refine the PAS over time. With the deployment of field research cameras across Washington, WSDOT will be better equipped to record species' responses to transportation infrastructure and traffic. These data will greatly assist WSDOT in developing wildlife crossing structures and enhancements to existing structures that will promote permeability of roads for all wildlife. As the knowledgebase of what works and doesn't work for different species evolves, DOTs will be increasingly equipped to design effective crossing structures and improve the functionality of existing structures. Targeted monitoring where permeability enhancements have been implemented will create a positive feedback loop for maximizing the effectiveness of future improvements.

WSDOT is also advised to continue updating the Passage Enhancement Toolbox as new strategies are developed and tested in different situations. A complementary effort would be the compilation of engineering designs for each of these enhancement options so that WSDOT is equipped with a ready-to-go suite of designs from which engineers can draw upon when integrating permeability enhancements into transportation projects.

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## **APPENDICES**

Appendix A. Focal Species and Species Movement Guilds for the State of Washington

Appendix B. Passage Assessment System (PAS)

Appendix C. Passage Enhancement Toolbox

Appendix D. Structure Evaluations, Monitoring Results, and Recommendations for Improving Permeability for Terrestrial Wildlife in Washington State

**APPENDIX A. FOCAL SPECIES AND SPECIES MOVEMENT GUILDS FOR THE STATE OF WASHINGTON**

Species Guild	Common Name	Scientific Name	Bioregion				
			Semi-Desert Matrix	N. Rocky Mt Forest Matrix	Subalpine	Alpine	Vancouverian
<b>Low Mobility Small Fauna</b>	Cascades Frog	<i>Rana cascadae</i>			X		
	Columbia Spotted Frog	<i>Rana luteiventris</i>		X	X		
	Creeping Vole	<i>Microtus oregoni</i>					X
	Gopher Snake	<i>Pituophis catenifer</i>	X	X			
	Least Chipmunk	<i>Tamias minimus</i>	X				
	Northern Red-legged Frog	<i>Rana aurora</i>					X
	Northwestern Garter Snake	<i>Thamnophis ordinoides</i>					X
	Northern Alligator Lizard	<i>Gerrhonotus coerulea</i>					X
	Pika	<i>Ochotona princeps</i>				X	
	Sagebrush Lizard	<i>Sceloporus graciosus</i>	X				
	Southern Alligator Lizard	<i>Gerrhonotus multicarinatus</i>		X			
	Tiger Salamander	<i>Ambystoma tigrinum</i>	X				
	Vagrant Shrew	<i>Sorex vagrans</i>	X	X			X
	Western Rattlesnake	<i>Crotalus viridis</i>	X	X			
	Western Toad	<i>Bufo boreas</i>			X	X	XX
	Western Yellow-bellied Racer	<i>Coluber constrictor</i>	X	X			
Yellow Pine Chipmunk			X				
<b>Moderate Mobility Small Fauna</b>	American Badger	<i>Taxidea taxus</i>	X				
	American Marten	<i>Martes americana</i>		X	X		X
	Black-tailed Jackrabbit	<i>Lepus californicus</i>	X				
	Fisher	<i>Martes pennanti</i>		X	X		X
	Mink	<i>Mustela vison</i>					X
	Olympic Marmot	<i>Marmota olympus</i>			X	X	
	Snowshoe Hare	<i>Lepus americanus</i>		X			X
	Spotted Skunk	<i>Spilogale putorius</i>					X
	Washington Ground Squirrel	<i>Spermophilus washingtoni</i>	X				
	White-tailed Jackrabbit	<i>Lepus townsendii</i>	X				
	Western Gray Squirrel	<i>Sciurus griseus</i>					X
	Yellow-Bellied Marmot	<i>Marmota flaviventris</i>	X				

Species Guild	Common Name	Scientific Name	Bioregion				
			Semi-Desert Matrix	N. Rocky Mt Forest Matrix	Subalpine	Alpine	Vancouverian
<b>Adaptive High Mobility Fauna</b>	Black Bear	<i>Ursus americanus</i>		X	X	X	X
	Bobcat	<i>Lynx rufus</i>	X				
	Canada Lynx	<i>Lynx canadensis</i>			X		
	Coyote	<i>Canis latrans</i>		X	X		X
<b>High Openness High Mobility Carnivores</b>	Mountain Lion	<i>Felis concolor</i>			X		X
	Gray Wolf	<i>Canis lupus</i>		X	X		
	Grizzly Bear	<i>Ursus arctos</i>		X	X	X	X
	Wolverine	<i>Gulo gulo</i>			X	X	
<b>Adaptive Ungulates</b>	Black-tailed Deer	<i>Odocoileus hemionus columbianus</i>					
	Moose	<i>Alces alces</i>		X	X		
	Mountain Goat	<i>Oreamnos americanus</i>		X	X	XX	X
	Mule Deer	<i>Odocoileus hemionus</i>	XX	XX	X	X	
	White-tailed Deer	<i>Odocoileus virginianus</i>					
<b>Very High Openness Fauna</b>	Bighorn Sheep	<i>Ovis canadensis</i>		X			
	Elk	<i>Cervus elaphus</i>		X	X	X	X
	Greater Sage Grouse	<i>Centrocercus urophasianus</i>	X				
	Pronghorn	<i>Antilocapra americana</i>					
	Sharp-tailed Grouse	<i>Tympanuchus phasianellus</i>	Y				
	White-tailed Ptarmigan	<i>Lagopus leucurus</i>			X	X	
	Woodland Caribou	<i>Rangifer tarandus</i>			X	X (limited)	
<b>Arboreal Fauna</b>	Northern Flying Squirrel	<i>Glaucomys sabrinus</i>		X			X
<b>Aerial Fauna</b>	Fringed Myotis	<i>Myotis thysanodes</i>					X
	Long-legged Myotis	<i>Myotis volans</i>					Y
	Northern Spotted Owl	<i>Strix occidentalis</i>		X			X
	Short-eared Owl	<i>Asio flammeus</i>	Y (limited)				
	Silver-haired Bat	<i>Lasiurus noctivagans</i>				X	
	Townsend's Big-eared Bat	<i>Plecotus townsendii</i>				X	

APPENDIX B: PASSAGE ASSESSMENT SYSTEM

**PASSAGE ASSESSMENT SYSTEM: GENERAL QUESTIONS**

*Please complete this form for each structure visited*

Date:

Location ID:

Location Code:

Route #:

Milepost:

GPS ID:

GPS Latitude:

GPS Longitude:

**Structure Functional Class:** Class 1: small underpass      Class 2: medium underpass      Class 3: large underpass  
Class 4: extensive bridge      Class 5: wildlife overpass      Class 6: specialized culvert  
Class 7: canopy bridge

**Species Movement Guild (select all that apply):** Low Mobility Small      Moderate Mobility Small      Adaptive High Mobility Fauna      High Openness High Mobility Fauna      Adaptive Ungulates  
Very High Openness Fauna      Arboreal Fauna      Aerial Fauna

**Briefly describe the general environmental conditions at the time of the assessment (e.g., water levels, vegetation):**

**Bridge Number:**

**Divided or Undivided:** Divided      Undivided

**Highway Direction:** East/West      North/South

**Roadway Photos Numbers:** 1:      2:      3:      4:

## PASSAGE ASSESSMENT SYSTEM: DIVIDED HIGHWAY

**Special Note About Divided Highways with One Long Structure:** This form is designed for divided highways with two separate structures cross under or over opposing traffic lanes, although it may also be use where one long structure crossing the entire roadway, including the median. In this case, users need not complete the sections of the Assessment that correspond to the median side inlet/outlet, which are not present when there is just one long culvert. Users should complete the Median section of the assessment regardless.

### Preliminary Questions (i.e., fatal flaws)

Assess each of the following questions relative to the species guild of interest to determine whether the structure is fatally flawed for members of the Species Movement Guilds indicated:

<b>Is the structure longer than 300 feet? Consider each structure under a divided highway separately. (fatal flaw for Adaptive Ungulates and Very High Openness Fauna)</b>	No (continue)	Yes (structure is not suitable for enhancement)
<b>Is the culvert slope &gt; 30 degrees and 100' or longer? (fatal flaw for all Species Movement Guilds)</b>	No (continue)	Yes (structure is not suitable for enhancement)
<b>Is there extensive development/pavement in the immediate vicinity of one or both sides of the structure? (fatal flaw for all Species Movement Guilds)</b>	No (continue)	Yes (structure is not suitable for enhancement)
<b>Can you see through the structure to the other (for divided highways, consider each structure individually)? (if no, fatal flaw for Adaptive Ungulates, Very High Openness Fauna and High Openness High Mobility Carnivores)</b>	Yes (continue)	No (structure is not suitable for enhancement)

### West/North Structure

<b>What is the shape of the structure?</b>	Round Pipe	Squash Pipe	Box Culvert	Arch Culvert
	Bridge Underpass - sloped	Bridge Underpass - straight	Bridge Overpass	Other (text)
<b>What is the structure material?</b>	Concrete	Metal	Plastic/Fiberglass	Other (text)
<b>[If Shape = Box] Are there multiple chambers?</b>	No	Yes - Describe:		
**If Yes, select the most appropriate chamber for terrestrial passage to answer the following questions.				
<b>[If Shape = Bridge Underpass] Is this a single span or multispans structure?</b>	Single span		Multispans (1 or more supports)	
**If Multispans, select the most appropriate chamber for terrestrial passage to answer the following questions.				
<b>[If Shape = Bridge Underpass] What is the material of the abutments on the West/North side?</b>	Concrete	Concrete/Soil	Soil	Riprap
	Gabian Wall	Other (txt)		
-What is the slope ratio? (horizontal:vertical)	0:1	1:1	2:1	
<b>[If Shape = Bridge Underpass] What is the material of the abutments on the East/South side?</b>	Concrete	Concrete/Soil	Soil	Riprap
	Gabian Wall	Other (txt)		
-What is the slope ratio? (horizontal:vertical)	0:1	1:1	2:1	

**Road Attributes**

Number of lanes of road: \_\_\_\_\_

Is there parallel infrastructure such as railroads, recreational paths, frontage roads, etc?      No      Yes - Describe:

**Notes:**



**INLET SIDE (West/North Structure)**

Photo Number 1: 2: 3: 4:  
 Is there an apron at the inlet? No Yes, metal Yes, concrete  
 Does the culvert have wing walls? No Yes

**Structure Approximate Dimensions (functional dimensions if partial)**

Are the distances measured for the whole structure or for a single chamber of a multispan structure? Whole Structure Single Chamber  
 For each measurement, indicate 'actual' or 'estimated' measurement with an 'x' in the appropriate column. Actual Estimated  
 -Height/Rise (feet) – can be marked as graduated \_\_\_\_\_  
 -Width/Span (feet) – distance from side to side for animal crossing over/under road \_\_\_\_\_  
 -Length (feet) – distance through the structure for animal crossing over/under road \_\_\_\_\_

**Obstructions**

Is the immediate entrance blocked? None Cattle Fence Boulders humans would have to climb over  
 Rocks/Riprap (> volleyball size) Rocks/Riprap (> baseball size) Some rocks, not continuous  
 Thick Vegetation Gate Other:  
 Are there structures that block the entrance within 25 feet? No Cattle Fence Small Mesh Fence  
 Boulder Field Stream Flow High/Steep Cut or Fill Slope

**Fill Slope**

Is the structure located in a fill slope? No Yes, < 20' high Yes, > 20' high  
 -If yes, how is the structure situated in the slope? At the base Midway on fill slope Near top of fill slope

**Approach Vegetation & Cover**

Is there vegetation/cover within 25' of the inlet? No Yes, partially Yes, completely  
 -If yes, select predominant type: Grasses Bushes Bushes/Trees  
 Is there vegetation/cover within 25-50' of the inlet? No Yes, partially Yes, completely  
 -If yes, select predominant type: Grasses Bushes Bushes/Trees

**Land Use Within 100 feet of inlet:**

Predominant land use: Forest Prairie/Grassland Agriculture Wetlands  
 Shrub/Steppe Mixed: Human/Natural Residential Commercial Other:

**Noise**

What does passing traffic sound like at the entrance to the structure?  
 Silent Low Rumble Loud and Jarring

**Road Attributes**

How wide is zone of maintained vegetation (allowing extra visibility along the road shoulder)?  
 0' 0-6' 6-30' Undetermined  
 Is there a guard rail or jersey wall above the structure? No Yes, structure only Yes, extensive

**Notes:**



**OUTLET SIDE (West/North Structure)**

<b>Photo Number</b>	1:	2:	3:	4:
<b>Is there an apron at the outlet?</b>	No		Yes, metal	Yes, concrete
<b>Is the outlet perched?</b>	No		Yes, < 0.5 feet	Yes, > 0.5 feet
<b>Does the culvert have wing walls?</b>	No		Yes	

**Structure Approximate Dimensions (functional dimensions if partial)**

Are the distances measured for the whole structure or for a single chamber of a multispan structure? Whole Structure Single Chamber

For each measurement, indicate 'actual' or 'estimated' measurement with an 'x' in the appropriate column. Actual Estimated

-Height/Rise (feet) – can be marked as graduated				
-Width/Span (feet) – across or span of bridge/culvert along road				
-Length (feet) – for animal crossing over/under road				

**Obstructions**

<b>Is the immediate entrance blocked?</b>	None	Cattle Fence	Boulders humans would have to climb over
	Rocks/Riprap (> volleyball size)	Rocks/Riprap (> baseball size)	Some rocks, not continuous
	Thick Vegetation	Gate	Other:
<b>Are there structures that block the entrance within 25 feet?</b>	No	Cattle Fence	Small Mesh Fence
		Boulder Field	High/Steep Cut or Fill Slope
		Stream Flow	

**Fill Slope**

<b>Is the structure located in a fill slope?</b>	No	Yes, < 20' high	Yes, > 20' high
-If yes, how is the structure situated in the slope?	At the base	Midway on fill slope	Near top of fill slope

**Approach Vegetation & Cover**

<b>Is there vegetation/cover within 25' of the outlet?</b>	No	Yes, partially	Yes, completely
-If yes, select predominant type:	Grasses	Bushes	Bushes/Trees
<b>Is there vegetation/cover within 25-50' of the outlet?</b>	No	Yes, partially	Yes, completely
-If yes, select predominant type:	Grasses	Bushes	Bushes/Trees

**Land Use Within 100 feet of outlet:**

Predominant land use:	Forest	Prairie/Grassland	Agriculture	Wetlands
	Shrub/Steppe	Mixed: Human/Natural	Residential	Commercial
				Other:

**Noise**

<b>What does passing traffic sound like at the entrance to the structure?</b>	Silent	Low Rumble	Loud and Jarring
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**Road Attributes**

<b>How wide is zone of maintained vegetation (allowing extra visibility along the road shoulder)?</b>	0'	0-6'	6-30'	Undetermined
<b>Is there a guard rail or jersey wall above the structure?</b>	No	Yes, structure only	Yes, extensive	

**Notes:**

**Fencing/Walls (West/North Structure)**

<b>Photo Number</b>	1:	2:	3:	4:
<b>Is there fencing present on the West/North side of the structure?</b>	Yes	No		
<b>Select type of fencing to <i>right</i> when facing structure:</b>	Curb (not including wingwalls)		Wall (not including wingwalls)	
Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:
-If curb or wall, does it have a lip?	Yes	No		
-What is the height of fencing/wall?	None	! 6"	> 6" to ! 2'	2' to 4'
-What is the mesh size?	None	6x6"	6x6", graduating smaller to 2x3 at base	
-Is it connected to the structure?	Yes	No - small gap (! 0.5')		No - large gap (>0.5')
-Does the fencing reach all the way to ground level without gaps?	Yes	No		
-Is the fencing entrenched in the ground to prevent animals from digging under it?	Yes	No		
- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure?	Yes	No		
If no, what is the ROW fencing type:	Curb (not including wingwalls)		Wall (not including wingwalls)	
Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:
-Minimum distance fence extends from structure:	! 10 feet	10-50 feet	50-100 feet	>100 feet
	~" mile	1 mile	Miles	End not visible/known
<b>Select type of fencing to <i>left</i> when facing structure:</b>	Curb (not including wingwalls)		Wall (not including wingwalls)	
Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:
-If curb or wall, does it have a lip?	Yes	No		
-What is the height of fencing/wall?	None	! 6"	> 6" to ! 2'	2' to 4'
-What is the mesh size?	None	6x6"	6x6", graduating smaller to 2x3 at base	
-Is it connected to the structure?	Yes	No - small gap (! 0.5')		No - large gap (>0.5')
-Does the fencing reach all the way to ground level without gaps?	Yes	No		
-Is the fencing entrenched in the ground to prevent animals from digging under it?	Yes	No		
- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure?	Yes	No		
If no, what is the ROW fencing type:	Curb (not including wingwalls)		Wall (not including wingwalls)	
Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:
-Minimum distance fence extends from structure:	! 10 feet	101 feet	120-250 feet	# mile
	" mile	2 mile	Miles	End not visible/known
<b>What is the general condition of the fencing?</b>	Gaps and areas where fence is down		Some tacking up of fence needed	
	Vegetation needs to be cleared from fence		Fence in good working order	
<b>Is there an escape ramp(s) within a 1/2 mile of the structure in either direction?</b>	No	Yes - 1	Yes - 2 or more	
<b>Is there a one-way gate(s) within a 1/2 mile of the structure in either direction?</b>	No	Yes - 2	Yes - 2 or more	
<b>Are there uncontrolled driveways or intersections that cause breaks in the fencing within a 1/2 mile of the structure in either direction?</b>	None	1	2-5	6-10
				>10

**Notes:**





**INLET SIDE (East/South Structure)**

Photo Number 1: 2: 3: 4:

Is there an apron at the inlet? No Yes, metal Yes, concrete

Does the culvert have wing walls? No Yes

**Structure Approximate Dimensions (functional dimensions if partial)**

Are the distances measured for the whole structure or for a single chamber of a multispan structure? Whole Structure Single Chamber

For each measurement, indicate 'actual' or 'estimated' measurement with an 'x' in the appropriate column. Actual Estimated

-Height/Rise (feet) – can be marked as graduated

-Width/Span (feet) – across or span of bridge/culvert along road

-Length (feet) – for animal crossing over/under road

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Obstructions**

Is the immediate entrance blocked? None Cattle Fence Boulders humans would have to climb over  
 Rocks/Riprap (> volleyball size) Rocks/Riprap (> baseball size) Some rocks, not continuous  
 Thick Vegetation Gate Other:

Are there structures that block the entrance within 25 feet? No Cattle Fence Small Mesh Fence  
 Boulder Field Stream Flow High/Steep Cut or Fill Slope

**Fill Slope**

Is the structure located in a fill slope? No Yes, < 20' high Yes, > 20' high  
 -If yes, how is the structure situated in the slope? At the base Midway on fill slope Near top of fill slope

**Approach Vegetation & Cover**

Is there vegetation/cover within 25' of the inlet? No Yes, partially Yes, completely  
 -If yes, select predominant type: Grasses Bushes Bushes/Trees

Is there vegetation/cover within 25-50' of the inlet? No Yes, partially Yes, completely  
 -If yes, select predominant type: Grasses Bushes Bushes/Trees

**Land Use Within 100 feet of inlet:**

Predominant land use: Forest Prairie/Grassland Agriculture Wetlands  
 Shrub/Steppe Mixed: Human/Natural Residential Commercial Other:

**Noise**

What does passing traffic sound like at the entrance to the structure? Silent Low Rumble Loud and Jarring

**Road Attributes**

How wide is zone of maintained vegetation (allowing extra visibility along the road shoulder)? 0' 0-6' 6-30' Undetermined

Is there a guard rail or jersey wall above the structure? No Yes, structure only Yes, extensive

**Notes:**



**OUTLET SIDE (East/South Structure)**

<b>Photo Number</b>	1:	2:	3:	4:
<b>Is there an apron at the outlet?</b>	No		Yes, metal	Yes, concrete
<b>Is the outlet perched?</b>	No		Yes, < 0.5 feet	Yes, > 0.5 feet
<b>Does the culvert have wing walls?</b>	No		Yes	

**Structure Approximate Dimensions (functional dimensions if partial)**

Are the distances measured for the whole structure or for a single chamber of a multispan structure? Whole Structure Single Chamber

For each measurement, indicate 'actual' or 'estimated' measurement with an 'x' in the appropriate column. Actual Estimated

-Height/Rise (feet) – can be marked as graduated				
-Width/Span (feet) – across or span of bridge/culvert along road				
-Length (feet) – for animal crossing over/under road				

**Obstructions**

<b>Is the immediate entrance blocked?</b>	None	Cattle Fence	Boulders humans would have to climb over
	Rocks/Riprap (> volleyball size)	Rocks/Riprap (> baseball size)	Some rocks, not continuous
	Thick Vegetation	Gate	Other:
<b>Are there structures that block the entrance within 25 feet?</b>	No	Cattle Fence	Small Mesh Fence
		Boulder Field	High/Steep Cut or Fill Slope
		Stream Flow	

**Fill Slope**

<b>Is the structure located in a fill slope?</b>	No	Yes, < 20' high	Yes, > 20' high
-If yes, how is the structure situated in the slope?	At the base	Midway on fill slope	Near top of fill slope

**Approach Vegetation & Cover**

<b>Is there vegetation/cover within 25' of the outlet?</b>	No	Yes, partially	Yes, completely
-If yes, select predominant type:	Grasses	Bushes	Bushes/Trees
<b>Is there vegetation/cover within 25-50' of the outlet?</b>	No	Yes, partially	Yes, completely
-If yes, select predominant type:	Grasses	Bushes	Bushes/Trees

**Land Use Within 100 feet of outlet:**

Predominant land use:	Forest	Prairie/Grassland	Agriculture	Wetlands
	Shrub/Steppe	Mixed: Human/Natural	Residential	Commercial
				Other:

**Noise**

<b>What does passing traffic sound like at the entrance to the structure?</b>	Silent	Low Rumble	Loud and Jarring
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**Road Attributes**

<b>How wide is zone of maintained vegetation (allowing extra visibility along the road shoulder)?</b>	0'	0-6'	6-30'	Undetermined
<b>Is there a guard rail or jersey wall above the structure?</b>	No	Yes, structure only	Yes, extensive	

**Notes:**

## Fencing/Walls (East/South Structure)

<b>Photo Number</b>	1:	2:	3:	4:
<b>Is there fencing present on the East/South side of the structure?</b>	Yes	No		
<b>Select type of fencing to <i>right</i> when facing structure:</b>	Chain Link	Wildlife Fence	Curb (not including wingwalls) Sediment Fence	Wall (not including wingwalls) 4-Strand Wire Other:
-If curb or wall, does it have a lip?		Yes	No	
-What is the height of fencing/wall?	None	! 6"	> 6" to ! 2'	2' to 4'    4 to 6'    6 to 8'    >8'
-What is the mesh size?	None	6x6"		6x6", graduating smaller to 2x3 at base    Other:
-Is it connected to the structure?	Yes		No - small gap (! 0.5')	No - large gap (>0.5')
-Does the fencing reach all the way to ground level without gaps?		Yes	No	
-Is the fencing entrenched in the ground to prevent animals from digging under it?		Yes	No	
- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure?		Yes	No	
If no, what is the ROW fencing type:		Curb (not including wingwalls)		Wall (not including wingwalls)
	Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire    Other:
-Minimum distance fence extends from structure:				
	! 10 feet	10-50 feet	50-100 feet	>100 feet    ~" mile    1 mile    Miles    End not visible/known
<b>Select type of fencing to <i>left</i> when facing structure:</b>	Chain Link	Wildlife Fence	Curb (not including wingwalls) Sediment Fence	Wall (not including wingwalls) 4-Strand Wire Other:
-If curb or wall, does it have a lip?		Yes	No	
-What is the height of fencing/wall?	None	! 6"	> 6" to ! 2'	2' to 4'    4 to 6'    6 to 8'    >8'
-What is the mesh size?	None	6x6"		6x6", graduating smaller to 2x3 at base    Other:
-Is it connected to the structure?	Yes		No - small gap (! 0.5')	No - large gap (>0.5')
-Does the fencing reach all the way to ground level without gaps?		Yes	No	
-Is the fencing entrenched in the ground to prevent animals from digging under it?		Yes	No	
- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure?		Yes	No	
If no, what is the ROW fencing type:		Curb (not including wingwalls)		Wall (not including wingwalls)
	Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire    Other:
-Minimum distance fence extends from structure:				
	! 10 feet	101 feet	120-250 feet	# mile    " mile    2 mile    Miles    End not visible/known
<b>What is the general condition of the fencing?</b>			Gaps and areas where fence is down Vegetation needs to be cleared from fence	Some tacking up of fence needed Fence in good working order
<b>Is there an escape ramp(s) within a 1/2 mile of the structure in either direction?</b>			No	Yes - 1    Yes - 2 or more
<b>Is there a one-way gate(s) within a 1/2 mile of the structure in either direction?</b>			No	Yes - 2    Yes - 2 or more
<b>Are there uncontrolled driveways or intersectionsthat cause breaks in the fencing within a 1/2 mile of the structure in either direction?</b>	None	1	2-5	6-10    >10

**Notes:**

## Median

<b>Photo Number</b>	1:	2:	3:	4:
<b>Is there an open median?</b>	Yes	No		
[Include checkbox for each measurement below - Actual Measurements?]				
-What is the length of the median (distance between the two structures)? _____				
<b>What is the substrate of the median?</b>		Concrete/Asphalt	Mix: Man-made & Natural	Natural
<b>[if substrate = natural] Is there vegetation in the median?</b>		No	Yes, partially	Yes, completely
-If yes, select predominant type:				
		Grasses	Bushes	Bushes/Trees
<b>Is their median fencing/walls to prevent animals from accessing the highway via the median?</b>	Yes	No		
-Select type of fencing				
	Curb (not including wingwalls)	Wall (not including wingwalls)		4-Strand Wire
	Chain Link	Wildlife Fence	Sediment Fence	
<b>What is the general condition of the fencing?</b>		Gaps and areas where fence is down	Some tacking up of fence needed	
		Vegetation needs to be cleared from fence	Fence in good working order	

**Notes:**

## General

<b>Photo Number</b>	1:	2:	3:	4:
<b>Wildlife Use</b>				
<b>Are there signs of wildlife use in the structure such as tracks?</b>		Tracks	Scat	Live Animal
-If yes, describe				
<b>Are there signs of wildlife within 30 feet of the entrances?</b>		Tracks	Scat	Roadkill
-If yes, describe				
			Live Animal	None
				Other (text)
<b>Human Use</b>				
<b>Is there apparent human activity in the structure?</b>		Yes - Frequent/Daily	Yes - Occasional	No evidence Found
-What type(s) of activity? (check all that apply):				
		Camping/Occupancy	Vehicle/ATV use	Trail
		Recreation Dog	Night Use	Other:
<b>Which description best matches human activities immediately adjacent to the structure?</b>				
	Daily human activity at both entrances	Daily human activity at one entrance		
	Recreational use in a wild setting	Wild setting with infrequent human activity		Other:

**Notes:**



## Species Movement Guild Rankings

When ranking the structure, consider how changes in water levels and vegetation growth may affect passage for each Species Movement Guild.

A = This animal could make it though as is, or with small modifications

C = With modest modifications this structure could be functional

F = Can't be fixed with a retrofit

Rate this structure for **Low Mobility Small Fauna**, e.g., slow-moving animals that require a consistent environmental conditions, such as frogs or salamanders:

A                      C                      F

Comments:

Rate this structure for **Moderate Mobility Small Fauna**, e.g., small animals that are fairly adaptable, such as squirrels, skunks, raccoons, fishers and some turtles:

A                      C                      F

Comments:

Rate this structure for **Adaptive High Mobility Fauna**, e.g., fairly tolerant medium-sized animals, such as bobcat, coyote and black bear:

A                      C                      F

Comments:

Rate this structure for **High Openness High Mobility Carnivores**, e.g., larger animals that prefer larger structures, such as grizzly bear or mountain lion

A                      C                      F

Comments:

Rate this structure for **Adaptive Ungulates**, e.g., ungulates that require good visibility through a structure, such as deer, moose or mountain goats:

A                      C                      F

Rate this structure for **Very High Openness Fauna**, e.g., animals that require large structures with clear lines of sight that are less than 100' long, such as elk, pronghorn and turkey:

A                      C                      F

Comments:

**Which features could be changed to make the structure more functional for each target Species Movement Guild given an A or C rank?**

# PASSAGE ASSESSMENT SYSTEM: UNDIVIDED HIGHWAY

## Preliminary Questions (i.e., fatal flaws)

Assess each of the following questions relative to the species guild of interest to determine whether the structure is fatally flawed for members of the Species Movement Guilds indicated:

<b>Is the structure longer than 300 feet? (fatal flaw for <i>Adaptive Ungulates</i> and <i>Very High Openness Fauna</i>)</b>	No (continue)	Yes (structure is not suitable for enhancement)
<b>Is the culvert slope &gt; 30 degrees and 100' or longer? (fatal flaw for <i>all Species Movement Guilds</i>)</b>	No (continue)	Yes (structure is not suitable for enhancement)
<b>Is there extensive development/pavement in the immediate vicinity of one or both sides of the structure? (fatal flaw for <i>all Species Movement Guilds</i>)</b>	No (continue)	Yes (structure is not suitable for enhancement)
<b>Can you see through the structure to the other (for divided highways, consider each structure individually)? (if no, fatal flaw for <i>Adaptive Ungulates</i>, <i>Very High Openness Fauna</i> and <i>High Openness High Mobility Carnivores</i>)</b>	Yes (continue)	No (structure is not suitable for enhancement)

## Structure

<b>What is the shape of the structure?</b>	Round Pipe	Squash Pipe	Box Culvert	Arch Culvert
	Bridge Underpass - sloped	Bridge Underpass - straight	Bridge Overpass	Other (text)
<b>What is the structure material?</b>	Concrete	Metal	Plastic/Fiberglass	Other (text)
<b>[If Shape = Box] Are there multiple chambers?</b>	No	Yes - # of Chambers? (num)		
**If Yes, select the most appropriate chamber for terrestrial passage to answer the following questions.				
<b>[If Shape = Bridge Underpass] Is this a single span or multispans structure?</b>	Single span		Multispans (1 or more supports)	
**If Multispans, select the most appropriate chamber for terrestrial passage to answer the following questions.				
<b>[If Shape = Bridge Underpass] What is the material of the abutments on the West/North side?</b>	Concrete	Concrete/Soil	Soil	Riprap
	Gabian Wall	Other (txt)		
-What is the slope ratio? (horizontal:vertical)	0:1	1:1	2:1	
<b>[If Shape = Bridge Underpass] What is the material of the abutments on the East/South side?</b>	Concrete	Concrete/Soil	Soil	Riprap
	Gabian Wall	Other (txt)		
-What is the slope ratio? (horizontal:vertical)	0:1	1:1	2:1	

**Road Attributes**

Number of lanes of road: \_\_\_\_\_

Is there parallel infrastructure such as railroads, recreational paths, frontage roads, etc?      No      Yes - Describe:

**Notes:**

**INLET SIDE**

Photo Number 1: 2: 3: 4:

Is there an apron at the inlet? No Yes, metal Yes, concrete

Does the culvert have wing walls? No Yes

**Structure Approximate Dimensions (functional dimensions if partial)**

Are the distances measured for the whole structure or for a single chamber of a multispan structure? Whole Structure Single Chamber

For each measurement, indicate 'actual' or 'estimated' measurement with an 'x' in the appropriate column. Actual Estimated

- Height/Rise (feet) – can be marked as graduated \_\_\_\_\_
- Width/Span (feet) – across or span of bridge/culvert along road \_\_\_\_\_
- Length (feet) – for animal crossing over/under road \_\_\_\_\_

**Obstructions**

Is the immediate entrance blocked? None Cattle Fence Boulders humans would have to climb over  
 Rocks/Riprap (> volleyball size) Rocks/Riprap (> baseball size) Some rocks, not continuous  
 Thick Vegetation Gate Other:

Are there structures that block the entrance within 25 feet? No Cattle Fence Small Mesh Fence  
 Boulder Field Stream Flow High/Steep Cut or Fill Slope

**Fill Slope**

Is the structure located in a fill slope? No Yes, < 20' high Yes, > 20' high  
 -If yes, how is the structure situated in the slope? At the base Midway on fill slope Near top of fill slope

**Approach Vegetation & Cover**

Is there vegetation/cover within 25' of the inlet? No Yes, partially Yes, completely  
 -If yes, select predominant type: Grasses Bushes Bushes/Trees

Is there vegetation/cover within 25-50' of the inlet? No Yes, partially Yes, completely  
 -If yes, select predominant type: Grasses Bushes Bushes/Trees

**Land Use Within 100 feet of inlet:**

Predominant land use: Forest Prairie/Grassland Agriculture Wetlands  
 Shrub/Steppe Mixed: Human/Natural Residential Commercial Other:

**Noise**

What does passing traffic sound like at the entrance to the structure?  
 Silent Low Rumble Loud and Jarring

**Road Attributes**

How wide is zone of maintained vegetation (allowing extra visibility along the road shoulder)?  
 0' 0-6' 6-30' Undetermined

Is there a guard rail or jersey wall above the structure? No Yes, structure only Yes, extensive

**Notes:**

## Inlet Side: Fencing/Walls

<b>Photo Number</b>	1:	2:	3:	4:			
<b>Is there fencing associated with the inlet side of the structure?</b>			Yes	No			
<b>Select type of fencing to <i>right</i> when facing structure:</b>	Curb (not including wingwalls)		Wall (not including wingwalls)				
	Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:		
-If curb or wall, does it have a lip?		Yes	No				
-What is the height of fencing/wall?	None	! 6"	> 6" to ! 2'	2' to 4'	4 to 6'	6 to 8'	>8'
-What is the mesh size?	None	6x6"	6x6", graduating smaller to 2x3 at base		Other:		
-Is it connected to the structure?	Yes	No - small gap (! 0.5')		No - large gap (>0.5')			
-Does the fencing reach all the way to ground level without gaps?	Yes	No					
-Is the fencing entrenched in the ground to prevent animals from digging under it?	Yes	No					
- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure?	Yes	No					
If no, what is the ROW fencing type:	Curb (not including wingwalls)		Wall (not including wingwalls)				
	Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:		
-Minimum distance fence extends from structure:							
	! 10 feet	10-50 feet	50-100 feet	>100 feet	~" mile	1 mile	Miles      End not visible/known
<b>Select type of fencing to <i>left</i> when facing structure:</b>	Curb (not including wingwalls)		Wall (not including wingwalls)				
	Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:		
-If curb or wall, does it have a lip?		Yes	No				
-What is the height of fencing/wall?	None	! 6"	> 6" to ! 2'	2' to 4'	4 to 6'	6 to 8'	>8'
-What is the mesh size?	None	6x6"	6x6", graduating smaller to 2x3 at base		Other:		
-Is it connected to the structure?	Yes	No - small gap (! 0.5')		No - large gap (>0.5')			
-Does the fencing reach all the way to ground level without gaps?	Yes	No					
-Is the fencing entrenched in the ground to prevent animals from digging under it?	Yes	No					
- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure?	Yes	No					
If no, what is the ROW fencing type:	Curb (not including wingwalls)		Wall (not including wingwalls)				
	Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:		
-Minimum distance fence extends from structure:							
	! 10 feet	101 feet	120-250 feet	# mile	" mile	2 mile	Miles      End not visible/known
<b>What is the general condition of the fencing?</b>	Gaps and areas where fence is down		Some tacking up of fence needed				
	Vegetation needs to be cleared from fence		Fence in good working order				
<b>Is there an escape ramp(s) within a 1/2 mile of the structure in either direction?</b>	No	Yes - 1		Yes - 2 or more			
<b>Is there a one-way gate(s) within a 1/2 mile of the structure in either direction?</b>	No	Yes - 2		Yes - 2 or more			
<b>Are there uncontrolled driveways or intersectionsthat cause breaks in the fencing within a 1/2 mile of the structure in either direction?</b>							
	None	1	2-5	6-10	>10		

**Notes:**

## INSIDE STRUCTURE

Photo Number 1: 2: 3: 4:

### Visibility

Does the inside of the structure appear much darker than the outside lighting? High Contrast Low Contrast  
 Is there a clear line of sight from one end of the structure(s) to the other? No Obscured Yes, complete visibility

### Water Features

Is there perennial water flow through structure? No < 3' deep 3-10' deep >10' deep  
 Does there appear to be a dry natural substrate/dirt pathway through the structure during average flows?  
 None Dry Dirt Pathway Rock/Dirt Pathway Dry Rocky Pathway

Is there evidence that the dry pathway may be obliterated seasonally or during high water events?  
 No Yes Uncertain

### Substrate

What is the substrate of the floor at the bottom/center of the structure? Concrete/Asphalt Metal  
 Plastic Rocks Dry Soil Stream Bottom Other (txt)  
 -Is there a natural bottom through the length of the structure? Yes No  
 -Is there a natural bottom across the width of the structure? Yes No, > 6" No, 6" or greater

### Pathway Floor Substrate

Does the substrate through the structure appear similar to substrate outside of the structure? Yes No  
 -If No, what is the floor substrate?  
 Concrete Concrete with Steel Riprap Riprap Boulders Other (text)  
 (> baseball) (> volleyball)  
 -If Yes, what is the minimum width of the dry natural pathway all the way through the structure?  
 <2 feet 2-5 feet 5-10 feet 10-20 feet 20-50 feet Over 50 feet

### Vegetation

Is there vegetative cover and/or woody debris through the structure? None Some Logs, Down Trees  
 Some Grass/Brush Grasses Brush/Bushes/Trees

### Noise

What does passing traffic sound like from the middle of the structure?  
 Silent Low Rumble Loud and Jarring

### Other

Is there a road or trail through the structure? None Paved Road Dirt Road Railroad Paved Trail Dirt Trail  
 Are there obstructions inside the structure? None Debris Soil Baffles Gaps/Trenche Man-made Items  
 Is there a sky light in structure? No Yes

### Notes:





## Outlet Side: Fencing/Walls

Photo Number	1:	2:	3:	4:
<b>Is there fencing associated with the outlet side of the structure?</b>		Yes	No	
<b>Select type of fencing to <i>right</i> when facing structure:</b>		Curb (not including wingwalls)	Wall (not including wingwalls)	
Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:
-If curb or wall, does it have a lip?		Yes	No	
-What is the height of fencing/wall?	None	! 6"	> 6" to ! 2'	2' to 4'
-What is the mesh size?	None	6x6"	6x6", graduating smaller to 2x3 at base	
-Is it connected to the structure?	Yes	No - small gap (! 0.5')		No - large gap (>0.5')
-Does the fencing reach all the way to ground level without gaps?		Yes	No	
-Is the fencing entrenched in the ground to prevent animals from digging under it?		Yes	No	
- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure?		Yes	No	
If no, what is the ROW fencing type:		Curb (not including wingwalls)	Wall (not including wingwalls)	
Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:
-Minimum distance fence extends from structure:				
! 10 feet	10-50 feet	50-100 feet	>100 feet	~" mile
				1 mile
				miles
				end not visible/known
<b>Select type of fencing to <i>left</i> when facing structure:</b>		Curb (not including wingwalls)	Wall (not including wingwalls)	
Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:
-If curb or wall, does it have a lip?		Yes	No	
-What is the height of fencing/wall?	None	! 6"	> 6" to ! 2'	2' to 4'
-What is the mesh size?	None	6x6"	6x6", graduating smaller to 2x3 at base	
-Is it connected to the structure?	Yes	No - small gap (! 0.5')		No - large gap (>0.5')
-Does the fencing reach all the way to ground level without gaps?		Yes	No	
-Is the fencing entrenched in the ground to prevent animals from digging under it?		Yes	No	
- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure?		Yes	No	
If no, what is the ROW fencing type:		Curb (not including wingwalls)	Wall (not including wingwalls)	
Chain Link	Wildlife Fence	Sediment Fence	4-Strand Wire	Other:
-Minimum distance fence extends from structure:				
! 10 feet	101 feet	120-250 feet	# mile	" mile
				2 mile
				miles
				end not visible/known
<b>What is the general condition of the fencing?</b>		Gaps and areas where fence is down		Some tacking up of fence needed
		Vegetation needs to be cleared from fence		Fence in good working order
<b>Is there an escape ramp(s) within a 1/2 mile of the structure in either direction?</b>		No	Yes - 1	Yes - 2 or more
<b>Is there a one-way gate(s) within a 1/2 mile of the structure in either direction?</b>		No	Yes - 2	Yes - 2 or more
<b>Are there uncontrolled driveways or intersections that cause breaks in the fencing within a 1/2 mile of the structure in either direction?</b>				
None	1	2-5	6-10	>10

### Notes:

## General

<b>Photo Number</b>	1:	2:	3:	4:	
<b>Wildlife Use</b>					
<b>Are there signs of wildlife use in the structure such as tracks?</b>	Tracks	Scat	Live Animal	None	Other (text)
-If yes, describe					
<b>Are there signs of wildlife within 30 feet of the entrances?</b>	Tracks	Scat	Roadkill	Live Animal	None
-If yes, describe					Other (text)

### Human Use

<b>Is there apparent human activity in the structure?</b>	Yes - Frequent/Daily	Yes - Occasional	No evidence Found
-What type(s) of activity? (check all that apply):	Camping/Occupancy	Vehicle/ATV use	Trail
	Recreation Dog	Night Use	Other:

**Which description best matches human activities immediately adjacent to the structure?**

Daily human activity at both entrances	Daily human activity at one entrance	
Recreational use in a wild setting	Wild setting with infrequent human activity	Other:

### Notes:

## Species Movement Guild Rankings

When ranking the structure, consider how changes in water levels and vegetation growth may affect passage for each Species Movement Guild.  
 A = This animal could make it though as is, or with small modifications  
 C = With modest modifications this structure could be functional  
 F = Can't be fixed with a retrofit

**Rate this structure for *Low Mobility Small Fauna*, e.g., slow-moving animals that require a consistent environmental conditions, such as frogs or salamanders:**

	A	C	F
Comments:			

**Rate this structure for *Moderate Mobility Small Fauna*, e.g., small animals that are fairly adaptable, such as squirrels, skunks, raccoons, fishers and some turtles:**

	A	C	F
Comments:			

Rate this structure for *Adaptive High Mobility Fauna*, e.g., fairly tolerant medium-sized animals, such as bobcat, coyote and black bear:

A                      C                      F

Comments:

Rate this structure for *High Openness High Mobility Carnivores*, e.g., larger animals that prefer larger structures, such as grizzly bear or mountain lion

A                      C                      F

Comments:

Rate this structure for *Adaptive Ungulates*, e.g., ungulates that require good visibility through a structure, such as deer, moose or mountain goats:

A                      C                      F

Comments:

Rate this structure for *Very High Openness Fauna*, e.g., animals that require large structures with clear lines of sight that are less than 100' long, such as elk, pronghorn and turkey:

A                      C                      F

Comments:

**Which features could be changed to make the structure more functional for any Species Movement Guild given an A or C rank?**

## User's Guide to Passage Assessment System

This User's Guide is a *reference document* to assist users of the Passage Assessment System. For each structure that is being evaluated, the user will complete (1) General Assessment Questions, and (2) Divided or Undivided Highway Assessment Questions, depending on whether the structure is located on a divided or undivided highway. Each of the questions in these sections are fully explained in this User's Guide.

### **MATERIALS:**

Clipboard, GPS unit, camera, 200' measuring tape

***Special Note About Seasonality and Using the PAS:*** The time of year at which the PAS is conducted can greatly later perspectives on the functionality of the structure for a given Species Movement Guild because of changes in water flows in different seasons. At locations where terrestrial passage may be significantly affected by changes in water levels, it is recommended that the PAS be conducted two or more times throughout the year to more accurately capture the impacts on terrestrial passage through the structure. Multiple assessments can also provide additional information relating to changes in vegetation growth and signs of animal activity throughout the year.

***Special Note About Urban Environments:*** The Passage Assessment System was developed for the purpose of assessing highway infrastructure located in non-urban environments. This evaluation system may also be applied to structures located in urban environments, however, users should be aware that urban wildlife are more adapted to human activity and infrastructure than their non-urban counterparts and may, therefore, have different tolerances for which the user will need to account when developing enhancement solutions.



## TAB 1: GENERAL QUESTIONS

*This form should be completed for each structure being evaluated.*

<b>Date:</b>	Today's date (dd/mm/yyyy)
<b>Location ID:</b>	Unique location number assigned to a given structure during a given field session (i.e., 01, 02, 03, etc)
<b>Location Code:</b>	Unique identifier code for a given structure written as: route_number_milepost_location id (e.g., 90_234_07 for US90, MP 234, Location #7)
<b>Route #:</b>	Highway number (e.g. US 101)
<b>Milepost:</b>	Milepost number to the nearest tenth mile
<b>GPS ID:</b>	Record ID number automatically generated by the GPS unit
<b>GPS Latitude:</b>	Derived from the GPS unit
<b>GPS Longitude:</b>	Derived from the GPS unit
<b>Structure Functional Class:</b>	Select the appropriate Functional Class of the structure being evaluated: 1 = small underpass (<5' span); 2 = medium underpass (5-8' span x 8' rise); 3 = large underpass (! 20' span x 8' rise, or ! 10' span x 10' rise) ; 4 = extensive bridge; 5 = wildlife overpass; 6 = specialized culverts; 7 = canopy bridge. Refer to the document <i>Functional Classes of Structures</i> for complete descriptions.
<b>Species Movement Guild:</b>	Identify the Species Movement Guilds that have been identified for this location (select all that apply): Low Mobility Fauna; Moderate Mobility Small Fauna; Adaptive High Mobility Fauna; High Openness High Mobility Fauna; Adaptive Ungulates; Very High Openness Fauna; Arboreal Fauna; Aerial Fauna. Refer to the document <i>Terrestrial Species Guilds</i> for complete descriptions.
<b>Bridge Number:</b>	WSDOT identification number
<b>Divided or Undivided:</b>	Note if the highway along this segment is divided or undivided at the point of the structure being evaluated.
<b>Highway Direction:</b>	Note if the primary direction of the roadway is east-west or north-south.
<b>Roadway Photo Numbers:</b>	Enter photo id numbers. Pictures are extremely helpful - take a lot!

## TAB 2 or 3: DIVIDED OR UNDIVIDED HIGHWAY

**Select the appropriate form for evaluating a given structure based on whether the structure is at a divided or undivided highway.**

While the questions posed are the same for a divided or undivided highway, they must be posed independently for each structure at a divided highway site. Evaluation questions are divided into distinct sections to guide the evaluation process. Some questions are repeated to capture conditions on both sides of a structure.

### Preliminary Questions

These are a collection of targeted questions designed to determine if there is a 'fatal flaw' with the structure relative to the Species Movement Guild(s) of interest. Each question should be considered relative to the Species Movement Guilds indicated. If a fatal flaw is identified, then the user need not complete all of the Passage Evaluations System questions as the fatal flaw renders the structure unsuitable for a enhancement; a redesigned and reconstructed structure is required to pass wildlife at that location.

**Is the structure longer than 300 feet?** A 'Yes' response is considered a fatal flaw for *Adaptive Ungulates* and *Very High Openness Fauna* and the structure is not suitable for enhancements. If the response is 'No', the user continues with the evaluation.

**Is the culvert slope > 30 degrees and 100' or longer?** A 'Yes' response is considered a fatal flaw for all *Species Movement Guilds* and the structure is not suitable for enhancement. If the response is 'No', the user continues with the evaluation. This threshold is intended as a general guideline; it may be adjusted based on additional research or local expertise.

**Is there extensive human development/pavement in the immediate vicinity of one or both sides of the structure?** A 'Yes' response is considered a fatal flaw for *all* Species Movement Guilds and the structure is not suitable for enhancement. While structures in a developed landscape may pass some animals that have adapted to that landscape, these structures offer limited use for passing wildlife populations and improving connectivity. If the response is 'No', the user continues with the evaluation.

**Can you see through the structure to the other side (for divided highways, consider each structure individually)?** A 'No' response is considered a fatal flaw for several species guilds and the structure is not suitable for enhancement. If the response is 'No', the user continues with the evaluation.

### Structure

**What is the shape of the structure?** Select one: Round Pipe, Squash Pipe, Box Culvert, Arch Culvert, Bridge Underpass with sloped sides, Bridge Underpass with straight sides, Bridge Overpass or Other (describe).

**What is the structure material?** Refers to the material used to construct the structure, on the inside of the structure that an animal passing through would experience. This question does not refer to the presence of natural or deposited sediment on the floor of the structure. Select one: Concrete, Metal, Plastic/Fiberglass

<b>[If Shape = Box] Are there multiple chambers?</b>	If the structure is a box culvert, the user is prompted to answer this question. Multiple chambers occur if the box has one or more divisions, resulting in discrete chambers. If the response is yes, there are multiple chambers, then the user is prompted to select the most appropriate chamber for responding to all subsequent questions (e.g., the largest or driest chamber)
<b>[If Shape = Bridge Underpass] Is this a single span or multispans structure?</b>	If the structure is a Bridge Underpass, the user is prompted to answer this question. A single span bridge has supports only at either end of the structure; a multispans bridge has one or more supports at intervals along the length of the structure.
<b>[If Shape = Bridge Underpass] What is the material of the abutments on the West/North side?</b> -What is their ratio?	If the structure is a Bridge Underpass, the user is prompted to answer this question. Select one: Concrete, Concrete/Soil mix; Soil, Riprap, Gabian Wall, or Other (describe)  What is the approximate ratio of the side slope on the West or North side of the structure?
<b>[If Shape = Bridge Underpass] What is the material of the abutments on the East/South side?</b> -What is the slope ratio?	If the structure is a Bridge Underpass, the user is prompted to answer this question. Select one: Concrete, Concrete/Soil mix; Soil, Riprap, Gabian Wall, or Other (describe)  0:1 = vertical; 1:1 = 45° angle; 2:1 = gentle low slope
<b>Road Attributes</b> <b>Number of lanes of road:</b>	Enter the total number of lanes, in both travel directions, including center lanes and turning lanes. Do not include highway exits or frontage roads.
<b>Is there parallel infrastructure such as railroads, recreational paths, frontage roads, etc?</b>	Describe any additional transportation infrastructure adjacent to the roadway.
<b>Notes:</b>	Provide any additional information about the structure or its situation in the surrounding environment that is not covered elsewhere.

## INLET/OUTLET SIDE

***For sites without water flow through the structure, the user should designate the uphill side as the inlet and the downhill side as the outlet. At locations where an uphill and downhill side cannot be distinguished, the user should simply designate one entrance to represent the inlet and the other the outlet.***

<b>Photo Number:</b>	Enter photo id numbers. Pictures are extremely helpful - take a lot!
<b>Is there an apron at the inlet/outlet?</b>	Yes or No. If yes, indicate whether metal or concrete
<b>Does the culvert have wing walls?</b>	Yes or No

**Is the outlet perched?**

A perched outlet refers to a culvert whose base is perched above the ground level. This situation often occurs with pipes either by design, or because the ground immediately beneath the culvert has eroded.

**Structure Approximate Dimensions (functional dimensions if partially buried)**

Actual or Estimated Measurements?

Indicate whether the structure was measured precisely or if the measurements were estimated.

-Height/Rise (feet):

Measure the height of the structure in feet

-Width/Span (feet):

Measure the width (span) of the structure in feet. Refers to the width of the structure from the perspective of an animal passing through.

-Length (feet):

Measure the length of the structure in feet. Refers to the length of the structure from the perspective of an animal passing through.

**Obstructions**

**Is the immediate entrance blocked?**

Are there physical barriers at the immediate entrance that may block entry for target species that may try to enter the structure? Select one: None, Cattle Fence (4-strand barbed wire), Boulders so big a human would have to climb over them, Riprap larger than a volleyball, Riprap larger than a baseball, Some rocks (not continuously blocking the entrance), Thick Vegetation, Gate, or Other (describe).

**Are there structures that block the entrance within 25 feet?**

Are there physical barriers within 25 feet that may block passage through the structure? Select one: None, Cattle Fence, Small Mesh Fence, Boulder Field, Stream Flow, High/Steep Cut or Fill Slope.

**Fill Slope**

**Is the structure located in a fill slope?**

Select one: No or Yes. If yes, is the slope less than 20' high or greater than or equal to 20' high?

-If yes, how is the structure situated in the slope?

Note the location of the structure relative to the fill slope. Select one: At the base; Midway on fill slope; or Near the top of fill slope

**Approach Vegetation & Cover**

**Is there vegetation/cover within 25' of the inlet?**

Select one: No, Yes - partial cover, or Yes - complete cover

-If yes, select predominant type:

Select one: Grasses, Bushes, Bushes/Trees mix

**Is there vegetation/cover within 25-50' of the inlet?**

Select one: No, Yes - partial cover, or Yes - complete cover

-If yes, select predominant type:

Select one: Grasses, Bushes, Bushes/Trees mix

**Land Use Within 100 feet**

Predominant land use:

Select the predominant land use within 100 feet of the structure entrance: Forest, Prairie/Grassland, Agriculture, Wetlands, Shrub/Steppe, Mixed Human/Natural, Residential, Commercial, or Other

## **Noise**

**What does passing traffic sound like at the entrance to the structure?**

Loud traffic noise at the entrance to a structure may deter passage use by some species. Select one of the following to best characterize how passing traffic sounds when standing in front of the entrance to a structure: Silent; Low Rumble; or Loud and Jarring.

## **Road Attributes**

**How wide is zone of maintained vegetation (allowing extra visibility along the road shoulder)?**

This refers to the portion of the right-of-way that is maintained to keep it clear of high vegetation and other obstructions. Note the approximate width of the apparent zone of maintained vegetation to the left and right of the structure.

**Is there a guard rail or jersey wall above the structure?**

No, Yes - immediately above the structure only, or Yes - extensive along the roadway segment

**Notes:**

## **INSIDE STRUCTURE**

**Photo Number:**

Enter photo id numbers. Pictures are extremely helpful - take a lot!

## **Visibility**

**Does the inside of the structure appear much darker than the outside lighting?**

Note High or Low Light Contrast. In some cases, animals (e.g., ungulates) may be deterred from structures where the lighting inside the structure contrasts significantly with the lighting outside the structure.

**Is there a clear line of sight from one end of the structure(s) to the other?**

A clear sight line means that you have visibility from one end of the structure to the other. Some wildlife have a higher tendency to use structures with clear lines of sight than those they cannot see the open area out the other end. Note if the line of sight is completely clear, partially obscured, or completely obscured.

## **Water Features**

**Is there perennial water flow through structure?**

Note the depth of perennial water flow through the structure: None; < 3' deep; 3-10' deep; or >10' deep

**Does there appear to be a dry natural substrate/dirt pathway through the structure during average flows?**

A dry, natural pathway through a structure from one end to the other is important to structure functionality for a number of terrestrial species. Select one: None, Dry Dirt Pathway, Rock/Dirt Pathway, or Dry Rocky Pathway.

**Is there evidence that the dry pathway may be obliterated seasonally or during high water events?**

The purpose of this question is to determine whether there are certain time periods when a structure may become unusable for certain species due to high water. Select: No, Yes, or Uncertain.



## **Substrate**

**What is the substrate of the floor at the bottom/center of the structure?** Select one: Concrete/Asphalt, Metal, Plastic, Rocks, Soil, Stream Bottom, or Other (describe).

-Is there a natural bottom through the length of the structure? Does a natural surface (non-manmade) extend the full length of the structure, for as least some portion of the width of the structure? Answer Yes or No.

-Is there a natural bottom across the width of the structure? Does a natural surface (non-manmade) extend across the entire width or some portion of the width of the structure? Answer Yes, No - less than 6"; No - 6" or greater

## **Pathway Floor Substrate**

**Does the substrate through the structure appear similar to substrate outside of the structure?** Yes or No.

-If No, what is the floor substrate? Select one: Concrete, Concrete with Baffles/Stabilizers, Steel, Riprap greater than a baseball, Riprap greater than a volleyball, Boulders, or Other (describe)

-If Yes, what is the minimum width of the dry natural pathway all the way through the structure? Select one: <2 feet; 2-5 feet; 5-10 feet; 10-20 feet; 20-50 feet; or Over 50 feet

## **Vegetation**

**Is there vegetative cover and/or woody debris through the structure?** Vegetation in a structure may provide protective cover which can encourage use by some species. Select one: None; Some Logs or Down Trees; Some Grass/Brush; Grasses; Mix of Brush/Bushes/Trees.

## **Noise**

**What does passing traffic sound like from the middle of the structure?** A broad, subjective assessment of traffic noise levels for animals crossing through the structure. Question does not consider traffic volumes. Select one: Silent; Low Rumble; or Loud and Jarring

## **Other**

**Is there a road or trail through the structure?** Select all that apply: None, Paved Road, Dirt Road, Railroad, Paved Trail, Dirt Trail.

**Are there obstructions inside the structure?** Indicate whether there are any features that could obstruct movement through the structure for the Species Guilds of interest. Select all that apply: None, Natural Debris, Soil, Human Structures/Equipment, Gaps/Trenches, Baffles.

**Is there a sky light in structure?** Yes or No

**Notes:**

## Fencing/Walls (completed for both inlet and outlet sides of the structure)

**Photo Number:** Enter photo id numbers. Pictures are extremely helpful - take a lot!

**Is there fencing associated with the structure?** Yes or No

**Select type of fencing to *right/left* when facing structure:** These questions apply to the fencing only, they do not apply to structure wingwalls. Select one: Curb (short wall to guide amphibians), Wall, Chain Link Fence, Wildlife Fence, Sediment Fence, 4-Strand Wire Fence, or Other (specify).

-If curb or wall, does it have a lip? Yes or No. (A lip inhibits animals from climbing over the wall)  
-What is the height of fencing/wall? Select one: ! 6"; > 6" to ! 2'; 2' to 4'; 4 to 6'; 6 to 8', >8'  
-What is the mesh size? Mesh size refers to the spacing of the fence strands. Small animals may be able to pass through larger mesh sizes. Select one: None; 6x6"; 6x6", graduating smaller to 2x3 at base; Other (describe)

-Is it connected to the structure? Note if there are gaps between the structure and the start of the fencing or wall, where an animal may be able to pass through. Select one: Yes, No - small gap (! 0.5'), No - large gap (>0.5')

-Does the fencing reach all the way to ground level without gaps? Yes or No. Animals may be able to pass underneath fencing if it does not extend to ground level along the full length of the fencing.

-Is the fencing entrenched in the ground to prevent animals from digging under it? Yes or No. Digging animals may be able to pas underneath fencing that is not entrenched into the ground.

- Is the ROW fencing the same as the fencing that is immediately adjacent to the structure? Yes or No. If no, what is the ROW fencing type: Curb (not including wingwalls); Walls (not including wingwalls); Chain Link; Wildlife Fence; Sediment Fence; 4-Strand Wire; or Other (specify).

-Minimum distance fence extends from structure: This question characterizes the purpose of the fencing as guide fencing or continuous fencing along a segment of roadway. Select the option that best approximates the length of the fencing: ! 10 feet; 10-50 feet; 50-100 feet; >100; ~1/2 mile; miles (may be determined if the user has driven a long segment of roadway); or end not known or visible.

**What is the general condition of the fencing?** The condition of fencing is important to capture in the evaluation as poorly maintained fencing with gaps may allow animals to pass through and become trapped inside the right-of-way. Select all that apply: Gaps and areas where fence is down; Some tacking up of fence needed; Vegetation needs to be cleared from fence; Fence in good working order.

**Is there an escape ramp(s) within a 1/2 mile of the structure in either direction?** Escape ramps are designed to allow ungulates (in particular) and other large mammals that have become trapped inside the right-of-way to escape back to the other side of the fencing. Indicate if ramps are present along the fencing: No; Yes - 1; Yes - 2 or more.

**Is there a one-way gate(s) within a 1/2 mile of the structure in either direction?** One-way gates are a previously-used mechanism for allow ungulates that have become trapped inside the right-of-way to escape back to the other side of the fencing, however they are difficult to maintain and often themselves become gaps in the fencing. Their installation is no longer recommended as an effective mitigation measure. Indicate if ramps are present along the fencing: No; Yes - 1; Yes - 2 or more.

**Are there uncontrolled driveways, intersections or exit ramps that cause breaks in the fencing within a 1/2 mile of the structure in either direction?** An uncontrolled driveway, intersection or exit ramp is point where there is a break in the fencing to allow vehicular access to adjacent infrastructure that also acts as a gap in the fencing for wildlife. Such breaks may be controlled by double cattle guards, specifically-designed electric mats, gates, or other mechanisms, however controlling these breaks can be expensive if there are multiple breaks in a segment of fencing. Select one: None; 1; 2-5; 6-10; >10

**Notes:** Provide any additional information about fencing

## General

**Photo Number:** Enter photo id numbers. Pictures are extremely helpful - take a lot!

### Wildlife Use

**Are there signs of wildlife use in the structure such as tracks?** Select all that apply: Tracks, Scat, Live Animal, None or Other (describe)

-If yes, describe

Note species, if known, and other pertinent information

**Are there signs of wildlife within 30 feet of the entrances?** Select all that apply: Tracks, Scat, Live Animal, None or Other (describe)

-If yes, describe

Note species, if known, and other pertinent information

### Human Use

**Is there apparent human activity in the structure?** Yes - Frequently/Daily; Yes - Occasional; or No evidence Found

-What type(s) of activity?

Select all that apply: Camping/Occupancy, Vehicle/ATV use, Trail, Recreation, Dog, Night Use, Other

**Which description best matches human activities immediately adjacent to the structure?** The purpose of this question is to get a general understanding of human activity - not including permanent development - at the structure, in terms of frequency, location (at one or both entrances) and the setting itself. Select one: Daily human activity at both entrances; Daily human activity at one entrance; Recreational use in wild setting; Wild setting with infrequent human activity; Other.

**Notes:**

## Species Movement Guild Rankings

*The following questions are designed to get a general impression while the user is in the field of how functional the structure is for each of the Species Movement Guild of interest. They are subjective and responses should be based on the user's overall impression having completed the rest of the structure assessment. Refer to Species Movement Guilds for complete descriptions.*

*Each question should be ranked as follows:*

A = This animal could make it though as is, or with small modifications

C = With modest modifications this structure could be functional

F = Can't be fixed with a retrofit

Rate this structure for **Low Mobility Small Fauna**, e.g., slow-moving animals that require a consistent environmental conditions, such as frogs or salamanders:

A                      C                      F

Rate this structure for **Moderate Mobility Small Fauna**, e.g., small animals that are fairly adaptable, such as squirrels, skunks, raccoons, fishers and some turtles:

A                      C                      F

Rate this structure for **Adaptive High Mobility Fauna**, e.g., fairly tolerant medium-sized animals, such as bobcat, coyote and black bear:

A                      C                      F

Rate this structure for **High Openness High Mobility Carnivores**, e.g., larger animals that prefer larger structures, such as grizzly bear or mountain lion

A                      C                      F

Rate this structure for **Adaptive Ungulates**, e.g., ungulates that require good visibility through a structure, such as deer, moose or mountain goats:

A                      C                      F

Rate this structure for **Very High Openness Fauna**, e.g., animals that require large structures with clear lines of sight that are less than 100' long, such as elk, pronghorn and turkey:

A                      C                      F

**Which features could be changed to make the structure more functional for any Species Movement Guild given an A or C rank?**

*This question offers an opportunity for the user to suggest potential retrofits to improve the structure functionality. These may, of course, be amended later, but it is often helpful to capture initial impressions and ideas while still in the field.*

## APPENDIX C. PASSAGE ENHANCEMENT TOOLBOX FOR IMPROVING EXISTING STRUCTURES FOR TERRESTRIAL WILDLIFE

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
<b>Remove Obstacles to Wildlife Passage</b>			
Remove obstruction or barrier at one or both structure entrances, inside the structure, or in the approaches to the structure (e.g., cattle fencing across structure entrances; trash or debris).	Low Mobility Small Fauna Moderate Mobility Small Fauna Adaptive High Mobility Fauna High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	ALL	
Clear debris and install sediment traps and/or regularly maintain to prevent structure from being blocked, filled or clogged.	Low Mobility Small Fauna Moderate Mobility Small Fauna Adaptive High Mobility Fauna	Class 1, 2	Yanes, M., J.M. Velasco, and F. Suárez. 1995. Permeability of roads and railways to vertebrates: the importance of culverts. <i>Biological Conservation</i> 71:217-222.
Keep culvert entrances clear of heavy vegetation growth that could block wildlife passage.		Class 1, 2, 3	Clevenger, A.P., B. Chruszcz, and K. Gunson. 2001. Drainage culverts as habitat linkages and factors affecting passage by mammals. <i>Journal of Applied Ecology</i> 38:1340-1349.



PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
<b>Facilitate Movement and Create Pathways</b>			
Add a dry, natural pathway through structure, on both sides of waterway if a stream or river is present.	Adaptive Ungulates Very High Openness Fauna	Class 3, 4, 5	Forman, R. T., Sperling, D., Bissonette, J. A., Clevenger, A. P., Cutshall, C. D., Dale, V. H., et al. 2003. Mitigation for wildlife. Pages 139-167 in: Road Ecology: Science and Solutions. Island Press, Washington, D.C.
Minimize or cover riprap on side-slopes with dirt to create a dry, smooth pathway.	Adaptive Ungulates Very High Openness Fauna	Class 3, 4, 5	
Install interlocking brick to support slopes instead of riprap to open up a pathway and facilitate wildlife passage.	Adaptive Ungulates Very High Openness Fauna	Class 3, 4, 5	
Install a raised shelf through water-filled culverts to provide a dry pathway for small mammals; Include a shelf tube to provide protective cover for voles.	Low Mobility Small Fauna	Class 1, 2	
Add baffles to culvert floor to retain sediment on artificial culvert floor (where water flows occasionally through the culvert).	Moderate Mobility Small Fauna Adaptive High Mobility Fauna High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	Class 1, 2, 3	

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Install woody debris (e.g., down logs) through a structure for small species requiring cover from predators.	Low Mobility Small Fauna Moderate Mobility Small Fauna	Class 2, 3, 4, 5	Ehinger, W., P. Garvey-Darda, R. Gersib, K. Halupka, P. McQueary, W. Meyer, R. Schanz and P. Wagner. 2006. Interstate 90 Snoqualmie Pass East Mitigation Development Team: Recommendation package. Submitted to: U.S. Department of Transportation, Federal Highway Administration and Washington State Department of Transportation.
Maintain natural streambanks through the structure.	Low Mobility Small Fauna Moderate Mobility Small Fauna (riparian species)	Class 2, 3, 4	
Add a strip of natural substrate and vegetation along one or both sides of a road through a structure.	Low Mobility Small Fauna Moderate Mobility Small Fauna	Class 3	
Where scour has resulted in perched culverts, build up scour resistant materials to create a navigable pathway into the culvert. Use natural materials; if riprap is used to build up the entrance pathway, it should be covered with natural substrate.	Low Mobility Small Fauna Moderate Mobility Small Fauna	Class 1, 2,	

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Rerrange substrate material around inlet/outlet of small culverts to allow greater visibility through structures.	Low Mobility Small Fauna Moderate Mobility Small Fauna	Class 1	
Add salamander ramps at curbs.	Low Mobility Small Fauna		
Add grates to existing culverts to allow light/moisture/temperature penetration into the culvert.	Low Mobility Small Fauna	Class 1, 6	Carr, T., R. Dacanay, K. Drake, C. Everson, A. Sperry and K. Sullivan. 2003. Wildlife Crossings: Rethinking Road Design to Improve Safety and Reconnect Habitat. Portland State University Planning Workshop, Prepared for Metro. 111 pp.
Modify existing trenched drains to allow animals to enter.	Low Mobility Small Fauna	Class 6	Bank, F.G., C.L. Irwin, G.L. Evink, M.E. Gray, S. Hagood, J.R. Kinar, A. Levy, D. Paulson, B. Ruediger, and R.M. Sauvajot. 2002. Wildlife Habitat Connectivity Across European Highways. Federal Highway Administration. Alexandria, VA. URL: <a href="http://international.fhwa.dot.gov/wildlife_web.htm">http://international.fhwa.dot.gov/wildlife_web.htm</a>

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
For Multi-chambered structures with waterflow, divert waterflow so that one chamber remains dry for terrestrial wildlife.	Moderate Mobility Small Fauna Adaptive High Mobility Fauna High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	Class 2, 3, 4	
Promote waterflow through culverts to prevent standing water from inhibiting passage through a culvert or deterring entry into the culvert.	Moderate Mobility Small Fauna Adaptive High Mobility Fauna High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	Class 1, 2, 3	
Prevent polluting agents and road sediment from being flushed through culverts.	Low Mobility Small Fauna Moderate Mobility Small Fauna	Class 1, 6	
<b>Reduce Intimidation</b>			
Replace steep abutment slopes or walls with natural 2:1 slopes.	Adaptive Ungulates Very High Openness Fauna	Class 2, 3, 4	Dodd, N.L., J.W. Gagnon, A.L. Manzo, and R.E. Scheinsburg. 2007. Video surveillance to assess highway underpass use by elk in Arizona. Journal of Wildlife Management 71(2):637-645.

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Remove fill predator perches - ledges or places where prey species may be fearful of unseen predators.	Adaptive Ungulates Very High Openness Fauna	Class 2, 3, 4	Little, S.J., R.G. Harcour, A.P. Clevenger. 2002. Do wildlife passages act as prey-traps? Biological Conservation 107:135-145.
Add median skylights or openings. [This measure is not appropriate for all culvert situations. Avoid creating very high contrast conditions inside the culvert; Avoid where there is a narrow median that would result in a large increase in traffic noise inside the culvert; Avoid allowing precipitation to enter the culvert where winter temperatures could cause the creation of ice mounds inside the culvert, thereby inhibiting wildlife passage].	Adaptive Ungulates Very High Openness Fauna	Class 2	Reed, D.F., T.N.Woodard, T.M. Pojar. 1975. Behavioral Response of Mule Deer to a Highway Underpass. J. Wild Manage. 39(2):361-367.



PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Avoid/remove highway lighting near structure entrances.	ALL	ALL	Jackson, S. D. (2000). Overview of Transportation Impacts on Wildlife Movement. <i>Wildlife and Highways: Seeking Solutions to an ecological and Socio-economic Dilemma</i> . T. A. Messmer and B. West, The Wildlife Society.
Implement measures to reduce traffic noise inside culvert and/or at structure entrances (e.g., concrete shoulder barriers placed above the structure)	ALL	ALL	Jackson, S. D. (2000). Overview of Transportation Impacts on Wildlife Movement. <i>Wildlife and Highways: Seeking Solutions to an ecological and Socio-economic Dilemma</i> . T. A. Messmer and B. West, The Wildlife Society.
To the extent possible, avoid laying trails or other human access through crossing structures. Where trails do pass through a structure, separate human trails from wildlife pathways through the structure.	High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	Class 2, 3, 4, 5	Hartmann, M. (2003). Evaluation of Wildlife Crossing Structures: Their Use and Effectiveness.

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Install signs near crossing structures or where trails cross through structures to limit human activity in and around wildlife crossings [Avoid drawing attention to unobtrusive crossing structures with unnecessary signage]	ALL	ALL	Clevenger, A. and N. Waltho. 2005. Performance indices to identify attributes of highway crossing structures facilitating movement of large mammals. <i>Biological Conservation</i> 121:453-464.
Install barriers (e.g., large boulders) to prevent motorized travel through crossing structures.	High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	Class 3, 4, 5	
<b>Enhance Structure Approaches</b>			
Enhance/maintain native vegetation cover in front of structure entrances.	ALL	ALL	Ng, S., J. Dole, R. Sauvajot, S. Riley, and T. Valone. 2004. Use of highway undercrossings by wildlife in southern California. <i>Biological Conservation</i> 1115:499-507.
Thin heavy vegetation that may obstruct wildlife passage at structure entrances.	Adaptive High Mobility Fauna High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	Class 2, 3	Maintain a balance between enough cover for prey species to feel safe entering a culvert, but not so much that animals cannot enter or have good visibility into and through the culvert.
Avoid the use of herbicides around structure entrances.	Low Mobility Small Fauna	ALL	

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Plant bushes in the median to provide better cover and insulation from highway traffic noise and lights.	High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	Wherever open median is present	
Avoid the use of erosion netting in landscaping around crossing structures, which may ensnare snakes.	Moderate Mobility Small Fauna	ALL	
Convert cattle fencing near structure approaches to wildlife-friendly rail fencing to allow young to pass through to access structures.	Adaptive Ungulates Very High Openness Fauna	Class 2, 3, 4	
<b>Fencing and Barriers</b>			
Add wildlife fencing and/or guide walls to existing suitable structures - do not install extensive fencing where there are no suitable crossing structures.	ALL - type, design & height of fencing or guide wall depends on species (see notes)	N/A	For guidance on different types of wildlife fencing, see: <a href="http://www.azdot.gov/highways/EPG/EPG_Common/PDF/Technical/Wildlife_Connectivity/Wildlife_Funnel_Fencing/Wildlife_Funnel_Fencing_Summary.pdf">http://www.azdot.gov/highways/EPG/EPG_Common/PDF/Technical/Wildlife_Connectivity/Wildlife_Funnel_Fencing/Wildlife_Funnel_Fencing_Summary.pdf</a>
Modify existing right-of way fencing by adding height to convert it to wildlife fencing.	High Openness High Mobility Carnivores Adaptive Ungulates Very High Openness Fauna	N/A	FHWA. Keeping it Simple - Arizona. <a href="http://www.fhwa.dot.gov/environment/wildlifeprotection">http://www.fhwa.dot.gov/environment/wildlifeprotection</a>

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Angle fence ends away from roadway to preven 'end-arounds'.	ALL		Clevenger, A. P., B. Chruszcz, and K. E. Gunson. 2001. Highway mitigation fencing reduces wildlife-vehicle collisions. Wildlife Society.
Do not end fencing in good wildlife habitat; end in transitional areas (e.g., steep terrain, change in habitat or land use).			Hardy, A.R., J. Fuller, M.P. Huijser, A. Kocielek and M. Evans. 2006. Evaluation of wildlife crossing structures and fencing on US Highway 93, Evaro to Polson. Phase I: Preconstruction data collection and finalization of evaluation plan. Final report. Western Transportation Institute, College of Engineering, Montana State University.
Place large boulders at fence ends to prevent animals at-grade crossings at fence ends.	Adaptive Ungulates Very High Openness Fauna	N/A	Clevenger, A.P., B. Chruszcz, K. Gunson, K. and M. Brumfit. 2002. Highway mitigation monitoring: Three Sisters Parkway interchange. Final report, August 1999 - July 2002. Prepared for Alberta Sustainable Resource Development, Canmore, Alberta, Canada.
Install wildlife fencing across a median to adjacent structures.	ALL	N/A	

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Install escape ramps along fenced sections.	Adaptive Ungulates Very High Openness Fauna	N/A	<p>Bissonette, J.A. and M. Hammer. 2000. Effectiveness of earthen ramps in reducing big game highway mortality in Utah: Final Report. Utah Cooperative Fish and Wildlife Research Unit Report Series 2000 (1): 1-29.</p> <p><a href="http://www.azdot.gov/highways/EPG/EPG_Common/PDF/Technical/Wildlife_Connectivity/Wildlife_Connectivity/Description_of_Wildlife_Escape_Measures.pdf">http://www.azdot.gov/highways/EPG/EPG_Common/PDF/Technical/Wildlife_Connectivity/Wildlife_Connectivity/Description_of_Wildlife_Escape_Measures.pdf</a></p>
Replace one-way gates with escape ramps.	Adaptive Ungulates Very High Openness Fauna	N/A	<p>Bissonette, J.A. and M. Hammer. 2000. Effectiveness of earthen ramps in reducing big game highway mortality in Utah: Final Report. Utah Cooperative Fish and Wildlife Research Unit Report Series 2000 (1): 1-29.</p>
Maintain fencing to prevent gaps in fence.	Adaptive Ungulates Very High Openness Fauna	N/A	



PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
Install Electromat at gaps in fencing, such as highway on/off ramps, driveways.	Adaptive Ungulates Very High Openness Fauna	N/A	<a href="http://www.electrobraid.com/wildlife/highway_fence.html">http://www.electrobraid.com/wildlife/highway_fence.html</a> Dodd, N. and J. Wise. The Nation's Most Advanced Game Crossing System. IMSA Journal 45(2); T.W. Seamans, Z.J. Patton, and K.C. VerCauteren. ElectroBraid Fencing for Use as a Deer Barrier. <a href="http://www.itre.ncsu.edu/cte/icoet">http://www.itre.ncsu.edu/cte/icoet</a>
Construct crosswalk at controlled gap in fencing to allow animals to cross at-grade.	Adaptive Ungulates Very High Openness Fauna	N/A	Gagnon, J.W., N.L. Dodd, S.C. Sprague, K. Ogren, and R.E. Schwuinsburg. 2010. Preacher Canyon Fence and Crosswalk Enhancement Project Evaluation. Report No. JPA 04-088. Arizona Department of Transportation, Phoenix, AZ. <a href="http://www.azgfd.gov/w_c/StateRoute_260_Elk_Crosswalk.shtml">http://www.azgfd.gov/w_c/StateRoute_260_Elk_Crosswalk.shtml</a>
Install shoulder or median barriers with scuppers (at least 25cm high and 100cm wide) every 5th barrier to facilitate small animal passage through the barrier.	Moderate Mobility Small Fauna	N/A	Clevenger, A.P. and A.V. Kociolek. 2006. Highway median impacts on wildlife movement and mortality: state of the practice survey and gap analysis. Report No. F/CA/MI-2006/09. California Department of Transportation, Sacramento, CA.

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
<p>Arrange shoulder or median barriers with intermittent gaps to facilitate wildlife passage at-grade.</p>	<p>Moderate Mobility Small Fauna            Adaptive High Mobility Fauna            High Openness High Mobility            Carnivores            Adaptive Ungulates            Very High Openness Fauna</p>		<p>Clevenger, A.P. and A.V. Kociolek. 2006. Highway median impacts on wildlife movement and mortality: state of the practice survey and gap analysis. Report No. F/CA/MI-2006/09. California Department of Transportation, Sacramento, CA.</p>
<p>Replace concrete shoulder and median barriers with cable median barriers where it is desirable to facilitate at-grade wildlife passage [cable barriers are considered more permeable for all species guilds than box-beam barriers, though more research is needed].</p>	<p>Moderate Mobility Small Fauna            Adaptive High Mobility Fauna            High Openness High Mobility            Carnivores            Adaptive Ungulates            Very High Openness Fauna</p>	N/A	<p>Clevenger, A.P. and A.V. Kociolek. 2006. Highway median impacts on wildlife movement and mortality: state of the practice survey and gap analysis. Report No. F/CA/MI-2006/09. California Department of Transportation, Sacramento, CA.</p>
<p>Install double cattle-guards and convert existing flat-bar cattle guards with round bars at controlled gaps in wildlife fencing, e.g., driveways or county roads. [May not be effective for all species]</p>	<p>Adaptive Ungulates            Very High Openness Fauna</p>	N/A	<p>Hardy, A.R., J. Fuller, M.P. Huijser, A. Kociolek and M. Evans. 2006. Evaluation of wildlife crossing structures and fencing on US Highway 93, Evaro to Polson. Phase I: Preconstruction data collection and finalization of evaluation plan. Final report. Western Transportation Institute, College of Engineering, Montana State University.</p>
<p>Avoid gaps in wildlife fencing or walls.</p>	ALL	N/A	

PASSAGE ENHANCEMENT SOLUTION	SPECIES MOVEMENT GUILDS	STRUCTURE FUNCTIONAL CLASS	NOTES & REFERENCES
<b>Add or Adjust Structural Features</b>			
Fix perched outlets to allow access into culvert.	Moderate Mobility Small Fauna	Class 1	
Add a gutter pipe for small mammals.	Moderate Mobility Small Fauna	Class 1	Foresman, K.R. 2004. The effects of highways on fragmentation of small mammal populations and modifications of crossing structures to mitigate such impacts. Final Report. FHWA/MT-04-005/8161.
Bore new dry culverts adjacent to inundated culverts to promote wildlife passage through drainages.	Low Mobility Small Fauna Moderate Mobility Small Fauna	Class 1	
Add bat boxes.	Aerial Fauna (bats)	Classes 3, 4, 5	
Install poles placed on bridge edges to help birds perceive the barrier and avoid colliding with vehicles.	Aerial Fauna	Animal-vehicle collision prevention mechanisms at roadway bridges bisecting flyways	FHWA. Keeping it Simple - Oklahoma. <a href="http://www.fhwa.dot.gov/environment/wildlifeprotection">http://www.fhwa.dot.gov/environment/wildlifeprotection</a>
Install aerial bridges across highways between poles to facilitate arboreal crossings.	Arboreal Fauna	Class 6	NCDOT flying squirrel platforms Rope bridges over roads

<b>PASSAGE ENHANCEMENT SOLUTION</b>	<b>SPECIES MOVEMENT GUILDS</b>	<b>STRUCTURE FUNCTIONAL CLASS</b>	<b>NOTES &amp; REFERENCES</b>
Decommission old roads through a structure and restore natural landscape features to convert to a wildlife crossing.	ALL	Class 3	

## **APPENDIX D.**

### **STRUCTURE EVALUATIONS, MONITORING RESULTS AND RECOMMENDATIONS FOR IMPROVING PERMEABILITY FOR TERRESTRIAL WILDLIFE IN WASHINGTON STATE**

*Conducted by:*

Julia Kintsch, ECO-resolutions, LLC

Dr. Patricia Cramer, Utah State University

*For:*

Washington State Department of Transportation

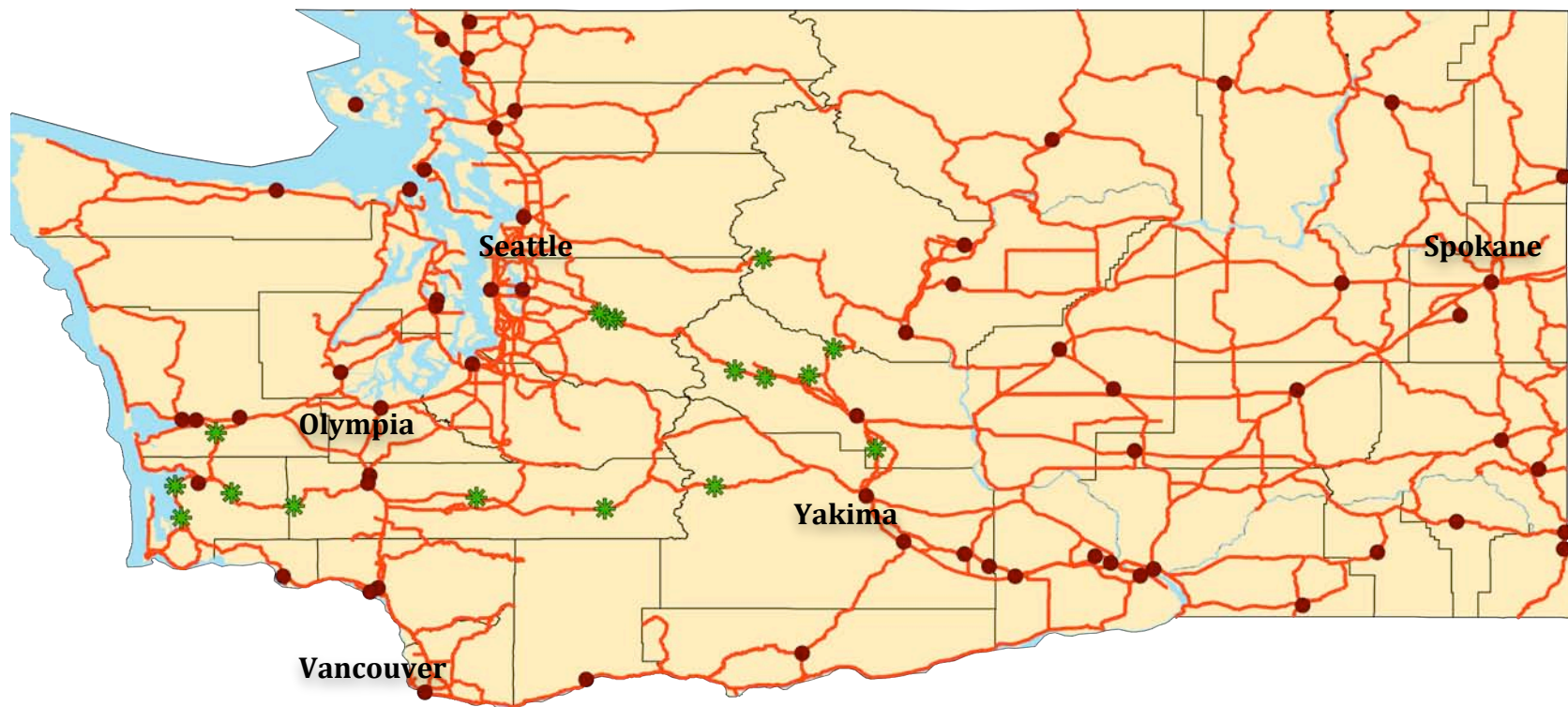
April 2011

Site assessments were conducted at seventeen highway structure locations (i.e., bridges or culverts) along eight state-maintained roadways between June 21 to 24, 2010 (Map 1). The purpose of these assessments was to test a system for evaluating existing structures with regards to their potential to pass different types of wildlife. The evaluation system is designed to help WSDO identify barriers to wildlife passage in existing transportation infrastructure and opportunities for retrofitting these structures so that they are more functional for passage of the diverse wildlife in Washington.

Following are the results of this evaluation and subsequent retrofit recommendations at all 17 of the assessed locations. These results are provided as examples of the evaluation system and how it can be used to determine preliminary recommendations for retrofitting or replacing bridges and culverts to enhance permeability for terrestrial wildlife. Each example includes descriptions of the roadway situation and general environs, the structure, and the surrounding habitat and terrain. These descriptions are followed with specific recommendations and guidance as to how the authors came to these recommendations.

Monitoring cameras were placed at 6 of these evaluation sites (2 cameras at each site) for 6 months. Two additional sites near North Bend were removed from the monitoring study due to vandalism. Summaries of the monitoring results are presented for each site after the site evaluation. The monitoring summaries provide





**Map 1.** Location of culverts and bridges evaluated in this study for their ability to pass terrestrial wildlife (green stars). Major cities are denoted by dark circles.

an overview of the photographic data including the number of deer and elk at the site, if the animals used the structure or were repelled (animals that looked into the structure's passage and turned away), seasonal use of the structure by deer, and tallies of all species detected at the site. For each site six sample pictures of the camera data are displayed to demonstrate wildlife activity at the site. These datasets can help WSDOT determine how different species will use certain structures more readily than others. The summaries also help support and clarify conclusions drawn during the site evaluations and refine the recommendations provided to better adapt the crossings for wildlife passage.

Monitoring at these sites entailed the placement of motion-triggered trail cameras inside metal utility boxes. Cameras were placed at either end of the outside edges of the structure. The cameras were locked to bicycle cables which were embedded in 60 to 120 pounds of concrete on the inside bottom of the utility box. Cameras were checked every two weeks. Camera visits entailed changing batteries and exchanging flash cards with photographic data. Data was transferred to Dr. Cramer via exchanges of thumb drives. Data was analyzed and entered into Excel spreadsheets for final tallies.

Of particular note during this study was elk use of two large bridged structures under I-90. Research throughout the western United States has documented the species' reluctance to pass through confined spaces such as culverts or small, restricted bridges. However, photographic evidence compiled through this research project shows elk movements under bridges that were wide, but less than 10 feet (3 m) high. This new insight may help WSDOT and other agencies to better design cost-effective bridged structures suitable for elk, and realize the potential for elk passage at existing bridges.

A very interesting site included in this study is a pair of corrugated steel culverts under I-90 near North Bend, Washington (Milepost (MP) 29). These culverts are located in a thickly vegetated area. Judging from the characteristics of the structures and the fact the small stream through this crossing was placed underground for half the crossing, and is above ground on the north side, it appears these culverts were designed specifically for wildlife passage. If wildlife were not considered, the stream could have been shunted underground for the entire length of the passage. This culvert appears to be among the most successful black bear crossings in the western U.S., as demonstrated by 31 black bear observations during 5 months of study. In comparison, at over 40 camera sites in two states combined (Montana and Utah) there have been less than 12 successful black bear crossings tallied over the course of two years. This passage is very successful particularly for black bear, whereas only three bobcats approached and crossed through the structure, and 7 of 19 approaches by coyotes were repelled. Our camera technician on several occasions could smell the bear presence in the culverts when she came to check the cameras. This may explain the low diversity of species using it. It may also support the idea that in an area of high species diversity, multiple crossings may be necessary for prey, predator and even competitor species.

## **Location Name: Mosquito Creek**

**Location ID:** 101\_76.5\_01

**Route:** 101

**Milepost:** 76.5

### Roadway & Site Description

This segment of Route 101 is a two-lane road that runs north-south along the southwestern coast of Washington, traversing several drainages that feed into the coastal waters. The surrounding habitat is largely forested in nature.

### Structure Description

*Type:* Concrete box culvert

*Structure Functional Class:* Class 2 (medium underpass)

*Dimensions:* 7' high x 15'9" span x 138' long

Mosquito Creek is a small, seasonal creek. Water flow through the structure at the time of the survey was shallow. The stream channel is naturally entrenched upstream and downstream of the roadway with thick bushes and trees to the edges of the banks. While the concrete box culvert at this location is large enough to allow for a relatively natural water flow through the structure, the stream channel is not maintained through the structure and the flow instead flattens out across the width of culvert. During low flows, muddy/gravelly pathways are present through the structure, although these likely become obliterated during higher flow periods.

There is no fencing associated with either side of the structure. Guardrail is present above the structure for the span of the structure, but not along the rest of the roadway segment. There is no apparent human activity at this structure.

### Wildlife

Raccoon, muskrat and small rodent tracks were observed in the muddy banks inside the structure. Raccoon tracks were also observed outside of the structure.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for Low Mobility Small Fauna, Moderate Mobility Small Fauna, and Adaptive High Mobility Fauna, meaning that the field evaluators concluded that animals from each of these guilds could successfully pass through this structure as is or with small modifications. The structure received a 'C' rank for High Openness High Mobility Carnivores and Adaptive Ungulates, indicating that the structure could be modified to be made functional for species of these Movement Guilds. The structure received an 'F' rank for Very High Openness Fauna, meaning that the structure cannot be retrofitted to accommodate these species.

## **Recommendations**

Overall, the evaluators determined that the culvert, as is, is not quite high enough to be a highly functional passageway, although it can still be used by some individuals of the more reluctant species, such as black-tailed deer. The addition of wildlife fencing tied into the structure would enhance usage by High Openness High Mobility Carnivores, such as bear or mountain lion, and Adaptive Ungulates, such as black-tailed deer. Greater functionality for bucks as well as does and fawns, and for Very High Openness Fauna such as elk would require replacement with a larger structure. Maintaining built up dirt banks along one or both of the inside edges of the culvert can also help to provide dry pathways for smaller animals during higher water flows.



**Figure 1.** Rte 101 looking south



**Figure 2.** View from outlet



**Figure 3.** Muddy pathway through culvert



**Figure 4.** Looking towards outlet

## **Monitoring Results**

### **US 101 Mosquito Creek Culvert**

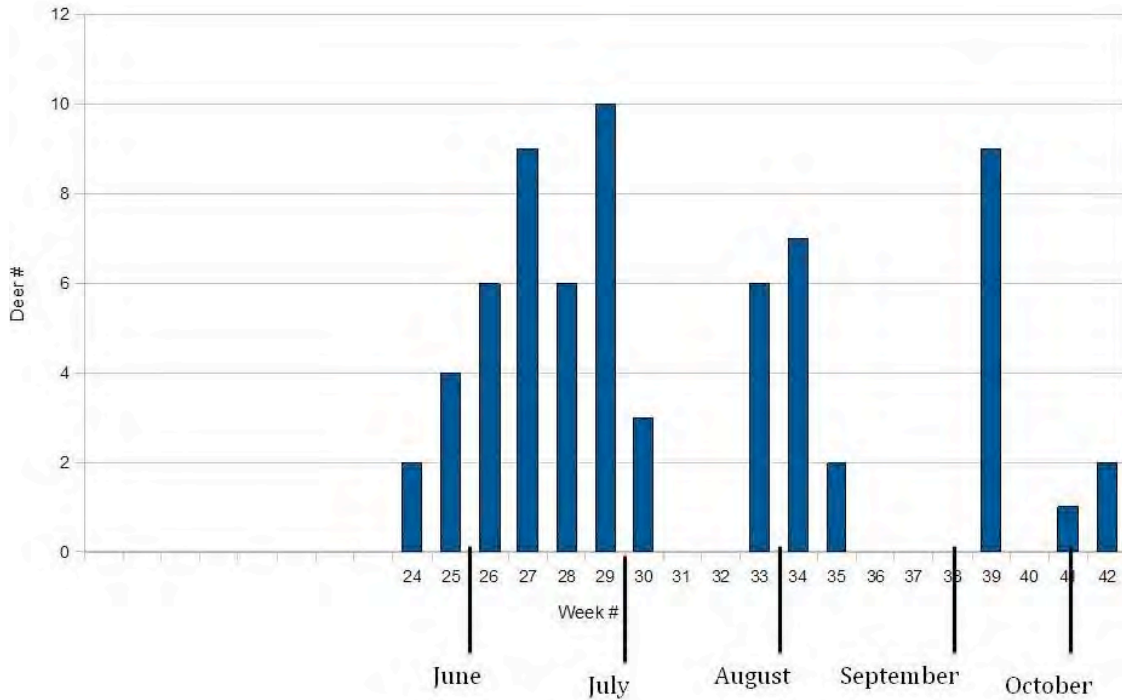
This concrete box culvert is under US 101 south of Aberdeen, Washington. At times of low flow, there is a muddy path to the side of the creek. There is no wildlife fencing at this site. The area is heavily vegetated and forested. WSDOT estimates for Average Daily Traffic approximates 5,000 vehicles. On June 9, 2010, two cameras were placed at the culvert entrances, both positioned facing inward.

In 138 days of monitoring, this culvert was most heavily used by black-tailed deer, specifically does and fawns. Of the 71 deer observations at the site, only two were of black-tailed deer bucks, the remainder was of does and fawns, probably the same family of three moving to either side of the road. One buck repelled from the structure, the second followed a doe and fawns through the structure, see photos below. Deer use peaked in June and early July, see Figure 5. Deer data is presented in Table 1.

**Table 1.** Black-tailed deer observation data tabulated for US 101 Mosquito Creek box culvert.

Camera Days Analyzed	Deer Photo-obs. at Site	Deer Photo-obs. per Day	Number of Successful Crossings through structure	Successful Deer crossings per day	Success Rate (%)	Rate of Repellency (%)	Parallel Rate (%)
138	71	0.51	60	0.43	84.5	5.6	9.9





**Figure 5.** Black-tailed deer passes through culvert per week at US 101 Mosquito Creek culvert over the weeks of monitoring in 2010.

One elk was photographed grazing at the entrance to the culvert. It did not enter the structure, (see photos below). The remaining species observed are presented in Table 2.

**Table 2.** Species and number of detections at the US 101 Mosquito Creek culvert.

**Species**

**Mammals**

- Black-tailed deer - 71
- Raccoon - 18 events, 36 individuals
- Cat - 18
- Humans - 2

**Birds**

- Crow - 3
- Raven - 1

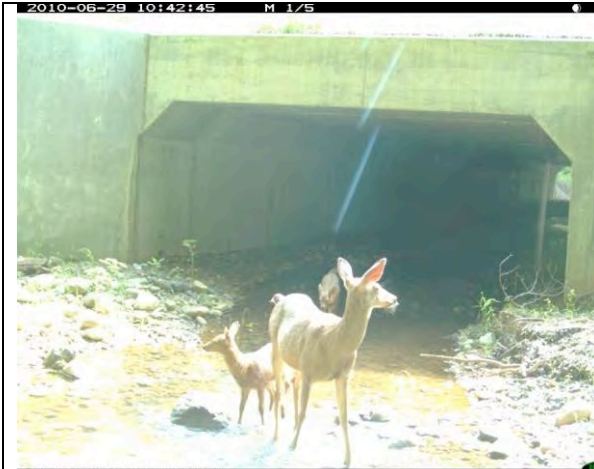


Figure 6. Black-tailed deer doe and fawns at US 101 Mosquito Creek culvert, they just passed through the culvert.



Figure 7. Black-tailed deer buck repelling from US 101 Mosquito Creek culvert.



Figure 8. Black-tailed deer fawns looking up at US 101 from Mosquito Creek.



Figure 9. Only buck photographed using US 101 Mosquito Creek culvert. Following doe and fawns.



Figure 10. Raven at Mosquito Creek culvert entrance under US 101. There is no evidence the raven went into the culvert.



Figure 11. The only elk photographed at US 101 Mosquito Creek culvert. It did not enter the culvert.

## **Location Name: Middle Fork Nemah River**

**Location ID:** 101\_38.8\_02

**Route:** 101

**Milepost:** 33.8

### Roadway & Site Description

This segment of Route 101 is a two-lane road north-south along the southwestern coast of Washington, traversing several drainages that feed into the coastal waters. Traffic levels at the time of the evaluation were low, but regular. A 10-minute traffic count resulted in an estimated daily average of 5,000 vehicles, which could inhibit some wildlife from attempting to cross at-grade. The surrounding habitat is largely forested in nature.

### Structure Description

*Type:* Wooden multi-span

*Structure Functional Class:* Class 3 (large underpass)

*Dimensions:* 8'5" high x 61'4" span x 29' long

This structure is a multi-span bridge underpass with wooden supports. The center span bridges the main portion of the stream while the two outside spans bridge the stream banks although water may pass through these sections during periods of high flows. The full height of the structure is realized only beneath the center span, whereas the outside chambers have higher stream banks/sediment, resulting in a significantly shorter functional height for animals passing through these sections. Water flow through the structure was approximately 3-10' deep at the time of the evaluation

There is no fencing associated with the structure. Guardrail is present above the structure for the span of the structure. There is no apparent human activity at this site.

### Wildlife

A roadside ditch along the east side of the road containing standing water and vegetation was found to have a Northwestern salamander egg mass, though no larvae remained in the eggs. A shrew was also observed at the inlet side of the structure.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for each of the target Species Movement Guilds, meaning that the field evaluators determined that animals from each of these guilds could successful pass through this structure as is or with small modifications.

### Other Considerations

The following considerations warrant additional follow-up:

- What is the land-ownership in this area? Are there any concerns with private lands development near the structure?

### **Recommendations**

Despite the 'A' rankings for all of the Species Movement Guilds, several retrofit recommendations are advised at this site:

- Remove the center supports to create a more open single-span structure (may not be possible without replacing the entire structure);
- Construct dry, natural dirt pathways on both sides of the stream that remain dry during seasonal high water;
- Minimize or cover riprap on side-slopes with dirt to create a dry, smooth pathway;
- Maintain the structure height for the full length of the span (so that the distance from the ground level to the ceiling of the structure is high enough to allow the passage by ungulate species and other larger mammals);
- Install wildlife fencing for larger mammals and salamander walls to guide animals towards the structure.



Figure 12. Rte 101 looking North



Figure 13. Rte 101 looking South



Figure 14. Bridge at Location 101\_38.8\_02



Figure 15. Stream flow through the center span portion of the bridge





Figure 16. Stream bank under outside span



Figure 17. View from structure to east (inlet side)



## **Location Name: Bone River**

**Location ID:** 101\_45.3\_03

**Route:** 101

**Milepost:** 45.3

### Roadway & Site Description

This segment of Route 101 is a two-lane road north-south along the southwestern coast of Washington, traversing several drainages that feed into the coastal waters. The surrounding habitat is largely coastal marsh and forest.

### Structure Description

*Type:* Wooden bridge underpass

*Structure Functional Class:* Class 4 (extensive bridge)

*Dimensions:* 100' span x 25' long

This structure is an extensive wooden bridge traversing a tidal river. The river is broad and deep, as the roadway is parallel to Willapa Bay. The river is highly influenced by the tides. While the river is largely confined within its channel, at high tide the adjacent riverbanks are flooded, eliminating any dry pathways for wildlife through the structure. The north side of the structure is reinforced with concrete sand bags, eliminating the natural banks through the structure.

There is no fencing associated with the structure. Guardrail is present above the structure for the span of the structure. There are no immediate signs of human activity at this structure, although camera monitoring did capture some human activity.

### Wildlife

No wildlife signs were observed at the time of the evaluation, but most signs are likely obliterated during daily high tide events, and camera monitoring revealed a variety of wildlife activity at this location.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for Moderate Mobility Small Fauna, meaning that the field evaluators determined that animals from each of these guilds could successfully pass through this structure as is or with small modifications. The structure received a 'C' rank for all other species guilds, indicating that the structure could be modified to be made functional for species of these Movement Guilds. Given that this location is a tidal system, it was not evaluated for Low Mobility Small Fauna, such as frogs and salamanders.

### **Recommendations**

Given the tidal nature of this system, a structure at this location is not useable by wildlife during the daily high tides. The following recommendations can help make the structure more functional during low and high tides

- Expand the span to include more of the riverbanks, including a minimal dry or semi-dry pathway during high tides.
- Install wildlife fencing for larger mammals and salamander walls to guide animals towards the structure.



Figure 18. Inlet side, looking west.



Figure 19. Bank on south side of structure during low tide.



Figure 20. Roadway looking south



Figure 21. Structure looking southeast



Figure 22. Bank under structure on north side

## **Monitoring Results**

### **US 101 Bone River Bridge**

The highly tidal Bone River runs under this bridge. The river is wide, over 50 meters across. The northern end of the bridge has a dry land passage on the 2 to 1 slope under the bridge, while the southern end has a steeper, rip rap slope that is difficult to use for terrestrial passage. Cameras from both ends of the bridge documented high tides that could make terrestrial passage difficult. Average Daily Traffic approximates 2,700 vehicles. There is no wildlife fencing at this site. The area is heavily vegetated and forested, with the west side gradating to tidal marsh. On April 13, 2010, two cameras were placed at this high arch bridge, along US 101, south of South Bend, Washington. The cameras were positioned on dry ground pointed toward the underside of each end of the bridge.

In 197 days of monitoring, the bridged area was rarely used by deer. There were 16 deer observations at the north end of the bridge for an average of 0.08 deer observations per day. All deer photographed were black-tailed deer does and fawns. All deer were photographed between May 12 and July 30, 2010. In six of the 11 events when deer were photographed, the deer could be seen moving under the bridge, solely on the north end of the structure. This amounts to 10 deer out of 16 using the structure, for a success rate of 62.5%. The rest of the movements were parallel. Eight deer events were during the day, 2 occurred at night, and one at dawn.

No other ungulates were photographed. Human use was fairly high at this structure, with 37 events where people came by to prepare the area for construction, apply pesticides, collect plants, fish, hike, clam, and ride in boats up and down the river. One pair of travelers spent the night camping in front of the south camera. Meso-mammals were fairly common at this site, with more raccoon and coyote observations occurring in front of these cameras than any other sites in the study.

**Table 3.** Species detected at the US 101 Bone River bridge culvert and the number of observations for that species.

#### ***Species***

##### **Mammals**

Black-tailed deer - 16

Humans - 37

Raccoon 54 events - 68 individuals

Coyote - 14 events, 15 individuals

River Otter - 1

Rabbit - 1

Seasonal use of the area by all species was tallied. Wildlife detection rates were fairly constant per month over time (Table 4).

**Table 4.** Monthly tallies for number of wildlife events recorded by cameras at Bone Creek Bridge, US 101.

Month	Number of wildlife events recorded	Month	Number of wildlife events recorded
April	17	August	5
May	11	September	13
June	11	October	11 (all raccoon events)
July	12	-	-



**Figure 23.** Black-tailed deer doe and yearling using north end of Bone River Bridge, US 101.



**Figure 24.** Black-tailed deer doe coming through bridge over Bone River, US 101.



**Figure 25.** Coyote looking to the west toward Willapa Bay from south end of Bone River Bridge, US 101. Coyotes attempted to move under the bridge at this site, but never appeared to succeed, always coming back.



**Figure 26.** Only river otter photographed in study, using area near southern base of Bone River Bridge, US 101.



**Figure 27.** Flooding of uplands along Bone River, south end of Bridge, US 101.



**Figure 28.** Curious raccoon at south end of Bone River Bridge, US 101.



## **Location Name: Willapa River**

**Location ID:** 6\_6.8\_04

**Route:** 6

**Milepost:** 6.8

### Roadway & Site Description

This segment of State Highway 6 is an east-west running, undivided two-lane road. A bike path runs parallel to the roadway along the north side along an old railroad grade. The structure spans the Willapa River as it is bisected by the highway. The surrounding landscape is largely agricultural with some residences.

### Structure Description

*Type:* Concrete span bridge

*Structure Functional Class:* Class 4 (extensive bridge)

*Dimensions:* 25' high x 100' span x 28' long

This structure is large multi-span bridge spanning the river and adjacent river banks. The height of the structure over the grassy river banks is approximately 15', leaving sufficient room for even large animals to pass beneath the structure.

There is no fencing associated with the structure. Guardrail is present above the structure for the length of the structure. There were no evident signs of human activity at this structure, however camera monitoring at this location captured dozens of human events throughout the monitoring period.

### Wildlife

A wildlife trail crosses under the structure and deer tracks were observed at the time of the evaluation.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for each of the target Species Movement Guilds, meaning that the field evaluators determined that animals from each of these guilds could successfully pass through this structure as is or with small modifications.

### **Recommendations**

Wildlife appeared to be using the structure, a conclusion that was verified through the camera monitoring (see monitoring results below). Wildlife fencing could be constructed to guide animals to the structure; however, it is uncertain whether such a measure is necessary. We recommend first assessing animal-vehicle collision rates at this location and communicating with adjacent landowners to determine whether animals are crossing at-grade along this segment of roadway.



Figure 29. West looking towards bike path bridge



Figure 30. Inlet side



Figure 31. Span over riverbank



Figure 32. Looking upstream



Figure 33. Primary section of span where river flows

## Monitoring Results

### SR 6 Willapa River Bridge

This bridge straddles the Willapa River several miles southeast of Raymond, Washington. The road is high above the river and surrounding upland, allowing for ample terrestrial movement on both banks under the bridge. Grass is the dominant vegetation at this bridge. Homes are within 50 meters at both the east and west sides of the road and north and south of the river, but there are also agricultural fields that are adjacent to the bridge on other corners. There is no wildlife exclusion fencing at this site. WSDOT estimates of Average Daily Traffic volume varies from 1,700 to 2,700 vehicles.

On April 14, 2010, two cameras were placed at each base of the bridge, on each side of the river. In 196 days of monitoring, the north camera was in operation 173 days and the south camera 148 days. From June 24 through July 14 no cameras were in operation. There were a total of 82 deer observations. The average deer observations per day was 0.42. Of the total deer, there were seven males, 56 females, and 19 young. Due to the dense grass vegetation and camera placement, actual repels and parallels could not be calculated. The 82 deer observations occurred in 51 events. The majority of these events (36) occurred on the north (west) end of the bridge. The majority of the events (36, 70.6%) occurred during the day. Deer use peaked in late June and early July, but otherwise was consistent throughout the study period. See Figure 34 below.

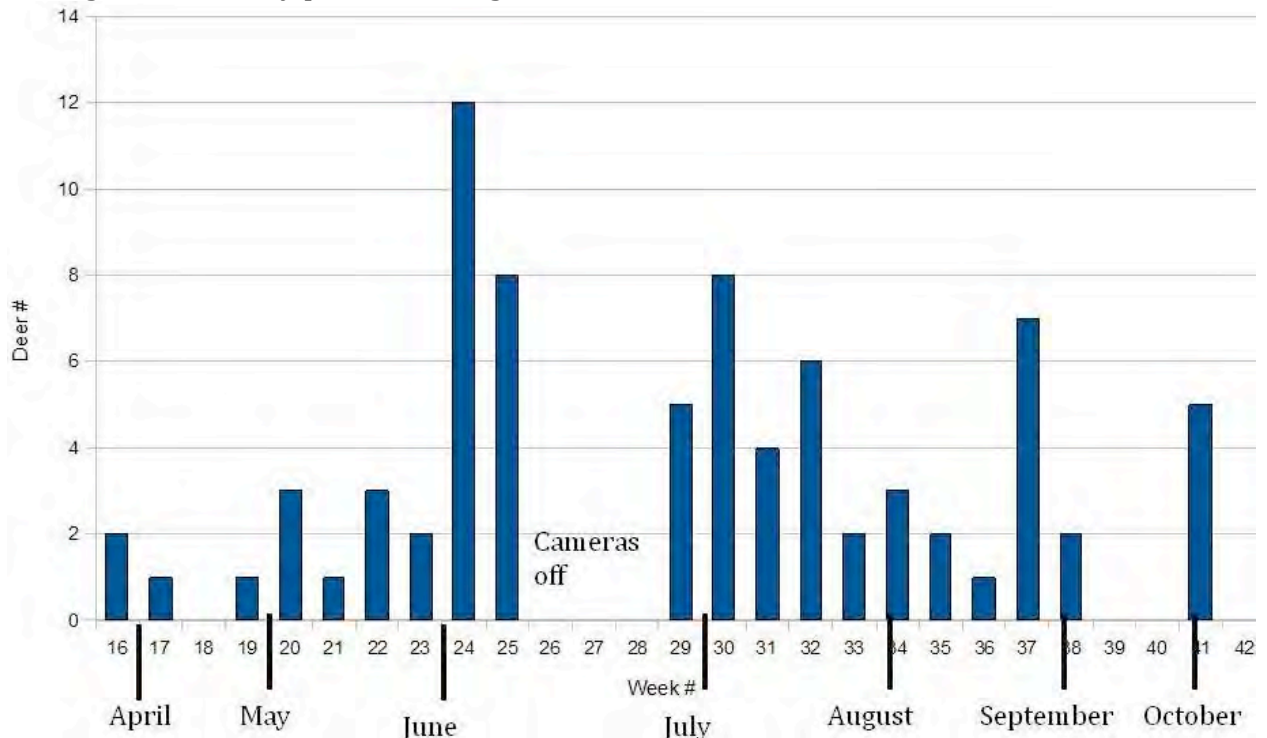


Figure 34. Black-tailed deer observations per week at SR 6 Willapa River Bridge over the weeks of monitoring in 2010.

Other species of wildlife were present at this bridge. This was the crossing for opossum, with 90 observations of this species, many of which were of different sizes, indicating more than just one or two animals. A single cat was responsible for the 73 cat events. It would sit in front of the camera, apparently watching for wildlife. One night an opossum did come and run directly in front of the cat, see picture below. Human use was persistent, with 43 events of people coming to the area to swim, bring tubes to float the river, fish, hike, walk dogs, and canoe. The majority of human events occurred at the north (west) end of the structure.

**Table 5.** Species observations at the SR 6 Willapa River Bridge.

***Species***

Mammals

Black-tailed deer - 82  
 Opossum - 90  
 Raccoon - 28 events, 27 individuals  
 Cat - 73  
 Skunk - 5  
 Coyote - 1  
 Dogs (only) - 12  
 Humans (only) - 41  
 Humans with dogs - 2

Birds

Robins - 1 event, 2 individuals

Wildlife events were fairly consistent across the months. After removing all events involving humans, dogs and cats, the pure wildlife events (including deer) were tallied for each month (Table 6). June was the month with the greatest wildlife activity.

**Table 6.** Monthly tallies for number of wildlife events recorded by cameras at Willapa River Bridge, SR 6.

Month	Number of wildlife events recorded	Month	Number of wildlife events recorded
April	18	August	26
May	15	September	25
June	41	October	7
July	21		





**Figure 35.** Black-tailed deer doe entering area under north side of bridge.



**Figure 36.** Two black-tailed deer does using area under south side of bridge.



**Figure 37.** Opossum using area under north side of bridge. Vegetation near opossum is attached to its tail.



**Figure 38.** Black-tailed deer doe and fawn in area where grass has been cut, north end of SR 6 Willapa River Bridge.



**Figure 39.** Black-tailed deer entering south end of bridge. Note long grass.



**Figure 40.** Cat and opossum under north side of bridge. Cat and opossum ran away in opposite directions.



## **Location Name: Rock Creek**

**Location ID:** 6\_26\_05

**Route:** 6

**Milepost:** 26

### Roadway & Site Description

This segment of State Highway 6 is an east-west running, undivided two-lane road. A bike path runs parallel to the roadway along the north side along an old railroad grade. Rock Creek runs through the structure, which is surrounded by forest cover to both the north and south.

### Structure Description

*Type:* Concrete span bridge

*Structure Functional Class:* Class 3 (large underpass)

*Dimensions:* 16'7" high x 106' span x 24' long

This structure is an old multi-span bridge underpass (plaque indicated it was constructed in 1924) with concrete support posts, which provide a more open feel through the structure. The center span bridges the main portion of Rock Creek – which was approximately 3-10' deep at the time of the assessment – while the two outside spans bridge riprap side slopes. The riprap is mostly larger sized (i.e., larger than a volleyball), although on the east side of the creek there is a narrow dry pathway composed of smaller riprap and dirt.

There is no fencing associated with the structure on the inlet (south) side. Limited 4-strand barbed wire fencing extends to the west for approximately 100' on the north side of the structure. This fencing is in poor condition with multiple holes and areas where the vegetation is pulling down the fence. Guardrail is present above the structure for the length of the structure. There is little evidence of human activity at this structure, although a few footprints were observed.

### Wildlife

Deer, raccoon, and small rodent tracks were observed by the structure, and ermine scat was found beneath the structure.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received 'C' ranks for Low Mobility Small Fauna, Adaptive Ungulates, and Very High Openness Fauna, meaning that structure could be retrofitted to better accommodate species of these guilds. All other species guilds received an 'A' rank. In general, the field evaluators determined that the structure is large and open enough to accommodate each of the target Species Guilds, but the riprap decreases the functionality of the structure for several Species Guilds.

## **Recommendations**

Following are the recommended retrofits at this site:

- Alter or cover riprap on side slopes to provide a dirt pathway through the riprap on either side of the creek; Maintain natural stream banks to the extent possible.
- Maintain native vegetation growth at the structure entrances and avoid the use of herbicides in these areas.
- Install wildlife fencing for larger mammals and small mammals to guide animals towards the structure.



**Figure 41.** Highway 6 looking east



**Figure 42.** Highway 6 looking west



**Figure 43.** Bridge and riprap side slopes



**Figure 44.** Main span



Figure 45. Bridge and adjacent forest



Figure 46. 4-strand barbed wire fencing on northwest side of structure

## **Location Name: Unnamed Tributary, Tilton River**

**Location ID:** 508\_24\_06

**Route:** 508

**Milepost:** 24

### Roadway & Site Description

Highway 508 is an east-west running two-lane highway through in southwestern Washington. This segment of the road crosses through forested, mountainous terrain.

### Structure Description

*Type:* Wooden bridge

*Structure Functional Class:* Class 2 (medium underpass)

*Dimensions:* 3'6" high x 24' span x 20' long

This structure is a small bridge underpass with straight, wooden abutments that spans a small stream, less than 3' deep at the time of the assessment. The structure spans only the stream itself and does not include any dry bank area beneath the bridge

There is no fencing associated with the structure. Guardrail is present above the structure for the length of the structure. There is no apparent human activity at this structure.

### Wildlife

No wildlife signs were observed at this structure.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. Because of the lack of a dry terrestrial pathway through the structure, this location received 'C' ranks for Low Mobility Small Fauna, Moderate Mobility Small Fauna and Adaptive High Mobility Fauna. The structure received 'F' ranks for High Openness High Mobility Carnivore, Adaptive Ungulates, and Very High Openness Fauna because it is too small to accommodate species in these Movement Guilds, and cannot be retrofit to accommodate them. A new structure would be required at this location to provide a safe passage for members of these Guilds.

### Recommendations

Following are the recommended retrofits at this site:

- Improve for small mammals by providing a dry pathway on one side of the stream either by constructing an artificial bank through the structure using small-diameter riprap and dirt, or by installing a small mammal shelf through the structure.

Following are the recommendations for replacing the structure to accommodate larger wildlife, such as deer, coyote and elk:

- Elevate the roadway to accommodate a higher structure;
- Construct a wider structure that spans the banks on either side of the stream to provide a dry pathway. Or create a double structure that accommodates the stream on one side, and the terrestrial passage an overflow in the other.
- Install wildlife fencing for larger mammals and small mammals to guide animals towards the structure.



Figure 47. Route 508 looking west



Figure 48. Outlet side



Figure 49. Looking downstream from outlet



Figure 50. Inlet side



## **Location Name: Cowlitz River**

**Location ID:** 12\_112.8\_07

**Route:** 12

**Milepost:** 122.8

### Roadway & Site Description

This segment of State Highway 12 is an east-west running, undivided two-lane road. A small county road intersects the highway immediately to the west of the structure. The surrounding landscape is largely agricultural, with a narrow strip of riparian forest lining the river. A wide clear zone adjacent to the road pavement is maintained on both sides of the road.

### Structure Description

*Type:* Steel and concrete span bridge

*Structure Functional Class:* Class 4 (extensive bridge)

*Dimensions:* 22' high x 200' span x 33' long

This structure is an extensive bridge spanning a broad river and adjacent banks, with multiple rows of concrete support posts along the length of the span. The bridge spans across the natural high bank slopes, such that there is a wide terrestrial area beneath the structure, even during periods of high flows. However, there is little vegetation cover beneath the structure itself. A dirt road extends from the highway to the structure entrance on the northwest side, for people to directly access the river.

There is no wildlife fencing associated with the structure, although the adjacent agricultural fields are fenced. There is a limited segment of guardrail associated with the structure. Human activity is apparent at the structure, and both human and dog tracks were observed.

### Wildlife

Deer tracks were observed under the structure, and both deer and elk tracks were observed in the vicinity of the structure. Elk tracks were also found along the roadside. A game trail was found leading from the riparian zone along the fenced-off agricultural fields on the southwest side up to the guardrail.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for each of the target Species Movement Guilds, meaning that the field evaluators determined that animals from each of these guilds could successfully pass through this structure as is or with small modifications.

## **Recommendations**

Following are the recommended retrofits at this site:

- Install wildlife fencing for larger mammals and small mammals to guide animals towards the structure.
- Minimize human activity at the structure; provide river access further up- or downstream from the structure itself.



Figure 51. Inlet side



Figure 52. Terrestrial area beneath bridge



Figure 53. Outlet side



Figure 54. Looking towards inlet



Figure 55. Game trail from riparian Zone and fenced fields to guardrail



Figure 56. Roadway

## **Location Name: Indian Creek**

**Location ID:** 12\_159\_08

**Route:** 12

**Milepost:** 159

### Roadway & Site Description

This segment of State Highway 12 is an east-west running, undivided two-lane road. The surrounding landscape is forested and in National Forest ownership. A horse ranch operates on the north side of the highway.

### Structure Description

*Type:* Steel and concrete span bridge

*Structure Functional Class:* Class 4 (extensive bridge)

*Dimensions:* 8' high\* x 150' span x 32' long

\**Note:* this is the functional height of the terrestrial pathway under the bridge, not the height from the river to the bridge.

This structure is an extensive bridge spanning a mountainous river drainage. The bridge spans the river as well as the adjacent high banks. It is supported by concrete pillars on both sides of the river and riprap reinforcement at the abutments. A defined dirt pathway is evident crossing through the structure, and appears to be used by horseback riders and wildlife alike. There is no vegetation cover beneath the structure itself.

There is no wildlife fencing associated with the structure, although the adjacent agricultural fields are fenced. Guardrail is present above the structure for the length of the structure. Human activity at the structure appears limited to occasional use by horseback riders. An interview with the horse ranch operators could confirm the level of human use.

### Wildlife

A game trail passes through the structure and a number of both deer and elk tracks were observed under the structure and in the adjacent habitat, as well as leading up to the roadsides. Small rodent scat was also found in the structure. Heavy elk droppings were observed in areas leading to the structure.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received 'A' ranks for Moderate Mobility Small Fauna, Adaptive High Mobility Fauna, and High Openness High Mobility Carnivores. The structure received 'C' ranks for Adaptive Ungulates and Very High Openness Fauna because the lack of a dry pathway on the west side of the river makes it impassable for species in these groups through that portion of the structure. The structure received a 'F' for Low Mobility Small Fauna because of the lack of natural riparian stream banks through the structure.

## **Recommendations**

Following are the recommended retrofits at this site:

- Construct natural substrate pathways along the water's edge for riparian species moving along that edge.
- Install wildlife fencing for larger mammals and small mammals to guide animals towards the structure and prevent at-grade crossings.
- Minimize human/horse activity at the structure; ensure appropriate access and controls for the horse ranch to ensure that if new wildlife fencing is installed it will not be in conflict with their needs.
- Maintain vegetation cover at structure entrances.

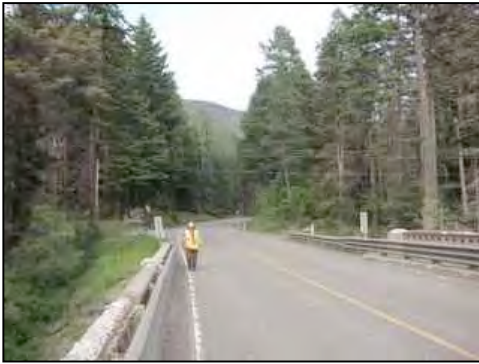


Figure 57. Roadway looking east



Figure 58. Inlet side



Figure 59. Steep bank on west side



Figure 60. Dry pathway on east side



Figure 61. View towards inlet

## **Location Name: McPherson Creek**

**Location ID:** 823\_13.8\_09

**Route:** 821

**Milepost:** 13.8

### Roadway & Site Description

State Highway 823 is a north-south running, undivided two-lane highway. The surrounding landscape is sagebrush. There is no development along this segment of roadway. Average daily traffic is predicted to be less than 2,000 vehicles.

### Structure Description

*Type:* Concrete box culvert

*Structure Functional Class:* Class 2 (medium underpass)

*Dimensions:* 6' high x 5' span x 165' long

This structure is a box culvert at the base of an approximately 15-foot high fill slope. The structure is positioned at an angle to the roadway, and appears as a long, narrow tunnel. The culvert floor is concrete. The drainage on the inlet side is wide and open, whereas on the outlet side it is narrow and steep. Woody debris and tumbleweeds have built up at the structure outlet, partially blocking the entrance. It appears the culvert is placed for an occasional flash flood.

Four-foot high barbed wire fencing is present on the inlet (east) side of the structure. The fence does run across the top of the fill slope and extends approximately 100 feet in either direction. There is no wildlife fencing associated with the outlet (west) side of the structure. There is no evidence of human activity at this location.

### Wildlife

Deer tracks were observed in the drainage on the inlet (east) side of the structure. The tracks do not approach the structure, but instead lead up the side of the fill slope, suggesting that they are crossing at-grade.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for Moderate Mobility Small Fauna and a 'C' rank for Adaptive High Mobility Fauna. The structure received 'F' ranks for Low Mobility Small Fauna, High Openness High Mobility Carnivores, Adaptive Ungulates and Very High Openness Fauna, meaning that it cannot be retrofit to accommodate species in these Movement Guilds.

### Recommendations

The existing structure is insufficient for most Species Movement Guilds and would have to be replaced with a larger box culvert, arch or bridge structure to provide a suitable passage for animals in these groups. Barring replacement, the structure could be made more functional for Moderate Mobility Small Fauna and Adaptive High Mobility Fauna by the following measures:



- Clear debris from the outlet and maintain on a regular basis.
- Add baffles to the culver floor to retain a dirt floor through the length of the structure.



Figure 62. Box culvert at base of fill slope



Figure 63. Long, narrow tunnel effect



Figure 64. Looking up the drainage from inlet



Figure 65. Debris at culvert outlet



Figure 66. Roadway looking north

## **Location Name: Teanaway River Bridge**

**Location ID:** 970\_6.3\_10

**Route:** 970

**Milepost:** 6.3

### Roadway & Site Description

SR 970 is an east-west running, undivided two-lane highway. The surrounding landscape is a mix of agricultural fields and forest, with riparian habitat maintained along the river corridor.

### Structure Description

*Type:* Concrete bridge

*Structure Functional Class:* Class 4 (extensive bridge)

*Dimensions:* 17' high x 300' span x 43' long

This structure is a concrete bridge spanning a large river. The bridge has vertical support walls at intervals along its span. At either end of the structure the walls are further reinforced with riprap slopes. The riprap slopes occupy much of the terrestrial area beneath the bridge, particularly on the east side, where the riprap extends for approximately 50 feet beyond the structure. The riprap is less continuous on the west side, although there is no defined terrestrial pathway through the structure.

Four-foot high four-strand barbed wire fencing is present on both sides of the structure, extending for approximately 1 mile in either direction. There is also extensive guardrail present on both sides of the roadway. No signs of human activity were observed at this location.

### Wildlife

Despite the lack of a well-defined pathway, deer tracks were observed crossing through the structure on the west side of the river along the flattest, least rocky section of the support slope.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for Moderate Mobility Small Fauna, Adaptive High Mobility Fauna and High Openness High Mobility Carnivores, meaning that the field evaluators concluded that animals from each of these guilds could successfully pass through this structure as is or with small modifications. The structure received a 'C' rank for Adaptive Ungulates and Very High Openness Fauna, indicating that the structure could be modified to be made functional for species of these Movement Guilds. The structure received a 'C' rank for Low Mobility Small Fauna, meaning the area under the bridge can be retrofitted to accommodate these species.

## **Recommendations**

The following measures are recommended to improve the functionality of this structure.

- Create dirt pathways through the riprap on both sides of the river.
- Revegetate the stream banks through the structure to accommodate Low Mobility Small Fauna and other riparian-dependent wildlife.
- Replace the barbed-wire fencing with 8'-foot high wildlife fencing to guide animals towards the structure and discourage at-grade crossings.



Figure 67. Roadway



Figure 68. Support wall



Figure 69. Side slope on west side of river



Figure 70. Bridge view from outlet



Figure 71. Riprap on east side of river outlet



Figure 72. View of drainage from outlet

**Location Name: Swauk Creek**

**Location ID:** 970\_159.7\_11

**Route:** 97

**Milepost:** 159.7

Roadway & Site Description

State Highway 970 is an east-west running, undivided two-lane highway. A 10-minute traffic count resulted in an estimated daily average of 8,000 vehicles, which could inhibit some wildlife from attempting to cross at-grade. This segment of roadway is located in a completely forested landscape.

Structure Description

*Type:* flat-bottomed metal pipe

*Structure Functional Class:* Class 2 (medium underpass)

*Dimensions:* 6' high x 9' span x 100' long

This structure is a flat-bottomed metal pipe with perennial stream flow situated in a low fill slope. The outlet is perched more than 0.5' feet above the channel and drops into a pool.

There is no fencing associated with the structure. Guardrail extends for approximately 200' in either direction on both sides of the roadway. No signs of human activity were observed at this location.

Wildlife

Deer tracks were observed in the drainage and appear to cross up and over the highway.

*Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This structure received a 'F' rank for all species movement guilds and cannot be retrofitted to accommodate terrestrial wildlife.

**Recommendations**

This structure must be replaced with a new structure to accommodate terrestrial wildlife passage for most Species Guilds at this location. A raised shelf could be placed along the length of the inside of the pipe and, with some effort, connected to the landscape at either end of the pipe to facilitate passage for smaller animals.





Figure 73. Riparian forest and culvert meadow at outlet



Figure 74. Flat-bottomed pipe



Figure 75. Roadway and adjacent forest



Figure 76. Inlet



## **Location Name: Mill Creek**

**Location ID:** 2\_70.2\_12

**Route:** 2

**Milepost:** 70.2

### Roadway & Site Description

This segment of the east-west running state Highway 2 is a divided four-lane highway through the forested Cascade Mountains.

### Structure Description

*Type:* Arch culvert

*Structure Functional Class:* Class 3 (large underpass)

*Dimensions:* 12' high x 36' span x 140' long\*

*\*Note both the north and south structures have approximately the same dimensions, although the south structure was not directly measured because of the lack of access due to the steep riprap slopes.*

There are two structures at this location; one under the eastbound lanes and another under the west bound lanes. Both structures are large arch culverts with perennial water flow through the structure. The structures are separated by wide (~200') vegetated median. The stream comes in from the south, where it is bisected by the highway, and meanders through the heavily-vegetated median, such that the north structure is offset from the southern one by about 1/10-mile. The north structure is situated in a low fill slope while the south structure is situated at the base of a somewhat higher and significantly longer fill slope.

Extensive riprap is associated with both structures as well as the stream banks through the median. At the north structure, riprap lines the stream banks (~30' wide) and adjacent fill slopes on both the outlet and median (inlet) sides of the structure. At the south structure, the extensive fill slope is reinforced with rip rap along its entire length.

Boulders have been placed inside of the structures to simulate a more natural flow. The culvert is completely occupied by the stream and, while the stream is not deep (less than 3' at the time of the evaluation), it is unlikely that even larger mammals would cross through these culverts.

There is no fencing associated with the structure. Guardrail extends throughout this segment on both sides of the roadway above both the north and south structures. While human use does not appear to occur regularly at this location, graffiti was found on the northern structure.

### Wildlife

Deer and elk tracks were observed in the vicinity of the north structure on both the outlet and median sides. In one place, deer tracks were found crossing through the narrowest portion of the riprap to ascend the fill slope. Road kill was also found at

this location, most likely a squirrel or rabbit. Tracks were found along the roadway at both the north and south structures. Possible bighorn sheep tracks were observed along the road at this site.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This structure received a 'F' rank for all species movement guilds and cannot be retrofit to accommodate terrestrial wildlife. Notably, the structure has received awards for its ability to accommodate fish passage, highlighting the need to consider terrestrial as well as aquatic passage when designing and constructing structures.

### **Recommendations**

While the structure must be replaced with a new structure to accommodate terrestrial wildlife passage, several improvements could be made to make the location more wildlife-friendly. These include:

- Minimize riprap on the slopes adjacent to the structure and/or provide 'escape pathways' for ungulates that are trapped on the roadway side of the riprap.
- Remove the slope netting, which may ensnare snakes and small animals.



Figure 77. North-side structure outlet



Figure 78. West bound lanes, looking east



Figure 79. View from north-side structure outlet



Figure 80. Riprap-lined stream bank and fill slope (north side structure inlet)



Figure 81. View from north-side structure across median to riprap fill slope along eastbound lanes



Figure 82. Riprap fill slope on south side (eastbound lanes)



Figure 83. From eastbound lanes looking across median towards north structure

## **Location Name: Cle Elum River Bridge (aka Bullfrog)**

**Location ID:** 90\_79\_13

**Route:** I-90

**Milepost:** 79

### Roadway & Site Description

This segment of Interstate 90 is an east-west running, 4-lane divide highway (2 lanes in each direction). The surrounding landscape is largely forested.

### Structure Description

*Type:* Concrete and Steel Bridges

*Structure Functional Class:* Class 4 (extensive bridge)

*Dimensions:* 12' high x 150' span x 30' long\*

*\*Note both the north and south structures have approximately the same dimensions.*

There are two structures at this location; one under the eastbound lanes and another under the west bound lanes. Both structures are large concrete and steel bridges with concrete support walls. The Cle Elum River flows through the structure. The structures are parallel to one another and separated by 60'-wide vegetated median. There is minimal vegetation (some grasses) beneath the structures themselves.

The river occupies much of the span under the bridges, however there is a 50 feet wide dirt river bank on the west side of the river. On the east side, there is little terrestrial area – the concrete support wall is close to the waters edge and further supported by riprap. Visibility through both structures is very high.

There is no fencing associated with the structure. There appears to be occasional human activity at this location. The purpose of such visits is unclear, but may be recreational (e.g., river access).

### Wildlife

Numerous deer tracks and scat were found under the structures on the west side of the river.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This structure received an 'A' rank for all species movement guilds, indicating that animals from each of the Movement Guilds could successfully pass through this structure as is, although passage could be further enhanced with some modifications.

## **Recommendations**

Currently, the structure is highly functional for wildlife passage on the west side of the river, but remains largely non-functional on the east side. A pathway through the riprap would improve passage opportunities on the east side.



**Figure 84.** View from beneath south structure



**Figure 85.** WSDOT staff and researcher in front of bridge



**Figure 86.** Riprap banks on east side of river



**Figure 87.** Dirt, rocky area on west side of river



**Figure 88.** East side median



## Monitoring Results

### I-90 Cle Elum River Bridge (Bullfrog Bridge)

This bridged structure is actually two bridges, each one accommodating opposing lanes of traffic. The median is naturally vegetated. The Cle Elum River runs through the site. There is no wildlife exclusion fencing present. WSDOT records indicate Average Daily Traffic is 26,547 vehicles, but a 15-minute count on a Friday afternoon in spring estimated 65,000 vehicles. There are natural forested areas on both sides of the west end of the bridge, west side of the river. The area to the east end of the bridge was not monitored, as there is little terrestrial passage opportunity. The area to the east is agricultural and cleared.

Two cameras were placed under the bridge on the west side of the river. One was placed along the south side of the bridge along the west side of the river, and a north camera was placed at the north bridge abutment. Both cameras faced inward toward the area under the paired bridges. Cameras were in operation from April 14 through October 21, totaling 189 days of camera coverage. The south camera was off 27 days in July and August. The north camera was on continuously. Mule deer results are below. There were 172 individual observations of deer at the site. These do not represent as many deer, but often in later summer and fall, these were repeat visits to the site by does and fawns. There were no obvious repels or parallel movements, see Table 7. The deer gender and ages of the animals photographed included: 95 does, 66 young, 6 bucks, 5 unknown. Males comprised 3.48% of passes recorded.

**Table 7.** Mule deer data tabulated for I-90 Cle Elum Bridge.

Camera Days Analyzed	Number of Deer Obs. at Site	Number of Deer Obs. per Day	Number of Successful Crossings through structure	Number of Deer crossing per day	Success Rate (%)	Rate of Repellency (%)	Parallel Rate (%)
189	172	0.91	172	0.91	100	0	0

Deer presence at the bridge was continuous through this phase of the study see Figure 89. In the 109 deer events recorded, 50(45.87%) occurred during daylight, and the remaining occurred at night or dawn or dusk.

Eight elk were photographed under the bridge in April in May. These consisted of four cows, two calves, one male, and one unknown. There was a multitude of other species of wildlife photographed at the bridge. Table 8 presents the animal species and the number of events with those animals. Human presence of the area was fairly regular, with 17 events. This is the site where a car crashed in the Cle Elum River directly in front of the South camera. Other human uses of the area include

swimming, hiking, fishing, and WSDOT maintenance ranging from trash pickup to cranes coming under the bridge for upkeep.

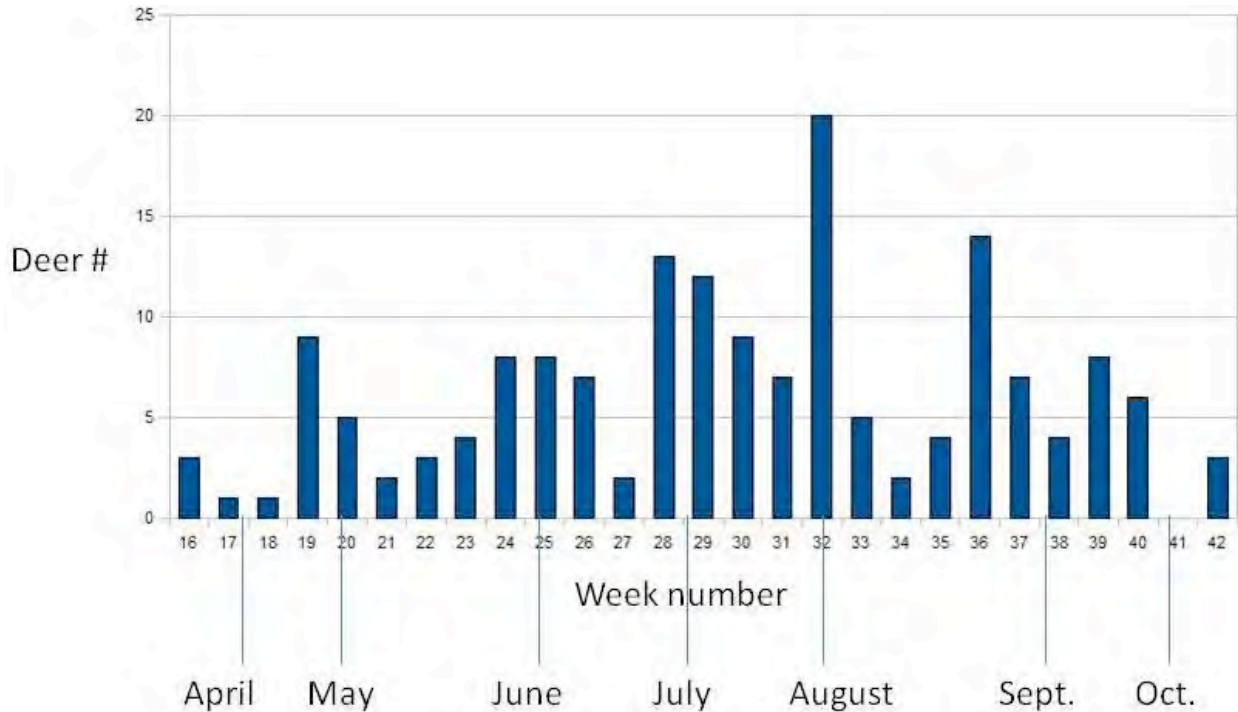


Figure 89. Mule deer passes per week at I-90 Cle Elum Bridge over the weeks of monitoring in 2010.

Table 8. Species detected at the I-90 Cle Elum Bridge and the number of events for that species.

**Species**

Mammals

- Humans - 17 events
- Humans with dogs - 2
- California Ground squirrel - 11
- Elk - 4 events, 8 animals
- Raccoon - 7
- Chipmunk - 2
- Porcupine - 1
- Red squirrel - 1
- Wood rat - 1

Birds

- Rock dove - 24
- Crow - 3
- Canada geese - 1
- Mallard duck - 1
- Raven - 1
- Robin - 1



**Figure 90.** Elk at south side of I-90 Cle Elum bridge.



**Figure 91.** California ground squirrel on north side of I-90 Cle Elum bridge.



**Figure 92.** Mule deer buck and doe on south side of I-90 Cle Elum Bridge.



**Figure 93.** Mule deer fawn looking up to I-90 on north side of the Cle Elum bridge.



**Figure 94.** Canada goose and goslings under I-90 Cle Elum Bridge.



**Figure 95.** Porcupine entering area under I-90 Cle Elum Bridge, north side of bridge.

## **Location Name: Tucker Creek MP 73 Double Box Culvert**

**Location ID:** 90\_73\_14

**Route:** I-90

**Milepost:** 73

### Roadway & Site Description

This segment of Interstate 90 is an east-west running, 4-lane divide highway (2 lanes in each direction). The surrounding landscape is semi-natural, forested with nearby residential development.

### Structure Description

*Type:* Concrete Box Culvert Underpass

*Structure Functional Class:* Class 2 (medium underpass)

*Dimensions:* 4'10" high x 9' span\* x 58'3" long

The structure is composed of two separate two-chambered concrete box culverts. There is a grassy, wet median (approximately 35' wide) separating the two structures. A small stream flows through the structures. The stream flow flattens out as it passes through the structure. There was no dry pathway all the way through the structure, although the water level was low and slow-moving at the time of the evaluation. The stream likely dries up partially by mid-summer, leaving more dry passage in both chambers. Similarly, dry pathways will likely be completely obliterated during high water events. The substrate through the structure is muddy and without rocks or gravel. A railroad runs parallel to the interstate on the south side of the structure, where the stream is channeled through an additional box culvert.

The surrounding habitat on both the north and south sides of the structure is largely forested. There are no obstructions or debris at any of the culvert entrances. Visibility through the structure is clear, but little light enters into the structure and there is a high light contrast compared to the daylight outside of the structure.

Barbed-wire right-of way fencing is present on both the north and south sides of the structure for the entire roadway segment. In addition, there is a guardrail immediately above the structure itself. There is no evidence of human activity at this location.

### Wildlife

Deer tracks were observed at both the north and south side entrances; any possible tracks inside the structure or in the median would be obscured by the water flow. A live deer was also observed approaching near the north-side entrance. Raccoon tracks were inside the west chamber of the south structure. Very high traffic volumes on the interstate (25,000 to 65,000 average vehicles per day) acting as a barrier are likely to incentivize deer and other animals to use these structures to the extent possible, despite the limitations. Raccoon tracks were inside the west chamber of the south structure.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for Moderate Mobility Small Fauna and Adaptive High Mobility Fauna, meaning that the field evaluators concluded that animals from each of these guilds could successfully pass through this structure as is or with small modifications. The structure received a 'C' rank for High Openness High Mobility Carnivores, indicating that the structure could be modified to be made functional for species of these Movement Guilds.

This structure received an 'F' rank for Adaptive Ungulates and Very High Openness Fauna – this ranking may seem contrary to the evidence of deer usage of the structure, however, the structure is only minimally functional for these animals as a result of the high traffic volumes, which leave no other option for accessing habitat bisected by the interstate. Use of the current structure by these species is likely limited to resident animals that have adapted to the only available passageway. To truly provide functional connectivity at this location for species in these Movement Guilds, a new, larger structure is needed.

The structure also received an 'F' rank for Low Mobility Small Fauna. The structure may be functional for some species in this group during certain times of the year (e.g., hydrophilic frogs during the wet season), but due to the ephemeral nature of the stream flow and the lack of riparian banks through the structure, there is no consistently reliable habitat through the structure year-round.

### **Recommendations**

The existing structure is insufficient for Adaptive Ungulates and Very High Openness Fauna and would have to be replaced with either a larger single-chamber box culvert, a large double box culvert, one side for stream flow, the other for overflow and more terrestrial passage, or an arch or bridge structure to provide a suitable passage for animals in these groups. The roadway could be gradually raised from both sides to accommodate the greater height of a new structure.

Barring replacement, the structure could be marginally improved by the following retrofits:

- Install a shelf through the culverts or buildup sediment on one side of the structure to provide a consistent dry pathway all the way through the structure during all seasons.
- Plant bushes in the median to provide better cover and insulation from highway traffic noise and lights.





Figure 96. South side outlet



Figure 97. Semi-dry path through west chamber of south structure, with raccoon tracks



Figure 98. Median



Figure 99. Adjacent culverts and infrastructure just beyond the south side of the interstate (under road & railroad)



Figure 100. Deer tracks at north-side inlet

## **Monitoring Summary**

### **I-90 Mile Post 73 Double Box Culvert**

There is a small stream through these double box culverts. There is an open median area. There is forested vegetation away from the right away, with grassy areas extending from the highway to the forest. There is no wildlife fencing to “guide” animals to the culvert. WSDOT estimates Average Daily Traffic is approximately 26,000 vehicles, but field estimates have put the value closer to 65,000 vehicles. Two cameras were placed at this double box culvert, each facing into the entrance of the culvert on each side of the highway.

Cameras were in operation from June 23 through October 21, totaling 120 days of coverage. There were 226 mule deer observations at the culvert, meaning these are the number of individual deer that were photographed. Although the total numbers include 143 females, 28 males, and 55 young, these pictures were often the same animals. It is estimated from viewing the photos that there were approximately six to seven bucks, and approximately six does and fawns. Of the 28 buck photos at the entrance, nine of the animals (32.14%) were repelled. Males comprised 9.70% of the successful passes recorded. For further numbers please see table below. The number of deer at the site peaked from the last week of June through the last week of July, see figure below. This number correlates with the period of time when the fawns of the year begin to follow the does through the culvert, which began July third. This period of time is also when 60% of the bucks appeared at the entrance to the culvert. Table 9 presents the success and repellency rates for deer at this site.

**Table 9.** Mule deer observation data tabulated for I-90 MP 73 double box culvert.

Camera Days Analyzed	Number of Deer Obs. at Site	Number of Deer Obs. per Day	Number of Successful Crossings through structure	Successful Deer Crossings per day	Success Rate (%)	Rate of Repellency (%)	Parallel Rate (%)
120	226	1.89	196	1.63	86	11	3

In the 156 deer events recorded, 75(48.08%) occurred during daylight, 69 (44.23%) occurred at night, and 12 (7.70%) occurred at dawn or dusk. No other ungulates were photographed at the culvert site.

There were several other species of wildlife photographed at the culvert. Below, Table 10 presents the animal species and the number of events with those animals. Human presence of the area was fairly regular. There were 22 events where humans came through the culvert, in all but two cases they were riding motorcycles and atvs.

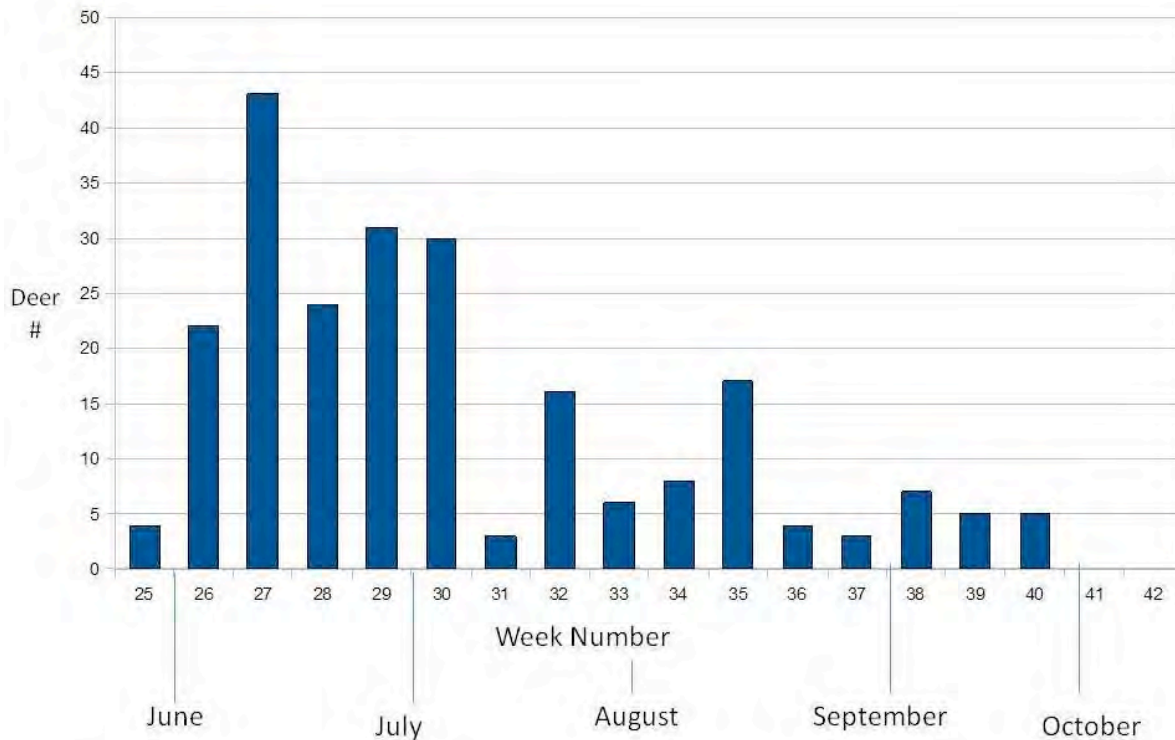


Figure 101. Mule deer passes per week at I-90 MP 73 box culverts over the weeks of monitoring in 2010.

Table 10. Species detected at the I-90 MP 73 double box culvert and the number of events for that species.

**Species**

Mammals

- Humans - 22 events
- Cat - 21
- Raccoon - 8
- Rabbit - 5
- California ground squirrel - 1
- Skunk - 1



**Figure 102.** Mule deer bucks pondering I-90 MP 73 culverts. They repelled away from structure



**Figure 103.** Mule deer brings fawn through the structure under I-90 at MP 73 for the first time.



**Figure 104.** Mule deer bucks entering and using culvert on I-90 MP 73.



**Figure 105.** Mule deer doe and fawns coming through structure under I-90 at MP 73.



**Figure 106.** Skunk using I-90 MP 73 culvert..



**Figure 107.** Typical motorized vehicle use of culvert under I-90 at MP 73.



## **Location Name: MP 33 Large Span Bridge**

**Location ID:** 90\_34\_15

**Route:** I-90

**Milepost:** 33.2

### Roadway & Site Description

This segment of Interstate 90 is an east-west running, 4-lane divide highway (2 lanes in each direction). The surrounding landscape is semi-natural, forested with nearby residential development.

### Structure Description

*Type:* Concrete Bridge Underpass

*Structure Functional Class:* Class 3 (large underpass)

*Dimensions:* 30' high x 58'7" span\* x 80' long

*\*Span measured as functional distance between support walls.*

This location has two structures – one under the eastbound lanes and another under the westbound lanes. Both structures are large span bridges with concrete support walls and sloping dirt side slopes (2:1 slope). A 2-lane road runs parallel to the interstate on the north side of the structure.

A wide dirt/gravel recreational trail runs through the center of the structure. There is some grassy cover through the structures on either side of the trail. Grass/shrub leading into forest cover is present at both entrances on either side of the trail. The trail receives regular use by walkers, joggers, cyclists and, presumably, dogs. Nearby neighborhoods are present on both the north and south sides of the interstates, and the evaluators also found evidence of night-time use and partying at the site.

A 145' vegetated median separates the two structures and provides partial bush/tree cover along both sides of the recreational trail. Barbed wire fencing connects the two structures through the median, however large gaps in the fencing do not provide a continuous barrier to wildlife access to the median.

Six to eight foot high chain link fencing extends along the interstate in both directions from the structure, though it contains many gaps along its length. The fencing on the southeast side of the structure is 4'-high barbed wire rather than the taller chain link. A large gap in the fence has evidence of elk passage with an ungulate trail with elk scat leading through this gap and providing access into the highway right-of-way. Guardrail is present immediately above the structure itself.

### Wildlife

Elk scat was observed on an ungulate trail that crosses through a gap in the fencing on the south side. A road killed rabbit was also observed on the highway.



### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This location received an 'A' rank for all species movement guilds except Low Mobility Small Fauna, for which it received a 'C' rank, meaning that this structure is suitable with small modifications for all types of species, though it could be improved to also be functional for Low Mobility Small Fauna.

### **Recommendations**

The existing primary limitation at this structure is the level of human activity, which may deter some wildlife activity, if they are not habituated to human presence, and the serious gaps in the existing fencing, which are likely to cause animals to become trapped inside of the highway right-of-way.

The following improvements are recommended to increase the efficacy of this structure for wildlife passage:

- Add cover and down logs through the structure and the median to improve crossing habitat for Low Mobility Small Fauna.
- Repair gaps in fencing and replace barbed wire fencing on south side with 8'-high chain link or wildlife fencing.
- Night-time policing to minimize human activity during the night hours when wildlife could be encouraged to use the structure.

### **Monitoring Summary**

#### **I-90 MP33 Bridges**

Two cameras were installed at this site on April 15 and 16, 2010. The initial day and night of monitoring revealed only human passages through the structure. By the third night, the camera utility boxes were broken into and the cameras were broken and stolen. This ended monitoring at this site. A camera was later recovered in a nearby river several months later.



Figure 108. View from north side of slope highway



Figure 109. Support wall and side of north structure



Figure 110. Gap in chain link fencing on south side



Figure 111. Large gap in barbed wire fencing through median

## **Location Name: Snoqualmie River Bridge, North Bend**

**Location ID:** 90\_30.5\_16

**Route:** I-90

**Milepost:** 31.5

### Roadway & Site Description

This segment of Interstate 90 is an east-west running, 4-lane divide highway (2 lanes in each direction). The surrounding landscape is largely forested.

### Structure Description

*Type:* Concrete Bridge

*Structure Functional Class:* Class 4 (extensive bridge)

*Dimensions:* 6'10" high x 90' span\* X 95' long

*\*Height and span measurements refers only to the eastern-most span of the north structure, where it spans the trail. The full structure is too large to measure directly.*

There are two structures at this location; one under the eastbound lanes and another under the west bound lanes. Both structures are large concrete bridges with three concrete support walls. The Snoqualmie River flows under both bridges. The bridges are parallel to one another and separated by 223'-wide vegetated median and the river. There is minimal vegetation (some grasses) beneath the structures themselves, but extensive Himalayan blackberry along the river banks at both ends of the structure which may limit wildlife movement along the banks. Visibility through both structures is very high.

The bridge spans the river as well as the banks and a substantial amount of upland area on either side of the river. A recreational trail runs through the east side of the structure, and the high banks are reinforced with riprap, which may prevent animals from accessing the upland trail from the river. However as people regularly use the trail (which provides access for the adjacent neighborhood), wildlife may be largely disinclined from sharing the trail during daylight hours. The trail appears to receive daily use by walkers/joggers and dogs.

Eight-foot tall chain link fencing is present on both the north and south sides of the structure. The fencing ties into the structure both in the median and at the ends of the bridge. The fence extends east and west along the highway for at least a mile. On the south side of the westbound bridge, in the median area, it is present only intermittently with large gaps allowing wildlife access to the median, and there is a game trail leading directly up to the highway.

### Wildlife

A mule deer was observed crossing through the structure from west to east at the time of the assessment. A lone doe crossed moved along the shallows to the riparian vegetation on the other side. Where the vegetation got particularly thick with Himalayan blackberry she swam across the river and exited on the other side. This observation was particularly interesting because no deer tracks were observed on

the riparian banks through the structures, where numerous dog and human tracks were observed. The animal instead chose to walk through the shallow water. Deer tracks were also observed on the trail 30 feet from the structure entrance. During an earlier visit when the monitoring cameras were installed, elk tracks were also observed.

#### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This structure received a 'C' rank for Low Mobility Small Fauna because of the lack of continuous riparian habitat through the structure. The structure received an 'A' rank for all other species movement guilds, indicating that animals from each of the Movement Guilds could successful pass through this structure as is, although passage could be further enhanced with some modifications.

#### **Recommendations**

Currently, the structure is highly functional for most wildlife, although regular human activity may limit some wildlife passage. The following recommendations would enhance successful crossings:

- Repair gaps in fencing and escape ramps for extensive stretches of fencing.
- Improve stream bank habitat on both sides of the river. Establish a riparian access area for people and their pets away from the structure and inhibit such human/dog activity directly under the structure itself.
- Control Himalayan blackberry brambles so wildlife can move through the riparian vegetation and their movements can be separated from recreationists and dogs on the trail.
- Add soil pathways over the riprap on both sides of the river (at least one pathway under each structure and in the median).



**Figure 112.** Beneath north structure



**Figure 113.** Trail under north structure



Figure 114. Riprap on west bank



Figure 115. Thick vegetation through median



Figure 116. Chain link fencing



Figure 117. Doe crossing through structure along water's edge



Figure 118. Doe jumping through brambles before swimming to opposite bank



## Monitoring Results

### **I-90 at Snoqualmie River**

Two cameras were installed under this bridge on April 15, 2010. They were positioned behind the existing chain link fence because the area is used as a trail by local citizens, thereby increasing the cameras' vulnerability to vandalism. Cameras pointed toward the trail near the median on the east side of the river. The area is known to be frequented by local elk headed to and from a golf course on the south side of the highway. On April 17 three cow elk were photographed moving under the bridges at this site (see photos below). No other wildlife was photographed. On the night of April 17 the pair of cameras nearby along the King County Trail were vandalized and stolen. On the night of April 18 several suspicious individuals were photographed at this site at 3:00 in the morning. These cameras were pulled immediately to protect them from theft. The elk photos are a major finding of this study. This is one of two places in this study where elk have been photographed successfully passing through a structure. The bridge is less than seven feet high where the elk traversed underneath, and over 20 feet high where the structure straddles the Snoqualmie River. Regardless, the section where elk moved through is among the lowest recorded heights for structures that elk have used in the United States. The fact these elk are habituated to humans in the North Bend area may make them more apt to use this type of structure.



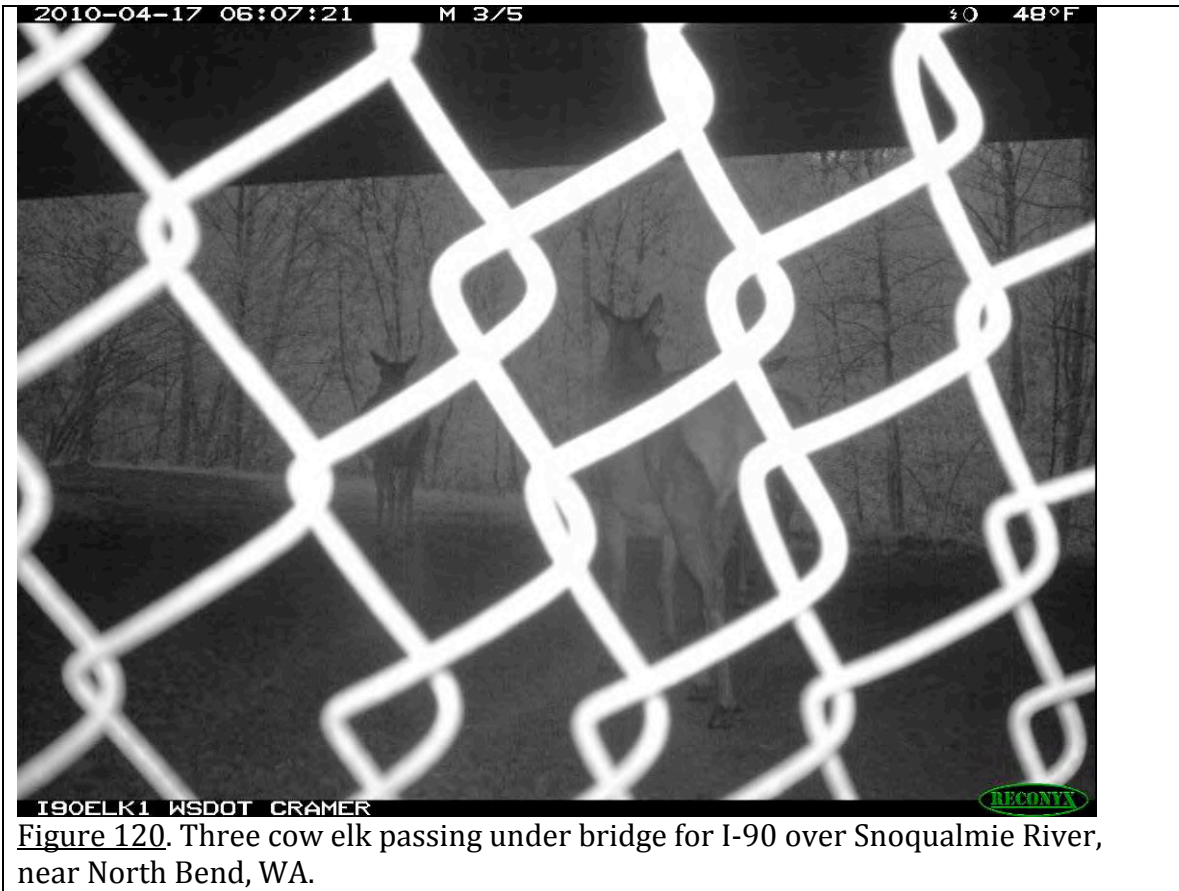


Figure 120. Three cow elk passing under bridge for I-90 over Snoqualmie River, near North Bend, WA.

## **Location Name: I-90 MP 29 Corrugated Steel Culverts**

**Location ID:** 90\_29\_17

**Route:** I-90

**Milepost:** 29

### Roadway & Site Description

This segment of Interstate 90 is an east-west running highway with four lanes of westbound traffic and three lanes of eastbound. The surrounding landscape is densely forested.

### Structure Description

*Type:* Metal Arch Culvert

*Structure Functional Class:* Class 3 (large underpass)

*Dimensions:* North Structure: 12' high\* x 29' span X 120' long

South Structure: 12' high\* x 29' span x 144' long

*\*Estimated height; not measureable.*

There are two structures at this location; one under the eastbound lanes and another under the west bound lanes. Both structures are large arch culverts with natural dirt bottoms separated by a 180'-wide vegetated median. Visibility through both structures is high, although the culverts allow limited natural light, so there is a high light contrast inside the structures relative to outside daylight. A small ephemeral stream flows through the south structure, but is buried under the structure, reemerging in the median and the north structure. Both culvert bottoms slope towards the south, the north culvert to a greater degree. Forest cover is abundant at both structure entrances.

Eight-foot tall wildlife fencing with a 6x6" mesh connects the two structures through the median and extends in each direction along the roadway for an unknown distance. The fence appears to be in good overall condition, although there is a small gap between the ground level and the bottom of the fencing through the median, and the fencing is not completely connected to the structure at all edges.

There were no apparent signs of human activity at either structure, although domestic dog tracks were observed.

### Wildlife

A number of tracks were observed inside both structures, including raccoon, black bear, fox and coyote. Bear scat was also found in the median area. A western toad and multiple slugs were seen in the structure at the time of the inventory. While no elk tracks were observed around the structures, they were seen along the above roadway.

### *Species Movement Guild Rankings*

This site was identified by WSDOT biologists as important for species in each of the Movement Guilds. This structure received a 'C' rank for Low Mobility Small Fauna because of the lack of continuous habitat and structure through the structure. The

structure also received a 'C' rank for Adaptive Ungulates and Very High Openness Fauna because the structures are quite long and enclosed for species in these groups. The structure received an 'A' rank for all other species movement guilds, indicating that animals from each of the Movement Guilds could successful pass through this structure as is, although passage could be further enhanced with some modifications.

### **Recommendations**

Currently, the structure is highly functional for a wide variety of wildlife. The following recommendations would enhance successful crossings:

- Repair gaps in fencing and escape ramps for extensive stretches of fencing.
- Add down logs to enhance structural complexity through the structure for Low Mobility Small Fauna. Monitoring data revealed use by carnivores but no raccoon, fox, skunk, rodents, or smaller wildlife which may be threatened by continuous carnivore presence. Even the researcher checking the cameras could smell the bear presence.
- Instead of burying the small creek as it passes through the structures, allow it to meander through the structure – perhaps by building up the grade further upslope – to provide additional habitat for Low Mobility Small Fauna and to enhance the structure's appeal for other species.
- Control the spread of invasive species around the structure.



Figure 121. South structure entrance



Figure 122. View from structure outlet



Figure 123. South structure, with unconfined flow



Figure 124. North structure outlet





Figure 125. Thick median vegetation



Figure 126. Western toad



Figure 127. View from north structure outlet



Figure 128. Westbound roadway

### **Monitoring Results**

#### **I-90 Mile Post 29 Corrugated Steel Culverts**

This dense forest location is just west of Bend, Washington. The culvert lies in an area that is heavily vegetated and forested, with no obvious human paths or roads to or near the area. There is a heavily vegetated median between the culverts and a small stream entering the culvert at the south (uphill) side. The stream is diverted to an underground culvert and reappears in the median. It then runs over the surface through the north culvert. There is eight feet high (2.4 meters) wildlife exclusion fencing made of chain link present at the site. The Average Daily Traffic for this area is 51,500 vehicles. Two cameras were placed at this pair of large steel culverts, on June 23, one on each entrance. Wildlife use was fairly consistent throughout the



monitoring period, with a high of 14 wildlife events in July, and a low of eight wildlife events in September.

In 120 days of monitoring, this culvert proved to be a heavily used by black bear. There were 31 black bear observations in 21 events. Of those, there were five events where a sow and two cubs were observed moving through the culvert. There were one to several yearling sized bears, and three distinct large bears, possibly males. On one occasion, a bear was repelled, otherwise, all bears moved through the culvert. Bear use during the daylight hours occurred in 60% of the bear passes.

Mule deer were observed in three events: all events involved a doe and two fawns. They went through the culvert on two occasions. On the third occasion the doe was photographed on the road right of way on the other side of the fence while the fawn was below at the entrance to the culvert. The three deer events occurred during dawn (1), day (1), and dusk (1). No bucks were photographed.

Single coyotes were observed at the cameras on 19 occasions. Their use of the culvert was not always definite. There were three occasions where the coyote repelled, and four occasions where the coyote paralleled the culvert. Of the 19 coyote observations, only four (21%) occurred during the day. Bobcat was observed on three occasions, and the animal(s) moved through the culvert on each one. All bobcat observations occurred at night. Total numbers for each species are presented in Table 11. Humans were observed in three events, all during daylight hours.

**Table 11.** Species detected at the I-90 MP 29 corrugated steel culvert and the number of observations for that species.

***Species***

**Mammals**

Black bear - 31

Coyote - 19

Mule Deer - 6

Bobcat - 3

Humans - 3



**Figure 129.** Black bear sow moving through I-90 culvert at mile post 29. First of two.



**Figure 1300.** Black bear cubs following mother through I-90 culvert at mile post 29. Second of two.



**Figure 131.** Coyote being repelled from culvert, south entrance, under I-90, mile post 29.



**Figure 132.** Black bear entering north end of culvert under I-90 at mile post 29. Ultimately bear went through.



**Figure 133.** Mule deer and young exiting culvert under I-90 at mile post 29.



**Figure 134.** Bobcat entering culvert under I-90 at mile post 29.

# STATE HIGHWAY 9 WILDLIFE CROSSINGS MONITORING – YEAR 3 PROGRESS REPORT

*December 2015 through April 2018*

Study Number 115.01

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Applied Research and Innovation Branch



Prepared by:

Julia Kintsch, Principal Investigator – ECO-resolutions

Patricia Cramer, Principal Investigator – Independent Researcher

Paige Singer, Research Assistant – Rocky Mountain Wild

Michelle Cowardin, Wildlife Biologist – Colorado Parks and Wildlife

Joy Phelan, Research Assistant – Independent Researcher

**Cover photos** (clockwise from upper left): Mule deer doe and fawn crossing through the BVA Underpass; Silhouette of a mule deer buck atop an escape ramp near the south fence end; Bighorn sheep approaching the CR 1000 wildlife guard; Moose calf following its mother through the North Underpass; Pronghorn at a habitat camera adjacent to a crossing structure; Elk at the south fence end.

## Research Study Panel

Bryan Roeder – Study Manager and Study Panel Leader, CDOT Research

Eric Bergman – CPW Wildlife Research

Michelle Cowardin – CPW Wildlife Biology

Cinnamon Levi-Flinn – CDOT Region 3 Environmental

Alison Michael – CDOT/US Fish & Wildlife Service

Jeff Peterson – CDOT Environmental Programs Branch

Francesca Tordonato – CDOT Region 1 Environmental

Catherine Ventling – CDOT Region 3 Environmental

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## Executive Summary

The State Highway 9 (SH 9) Colorado River South Wildlife and Safety Improvement Project in Grand County was designed by the Colorado Department of Transportation (CDOT) and partners to improve motorist safety by reducing wildlife-vehicle collisions (WVC) while providing opportunities for wildlife to move beneath and over SH 9 through wildlife crossing structures. Prior to the project, WVC were the most common accident type on this segment of highway, accounting for 60% of all accidents reported to law enforcement. In response to these concerns and with partner support, CDOT installed two wildlife overpass structures, five wildlife underpasses, 10.4 miles of eight-foot-high wildlife exclusion fencing, 61 wildlife escape ramps, and 29 wildlife guards to help reduce WVC while providing safe passages for wildlife. This research study evaluates the effectiveness of the mitigation infrastructure through the use of motion activated cameras and analyses of WVC carcass and accident data. The study maintained a total of 62 motion-triggered cameras at 40 locations in Year 3 to record animal movements and responses to the mitigation. Cameras were placed at crossing structure entrances and in the nearby habitat, at wildlife guards, escape ramps, and the south fence end. This progress report focuses on post-construction monitoring from December 2015 through April 2018.

Mule deer activity and success movements through or over the wildlife crossing structures increased each winter (Fig. E-1) resulting in a total of 45,759 mule deer success movements over the course of the study. From Winter 2016-17 to Winter 2017-18, the overall success rate for mule deer passage increased slightly from 96% to 97%. The total number of mule deer success movements increased by 17%, suggesting that the mitigation is succeeding in improving connectivity for mule deer across SH 9. In each year of the study, mule deer activity was highest during the winter months, corresponding with deer presence on winter range; however, some deer remained in the study area throughout the year. Among each of the crossing structure locations, mule deer activity varied substantially and patterns in crossing structure use also varied relative to the previous winter. Overall, mule deer use of wildlife crossing structures ranged from an average of 5 to 36.9 mule deer success movements per day in Winter 2017-18.



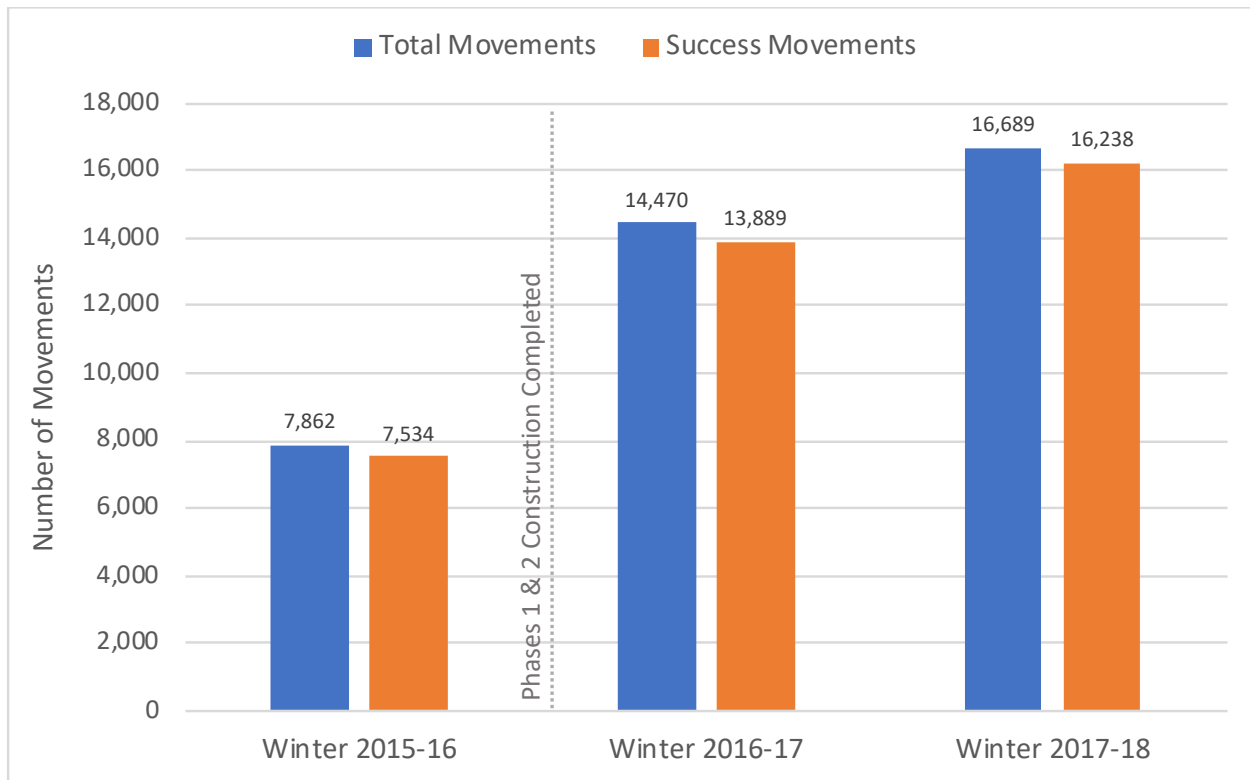


Figure E-1. Total number of mule deer movements and successful movements at crossing structures during each winter of the monitoring research study. In Winter 2015-16, only the north portion (Phase 1) of the project area was constructed and monitored.

Elk, white-tailed deer, moose, pronghorn, and bighorn sheep were also documented successfully using the wildlife crossing structures, although in much lower numbers than mule deer. Success movements by these species remained roughly consistent or increased from Year 2 to Year 3, with success rates ranging from 87% for moose ( $n=38$ ); 91% for elk ( $n=76$ ); 92% for white-tailed deer ( $n=39$ ); 98% for pronghorn ( $n=52$ ); and 100% for bighorn sheep ( $n=13$ ). In general, elk were recorded using underpass and overpass structures in the northern portions of the study area (from MP 131.6 – MP 136), with the highest level of elk success movements at the North Overpass (MP 134.3). The majority of elk success movements were by lone individuals or, in some cases, small groups of up to four animals. In addition to ungulates, success movements were made by other large and medium-sized mammals at all of the wildlife crossing structures, including black bear, mountain lion, coyote, red fox, bobcat, badger, hare, skunk and raccoon.

The researchers evaluated two different wildlife guard designs (round bar and flat bar), and found that round bar wildlife guards were, on average, more successful in deterring mule deer

from entering the fenced roadway (90% repel rate) than flat bar wildlife guards (78% repel rate). However, much of this difference may be attributed to plowed snow packed in-between the flat bars creating a surface for animals to walk across. In Winter 2017-18, no breaches occurred in this manner, possibly due to the low snow year or changes in plowing practices. From Year 2 to Year 3, the total number times mule deer attempted to breach the wildlife guards decreased by 30% and the number of successful breaches decreased 68% to a total of 23 breaches at all guard types. In Year 3, breach rates were nearly the same at both guard types (9% for round bar guards and 8% for flat bar guards), although the total number of breaches by ungulate species was higher at round bar guards ( $n=20$ ) than at flat bar guards ( $n=9$ ). Regardless of guard type, jumping the guard was the most common method of breaching a guard.

Researchers placed monitoring cameras on select escape ramps to evaluate the effects of ramp slope and the presence of perpendicular rail fencing placed to guide animals up a ramp on deer and elk use of escape ramps to exit the fenced right-of-way. Mule deer and elk escape rates off the escape ramps were comparatively low (13% for mule deer, 9% for elk) and results were mixed with respect to the two different slope designs and the presence of perpendicular rail fence. Escape ramps without perpendicular fences had higher intercept rates (61%) than ramps with perpendicular fencing (36%) but perpendicular fence did not have a discernable influence on the likelihood of deer or elk using the ramps to escape the right-of-way. At this point, there are great variations in usage rates at all ramp types and continued monitoring and analyses will help determine the most favorable designs.

Three wildlife-vehicle collision (WVC) datasets described a decreasing trend in WVC carcasses and accidents following the completion of mitigation construction in the SH 9 project area: Blue Valley Ranch/Colorado Parks and Wildlife (CPW) carcass reports; CDOT Maintenance carcass reports; and CDOT Traffic and Safety accident data. In Winter 2017-18, six mule deer and no elk carcasses were recorded in the Blue Valley Ranch/CPW carcass dataset, resulting in a decrease of 89% relative to the pre-construction 5-year average of 56.4 carcasses (Fig. E-2). This decrease was slightly greater than the 86% decrease reported the previous winter. No WVC carcasses were reported in the CDOT Maintenance carcass database in Winter 2017-18. Data from Winter 2017-18 were not available from CDOT Traffic and Safety at the time of this writing but, as of

Winter 2016-17, the number of reported WVC accidents dropped 100% from a pre-construction winter average of 10.2, and just one WVC accident was reported for the entire study period. These results support the assertion that wildlife crossing structures and other mitigation features have been effective in reducing WVC along SH 9, while also providing wildlife connectivity across the highway.

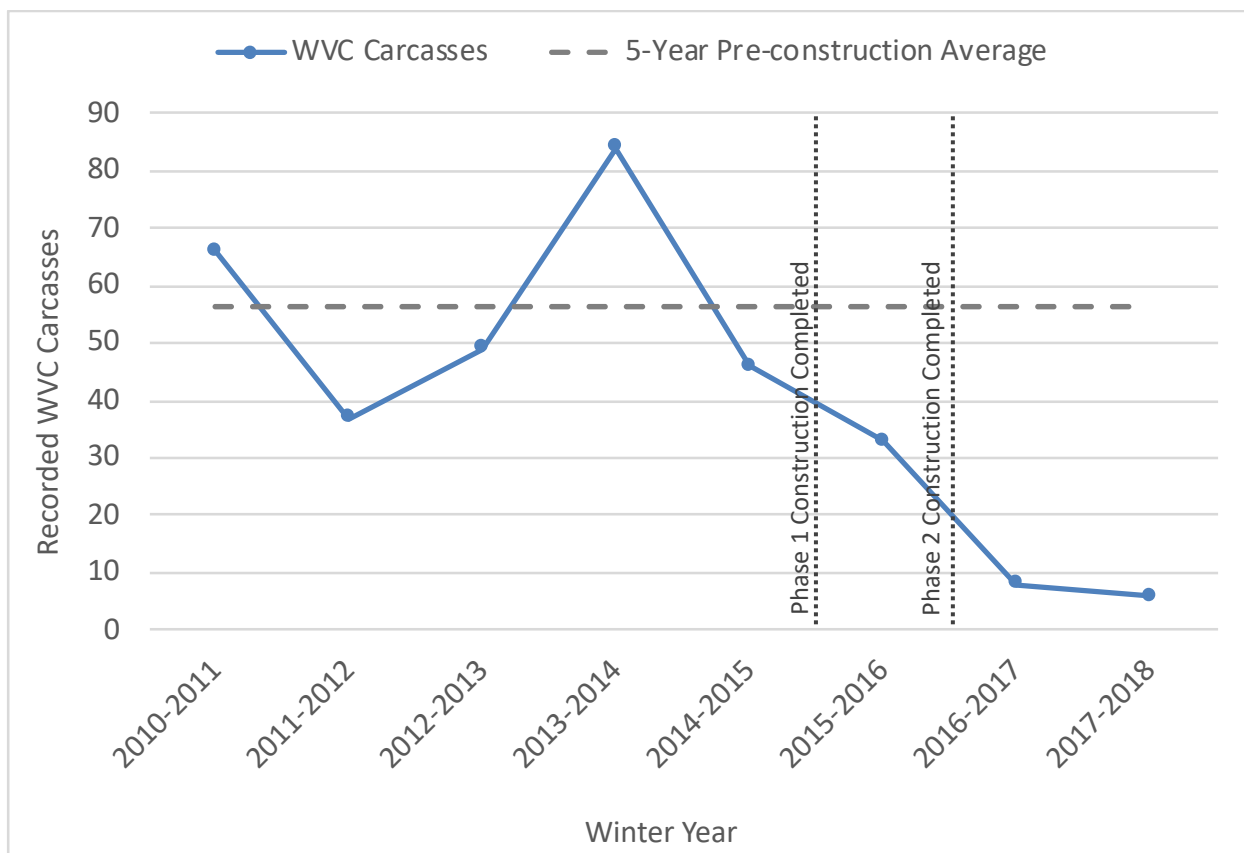


Figure E-2. Mule deer and elk carcass counts recorded by BVR and CPW compared to the five-year pre-construction average of 56.4 carcasses per year.

The results from the first three years of monitoring on SH 9 are promising and several performance measures for the mitigation project regarding mule deer use of crossing structures have already been achieved. Other objectives, for example, regarding elk use of crossing structures or ungulate use of escape ramps, have not yet been achieved, but will continue to be monitored and evaluated. The study will continue to evaluate and report on all of these features through Winter 2019-20, and the researchers will continue to work with CDOT and CPW to adaptively manage the structures, fencing, wildlife guards and escape ramps and to use these results to inform future wildlife-highway mitigation projects.

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## Introduction

The State Highway 9 (SH 9) Colorado River South Wildlife & Safety Improvement Project installed seven large wildlife crossing structures and 10.4 miles of wildlife exclusion fence between Kremmling and Green Mountain Reservoir in Grand County, Colorado. The project was designed to improve driver safety while providing permeability for wildlife. The highway runs north-south through the lower Blue valley, a broad sagebrush ecosystem between the Gore Range to the west and the Williams Fork Mountains to the east. The Blue River also runs from south to north through the valley, west of the highway, to its confluence with the Colorado River.

The lower Blue River valley supports a high concentration of mule deer (*Odocoileus hemionus*) and American elk (*Cervus canadensis*) during the winter months as wildlife settle onto their winter range. Resident mule deer and elk herds also inhabit the valley throughout the year. Other species include moose (*Alces alces*), pronghorn (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*) American black bear (*Ursus americanus*), bobcat (*Lynx rufus*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), and mountain lion (*Puma concolor*). Some animals make daily movements across SH 9, where the highway bisects an individual's range, while other animals may make more infrequent movements. These concentrations of wildlife have resulted in numerous wildlife-vehicle collisions (WVC), particularly during the winter months.

During the five winters (December through April) prior to the onset of project construction in 2015, reported WVC crashes were the most common accident type on this segment of highway, accounting for 60% of all accidents reported to law enforcement personnel. During this timeframe, 50 WVC accidents with mule deer or elk were reported, 4% of which resulted in injuries to humans. However, accident reports underestimated the full extent of the conflict between traffic and wildlife on SH 9. More comprehensive winter carcass counts conducted by Blue Valley Ranch during this same timespan recorded 282 WVC mule deer and elk carcasses, more than triple the number of reported accidents.

The goal of this mitigation project was to reduce vehicle conflicts with wildlife while providing permeability for animals to move safely through passages below or over the highway. To meet

these objectives, two wildlife overpasses and five arch underpasses and 10.4 miles of 8-foot high wildlife fencing on both sides of the highway were constructed in two construction phases. Other mitigation features include wildlife guards installed at all road intersections and private driveways; wildlife escape ramps; and pedestrian walk-through gates to provide a pathway for people through the wildlife fence. The project includes drainage culverts, including several medium-sized culverts (8' box or pipe culverts) that are integrated into the fencing and may provide passage for small or medium-sized fauna. This project is the culmination of a comprehensive and collaborative effort by the Colorado Department of Transportation (CDOT), Colorado Parks and Wildlife (CPW), and the privately-owned Blue Valley Ranch (BVR), as well as many other public and private partners. CDOT and CPW are supporting this research study to evaluate how well the wildlife mitigation achieves these goals.

This research study uses motion-triggered cameras to monitor wildlife activity at wildlife crossing structures, wildlife escape ramps, wildlife guards, pedestrian walk-through gates and the southern terminus of the wildlife exclusion fence to evaluate the wildlife mitigation with several performance measures. Cameras were deployed to correspond with the two project construction phases. Phase 1 construction was in the northern portion of the project area (milepost [MP] 131 – 137) and was completed in November 2015. Mitigation features in this phase included one wildlife overpass, three underpasses, six miles of continuous 8-foot high wildlife exclusion fencing on both sides of the highway, 34 escape ramps, 12 wildlife guards and 2 pedestrian walk-through gates. Phase 2, completed November 2016, was in the southern portion of the project area (MP 126 – 131), and included a second overpass, two wildlife underpasses, continued wildlife exclusion fencing through the project area, and an additional 27 escape ramps, 17 wildlife guards and 5 pedestrian walk-through gates.

In addition to camera monitoring, this research study analyzes WVC rates in each phase of the project area, using three long-term datasets. Long-term datasets offer a pre-construction baseline to which post-construction WVC rates may be compared.

This progress report focuses on post-construction monitoring from its onset at the completion of the Phase 1 segment (December 2015) through April 2018.

## Research Objectives

The following research objectives were established by the Study Panel for the five-year research study:

1. Determine to what extent the wildlife and safety mitigation measures reduce WVC.
2. Determine the level of effectiveness of wildlife overpasses and underpasses in allowing wildlife, primarily ungulates, to move underneath or above the highway.
3. Determine the ability of animals that breach the fenced right-of-way to use escape ramps to exit the fenced road area.
4. Determine if the fence end, pedestrian walk-through gate and wildlife guard designs are effective at deterring wildlife (ungulates primarily) from entering the fenced road area.
5. If utilization rates differ among the crossing structures, determine why.
6. Determine if any of the wildlife mitigation features appear to need modification to improve effectiveness.
7. Determine correlation of historic ungulate crossing patterns pre-completion to utilization of post-construction crossing patterns.
8. Compare pre-completion crossing rates to post-construction over/underpass crossing rates.



## Methods

Mitigation effectiveness was measured with two general types of measures: the number of movements made by mule deer, elk and other wildlife through the crossing structures and success vs. repel rates for each species; and the reduction in WVC. Complete camera monitoring, photo analysis and WVC data analysis methods and performance measures are presented in [Appendix A](#).

Pre-construction monitoring was conducted using motion triggered cameras at all crossing structure locations from November 2014 to the onset of mitigation construction in March 2015 by CPW. At each planned structure location, a camera was set up in the natural areas on either side of the highway to document wildlife presence. Additional pre-construction monitoring was conducted by the research team in the Phase 2 segment through Winter 2015-16. The results of pre-construction camera monitoring were presented in the Year 2 Progress Report and are available in [Appendix B](#). Post-construction monitoring commenced in December 2015 in the Phase 1 segment and in December 2016 in the Phase 2 segment and will continue through Winter 2019-20. Post-construction monitoring involved the deployment of 62 cameras at 49 locations, including 40 locations that were monitored in Year 3.

Definitions of the indices calculated for each monitoring location are defined as follows:

- **Total movements** – the sum of all success movements, repel movements, and parallel movements by a species at a given location.
- **Success rate** – For each species at a given crossing structure location, the total number of individual movements of the species that were recorded moving through the structure divided by the total movements by that species.
- **Repel rate** – For each species at a given crossing structure location, the total number of individual movements of the species that were recorded being repelled at a structure divided by the total movements by that species. Repel rate was also calculated for deer and elk at small culverts, wildlife guards and fence ends.
- **Parallel rate** – For each species at a given monitoring location, the total number of individual movements of the species that were recorded moving parallel to the mitigation

feature divided by the total movements by that species. This metric is calculated for crossing structures small culverts and escape ramps.

- **Intercept rate** – This metric is calculated for deer and elk at escape ramps. It is the total number of times deer/elk were recorded ascending an escape ramp divided by the number of times deer/elk approached an escape ramp.
- **Escape rate** – This metric is calculated for deer and elk at escape ramps. It is the total number of times deer/elk were recorded successfully jumping down from an escape ramp divided by the number of times cameras captured deer/elk ascending the escape ramp.
- **Breach rate** – This metric is calculated for deer and elk at wildlife guards, escape ramps, pedestrian walk-through gates, and fence ends. It is the total number of times individual deer/elk breached the mitigation feature divided by the total number of times deer/elk approached that mitigation feature. For example, at a wildlife guard, breaches occur when animals cross over the guard; at escape ramps, breaches occur when animals jump up onto an escape ramp from the habitat side of the wildlife exclusion fencing; at a pedestrian walk-through gate, breaches occur when animals pass through the gate; at the fence end, breaches occur when animals enter into the fenced right-of way from beyond the fence end.
- **Average deer per day** – The total number of unique deer movements (not individuals) observed at the structure divided by the sampling effort. Sampling effort is calculated as the number of days a camera was in operation (or the average number of days for locations with two cameras) and is useful for standardizing the number of mule deer photographed when there is variation in the number of days that cameras were in operation at different monitoring locations. Deer per day may also be calculated for wildlife guards.
- **Average mule deer success movements per day** – The total number of times deer successfully used a structure divided by sampling effort.

Monitoring locations are listed in Table 1; Figures 1 & 2 depict the locations of all monitoring sites across the study area. At various points during this research, monitoring cameras were moved to new locations to capture different mitigation features using a limited number of cameras.

**Table 1.** Monitoring Locations. Monitoring periods are defined as: Year 1 (December 2015 – April 2016); Year 2 (May 2016 – April 2017); Year 3 (May 2017 – April 2018). Highlighted gray rows were not monitored in Year 3.

MP	LOCATION NAME	MITIGATION TYPE	SPECIFICATIONS	MONITORING PERIODS	NOTES
<b>PHASE 1 SEGMENT – CONSTRUCTED SUMMER/FALL 2015</b>					
137.0	Colorado River Bridge	Bridge Underpass	Existing bridge	Year 3	-
136.9	County Road 33 Wildlife Guard	Wildlife Guard	Flat bar	Years 1-3	-
136.9	Thompson Wildlife Guard	Wildlife Guard	Round bar	Years 1-3	Replaced with round bar July 2016
136.8	Thompson Escape Ramp	Escape Ramp	2:1 slope with rail fence	Year 1	-
136.6	Trough Road Wildlife Guard	Wildlife Guard	Flat bar	Years 1-3	-
136.6	Trough Road 3:1 Escape Ramp	Escape Ramp	3:1 slope without fence	Years 2 & 3	Constructed Summer 2016
136.6	Trough Road 2:1 Escape Ramp	Escape Ramp	2:1 slope with rail fence	Years 2 & 3	-
136.0	North Underpass	Arch Underpass	44'W x 14'H x 66'L	Years 1-3	-
136.0	North Underpass Habitat	Adjacent Habitat	Habitat camera	Years 1-3	-
135.9	SWA Escape Ramp	Escape Ramp	2:1 slope with rail fence	Year 1	-
135.6	SWA Pedestrian Gate	Pedestrian Gate	n/a	Years 1 & 2	Gated Fall 2017
135.1	Culbreath 2:1 Escape Ramp	Escape Ramp	2:1 slope with rail fence	Years 2 & 3	-
135.1	Culbreath 3:1 Escape Ramp	Escape Ramp	3:1 slope without fence	Years 2 & 3	Constructed Summer 2016
135.1	Culbreath Concrete Box Culvert	Small Culvert	8'W x 8'H x 100'L	Years 2 & 3	-
135.1	Culbreath Wildlife Guard	Wildlife Guard	Round bar	Years 2 & 3	Replaced with round bar July 2016
134.5	Rusty Spur Wildlife Guard	Wildlife Guard	Flat bar	Year 1	Location gated Summer 2016
134.3	Overpass Escape Ramp	Escape Ramp	2:1 slope without fence	Years 1-3	-
134.3	North Overpass	Overpass	100'W x 66'L	Years 1-3	70' wide fence opening
134.3	North Overpass Habitat East	Adjacent Habitat	Habitat camera	Years 1-3	-
134.3	North Overpass Habitat West	Adjacent Habitat	Habitat camera	Years 1-3	-
134.2	BVR Concrete Pipe Culvert	Small Culvert	8' diameter x 193'L	Year 1	Plus 23'L concrete trough
133.8	BVR Concrete Box Culvert	Small Culvert	8'W x 6'H X 130'L	Years 2 & 3	Plus 30'L concrete trough
132.5	Middle Underpass	Arch Structure	44'W x 14'H x 66'L	Years 1-3	-

MP	LOCATION NAME	MITIGATION TYPE	SPECIFICATIONS	MONITORING PERIODS	NOTES
132.5	Middle Underpass Habitat	Adjacent Habitat	Habitat camera	Years 1-3	-
132.4	BLM Pedestrian Gate	Pedestrian Gate	n/a	Years 1 & 2	Gated Fall 2017
131.6	Harsha Gulch Wildlife Guard	Wildlife Guard	Flat bar	Year 1	-
131.6	Harsha Gulch Underpass	Arch Underpass	44'W x 14'H x 66'L	Years 1-3	-
131.6	Harsha Gulch Habitat	Adjacent Habitat	Habitat camera	Years 1-3	-
131.6	Harsha Jumpdown Escape Ramp	Escape Ramp	Jumpdown w/o fence	Year 3	Ramp graded into natural downslope
131.2	Harsha Escape Ramp	Escape Ramp	2:1 slope with fence	Year 1	-
131.0	Phase 1 Temporary Fence End	Fence End	20' clear zone	Year 1	Temporary location
<b>PHASE 2 SEGMENT – CONSTRUCTED SUMMER/FALL 2016</b>					
130.8	BVA Underpass	Arch Underpass	44'W x 14'H x 66'L	Years 2-3	-
130.8	BVA Habitat	Adjacent Habitat	Habitat camera	Years 2-3	-
130.8	CR 1002 Wildlife Guard	Wildlife Guard	Round bar	Year 3	-
129.7	CR 1000 Wildlife Guard	Wildlife Guard	Flat bar	Year 3	-
129.5	South Overpass	Overpass	100'W x 66'L	Years 2-3	68.5' wide fence opening
129.5	South Overpass Habitat	Adjacent Habitat	Habitat camera	Years 2-3	-
129.1	Badger Road Escape Ramp	Escape Ramp	3:1 slope without fence	Years 2 & 3	-
129.0	Badger Road Wildlife Guard	Wildlife Guard	Round bar	Year 3	Half guard length fenced
128.5	Triangle Road Wildlife Guard	Wildlife Guard	Round bar	Years 2-3	-
128.5	Spring Creek Wildlife Guard	Wildlife Guard	Flat bar	Years 2-3	-
128.5	Spring Creek Escape Ramp	Escape Ramp	3:1 slope without fence	Years 2-3	-
128.4	South Spring Creek Escape Ramp	Escape Ramp	3:1 slope with rail fence	Years 2-3	-
128.0	Summit County Pedestrian Gate	Pedestrian Gate	n/a	Year 2	Gated Fall 2017
127.7	Williams Peak Underpass	Arch Underpass	44'W x 14'H x 66'L	Years 2-3	-
127.7	Williams Peak Habitat	Adjacent Habitat	Habitat camera	Years 2-3	-
126.7	East Fence End Escape Ramp	Escape Ramp	3:1 slope without fence	Years 2-3	-
126.6	West Fence End Escape Ramp	Escape Ramp	3:1 slope with rail fence	Years 2-3	-
126.6	South Fence End	Fence End	30' clear zone	Years 2-3	-

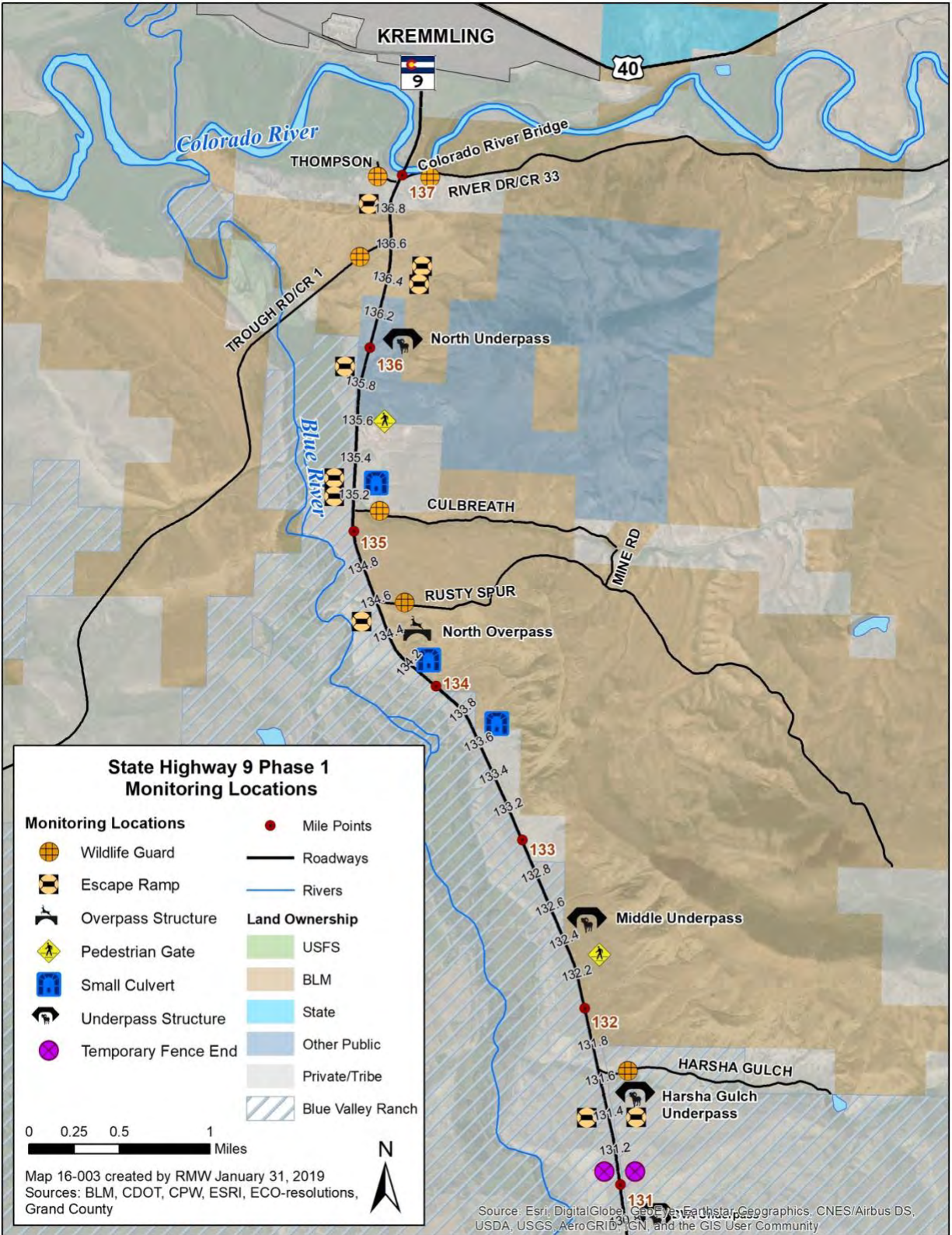


Figure 1. Phase 1 (north segment, MP 131 – 137) monitoring locations through April 2018.



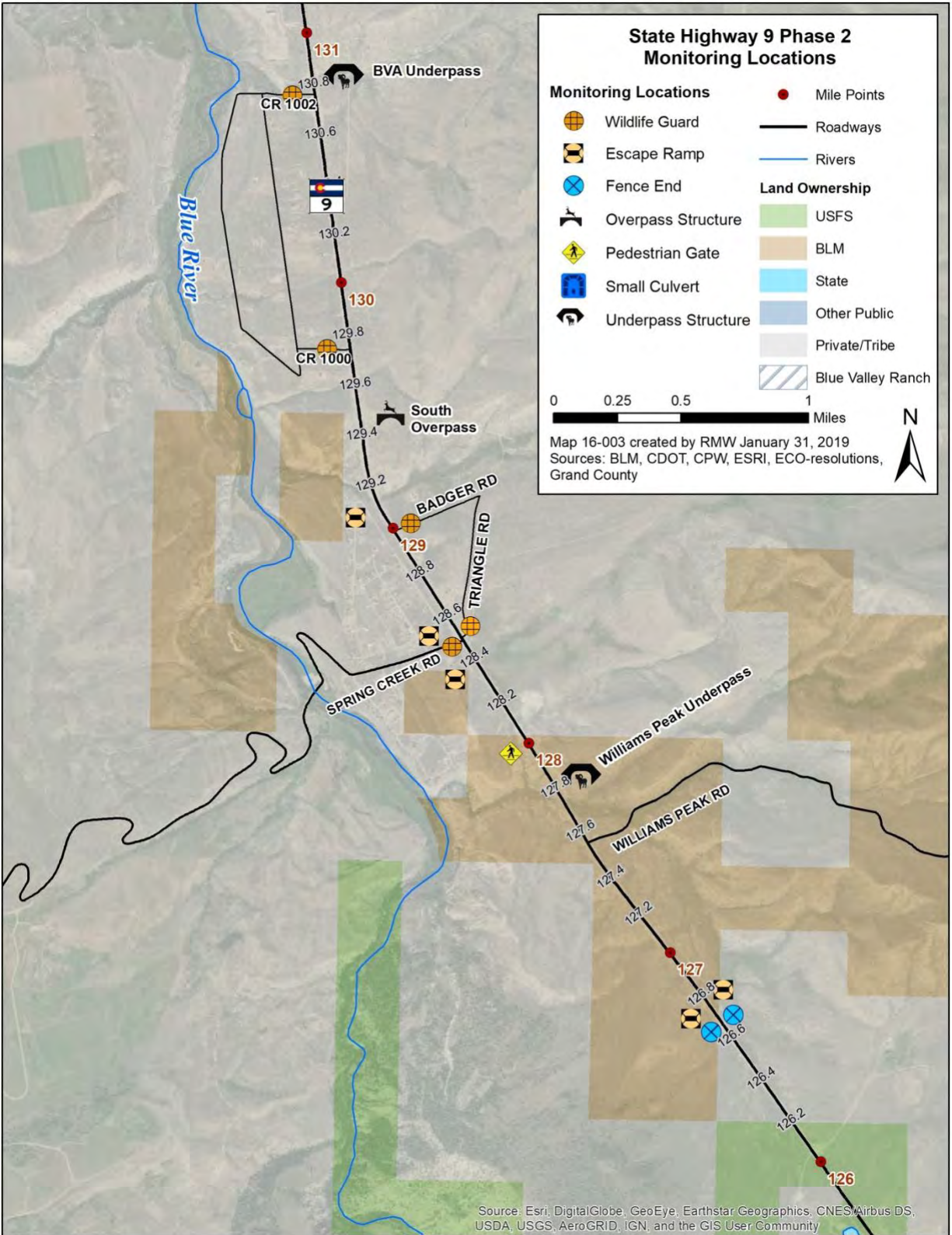


Figure 2. Phase 2 (south segment, MP 126 – 131) monitoring locations through April 2018.

## Results

### Post-Construction Monitoring

In Year 3, cameras were in operation for 226 days during the non-winter months of 2017 (April 19 – November 30) and 140 days during Winter 2017-18 (December 1 – April 19). Cameras were in operation for varying lengths of time depending on location. Battery depletions and equipment malfunctions also decreased the number of monitoring days at certain locations.

Since the start of this study in December 2015, monitoring cameras have recorded a total of 45,759 success movements by mule deer through or over the designated crossing structures. For the Year 3 reporting period, large and medium-bodied wildlife were recorded at crossing structures 24,707 times, including 23,808 success movements for an overall success rate of 96% for all structures combined. Mule deer account for the bulk of this activity, having made 23,691 individual movements at crossing structures, resulting in 22,863 success movements. From Winter 2016-17 to Winter 2017-18, the overall success rate for mule deer passage increased slightly from 96% to 97%, and the total number of mule deer success movements increased by 17%.

Mule deer activity was highest during the winter months, corresponding with deer arrival on winter range; however, some deer remained in the study area throughout the year. These resident deer made 6,441 success movements during the non-winter months of 2017 with an overall success rate of 95%. For this reporting period, elk were detected only during the non-winter months. Species such as black bear, moose, white-tailed deer, red fox and pronghorn were most commonly observed during non-winter months. Others, such as bighorn sheep, bobcat, coyote and moose were observed throughout the year. Mountain lions were most common during the winter months.

### Mule Deer Use of Wildlife Crossing Structures During Winter 2017-18

Mule deer activity and success movements through or over the crossing structures has increased each year of this research study since the completion of the Phase 1 construction in Winter 2015-16 (Fig. 3).

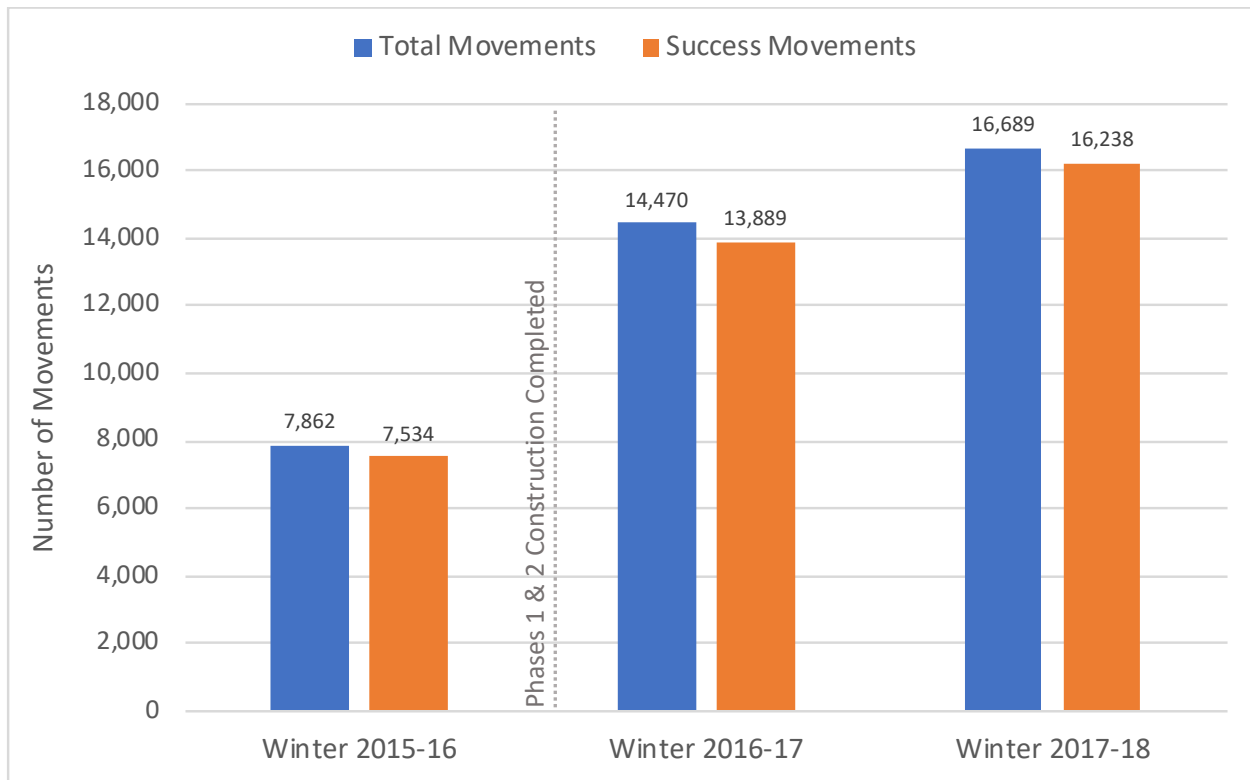


Figure 3. Total number of mule deer movements and successful movements at crossing structures during each winter of the monitoring research study. In Winter 2015-16, only the north portion (Phase 1) of the project area was constructed and monitored.

Table 2 summarizes mule deer activity at each of the crossing structures in Winter 2017-18 and compares changes in success movements to the previous winter. Across all structure locations success rates were 95% to 98%. The highest number of repels was observed at the BVA Underpass and the North Overpass, though the repel rate at each of these locations was only 1% and 2%, respectively. Repel rates decreased at the Williams Peak Underpass and the North Underpass from 10% in Winter 2016-17 to 4% and 3%, respectively, in Winter 2017-18.

As in the previous winter, mule deer activity varied substantially at each of the wildlife crossing structures during Winter 2017-18 (Fig. 4). While overall mule deer success movements at the crossing structures increased by 50%, several changes in the patterns of use at the crossing structures were observed. In Winter 2016-17, the North Overpass had the highest number of mule deer success movements of all the structures. In Winter 2017-18, the number of success movements at this location decreased by 36%; however, this location still had the third highest

number of mule deer success movements in Winter 2017-18. The greatest number of success movements occurred at the BVA Underpass. The Williams Peak Underpass remained the structure with the lowest number of mule deer movements, although success movements increased by 214% from the year prior.

**Table 2.** Mule deer movements at wildlife crossing structures during Winter 2017-18.

Monitoring Location	Total Move-ments	Success Move-ments	Change in Success Move-ments from Winter 2016-17	Average Deer per Winter day	Average Success per Winter Day	Success Rate	Repel Rate	Parallel Rate
<b>MP 127.7</b> Williams Peak Underpass	726	696	214%	5.2	5	96%	4%	<1%
<b>MP 129.5</b> South Overpass	2,972	2,919	19%	21.2	20.9	98%	1%	1%
<b>MP 130.8</b> BVA Underpass	5,246	5,145	30%	37.6	36.9	98%	1%	1%
<b>MP 131.6</b> Harsha Gulch Underpass	1,645	1,614	112%	11.8	11.5	98%	1.5%	<0.5%
<b>MP 132.5</b> Middle Underpass	2,102	2,026	37%	15	14.5	96%	2%	2%
<b>MP 134.3</b> North Overpass	2,870	2,760	-36%	20.5	19.7	96%	2%	2%
<b>MP 136.0</b> North Underpass	1,068	1,021	44%	7.6	7.3	96%	3%	1%
<b>MP 137.0</b> Colorado River Bridge	60	57	n/a*	0.4	0.4	95%	5%	0%

\*Camera failures at the Colorado River Bridge during Winter 2016-17 prevent this metric from being calculated.

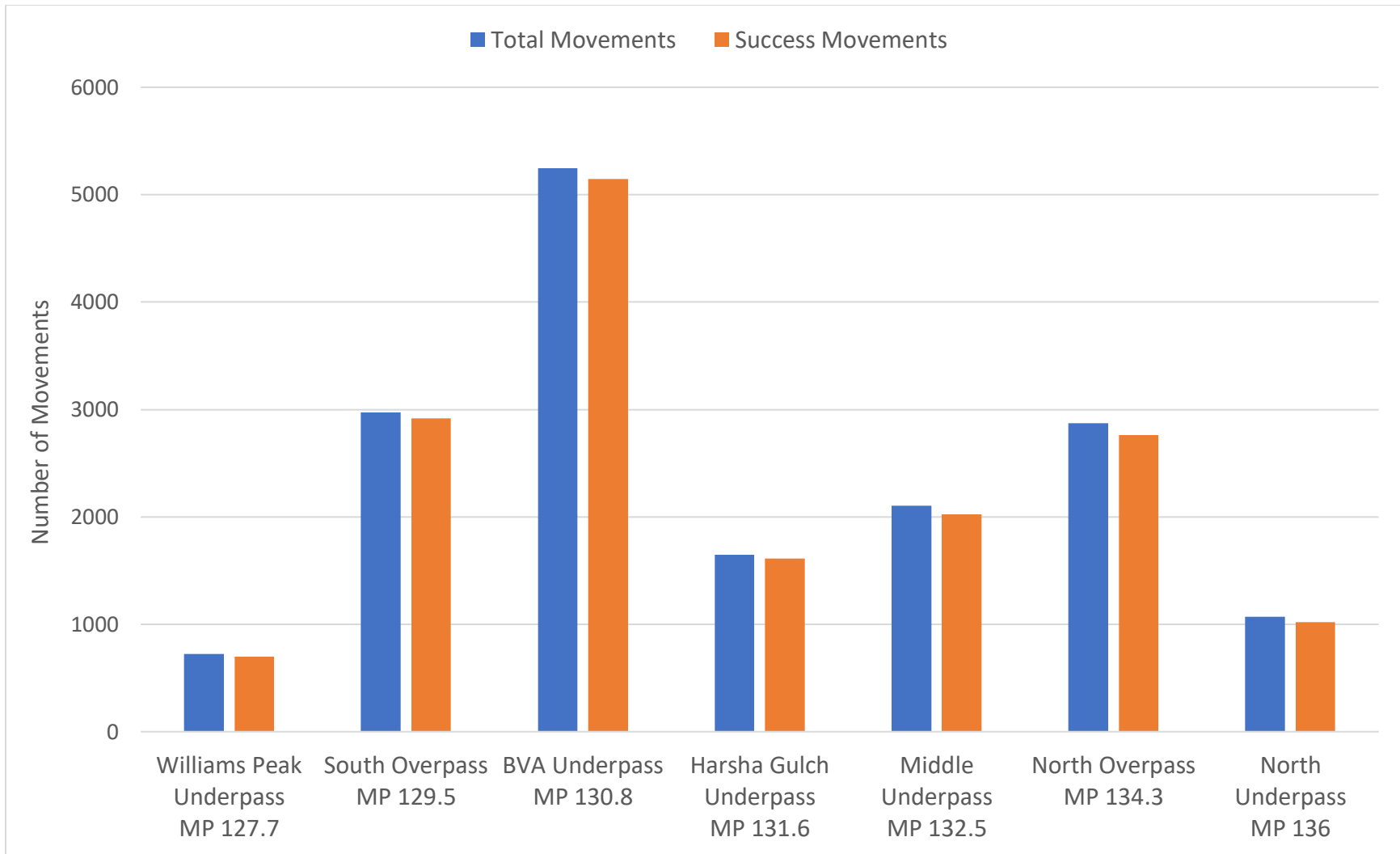


Figure 4. Total number of mule deer movements and success movements at each crossing structure location during Winter 2017-18.



Mule deer use of overpass structures versus underpass structures was compared between Winter 2017-18 and the previous winter (2016-17). Because there are two overpasses and five underpasses in the study area, the averages for the combined number of success movements at underpass structures versus the combined overpass structures was used to account for the unequal number of underpasses and overpasses. Overall in Winter 2017-18, 65% of all mule deer success movements occurred at the five underpasses and 35% at the two overpasses. However, when considered on a per unit basis, mule deer use of an overpass structure remained higher than underpass structures in Winter 2017-18, although not as high as in Winter 2016-17. Figure 5 depicts the average number of success movements across all crossing structure locations as a function of structure type (overpass versus underpass) during both post-construction winters. In Winter 2016-17, mule deer success movements were, on average, 138% higher at overpass structures than at underpass structures. In Winter 2017-18, mule deer success movements were, on average, 34% higher at overpass structures than at underpass structures.

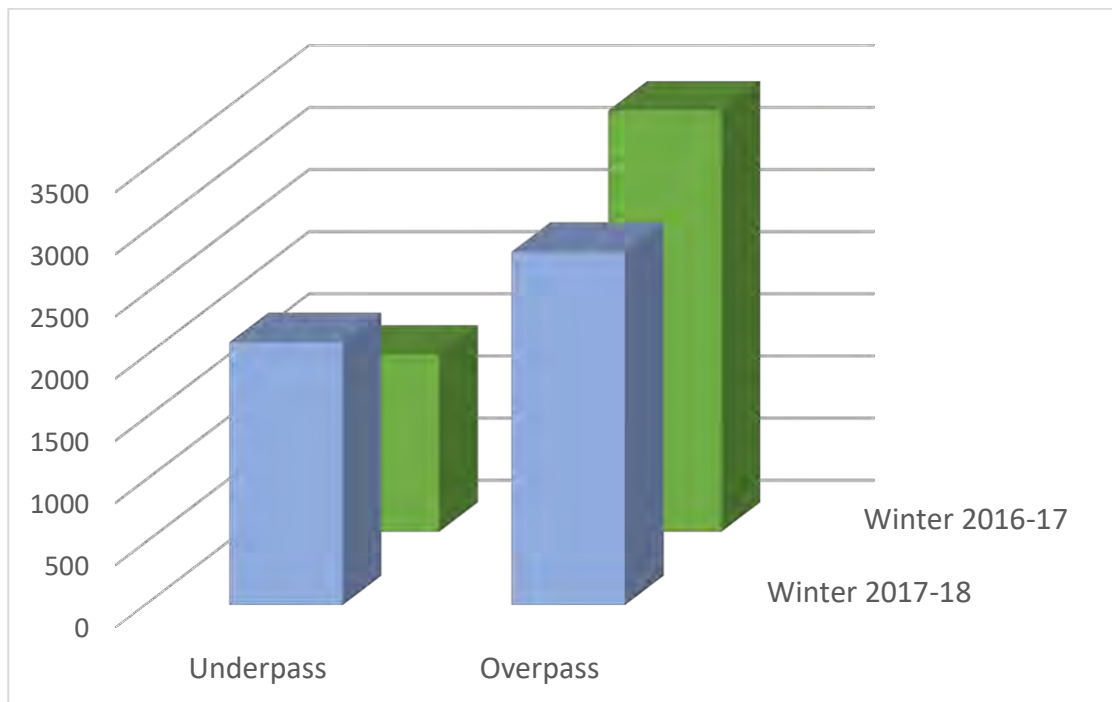


Figure 5. Average number of success movements by mule deer at overpass versus underpass structures during Winter 2016-17 and Winter 2017-18.

Movements through or over the crossing structures occurred in both directions, originating from the east and moving west, or originating from the west and moving east. During the winter months, east-to-west movements (51%) were nearly equal to west-to-east movements (49%). As the project area is located within winter range, many of the same animals are making regular movements through the structures to access the habitat and resources on either side. In general, the proportion of east-to-west movements increased during the fall migration and west-to-east movements increased during the spring migration. Movements during the summer months by resident animals occurred in both directions in roughly equal proportions.

Gender of mule deer was noted in photo analysis when possible. The numbers of males, females and fawns were recorded, although, in many cases, gender was undetermined, for example, in males who had shed their antlers or because of photo quality or animal position relative to the camera. Numbers and percentages for each gender of individual mule deer whose movements were detected are presented in Table 3. Across crossing structure locations, males represented 13% of the movements, females 41% and fawns 22%.

**Table 3.** Gender of mule deer whose movements were detected at wildlife crossing structures, Winter 2017-18.

Monitoring Location	% Male	% Female	% Fawns	% Unknown
Williams Peak Underpass	13%	31%	27%	29%
South Overpass	7%	26%	21%	45%
BVA Underpass	17%	53%	21%	9%
Harsha Gulch Underpass	24%	49%	21%	6%
Middle Underpass	19%	43%	19%	20%
North Overpass	4%	23%	26%	47%
North Underpass	11%	63%	16%	10%

#### Mule Deer Use of Wildlife Crossing Structures over Time

Figure 6 displays mule deer success movements at each of the crossing structures from the onset of the study in December 2015 through April 2018. Winter 2015-16 represents the first winter following construction of the Phase 1 (northern) segment of the project area. Monitoring in the Phase 2 (southern) segment began in late November and early December of 2016. Periods of

peak mule deer activity differed at each crossing structure location and varied from one year to the next. In general, mule deer numbers began decreasing in April as migratory herds moved to summer range and increased in October as these herds returned to winter range in the study area.

During Winter 2017-18, several locations had more than one peak in mule deer success movements. Mule deer activity peaked at several structures in January and, while there was a dip in activity in February at most structures, there was a peak in activity at the North Overpass during this timeframe. The highest number of mule deer success movements over all the years of the study were at the North and South Overpasses and the BVA Underpass, when compared to the other wildlife crossing structures.

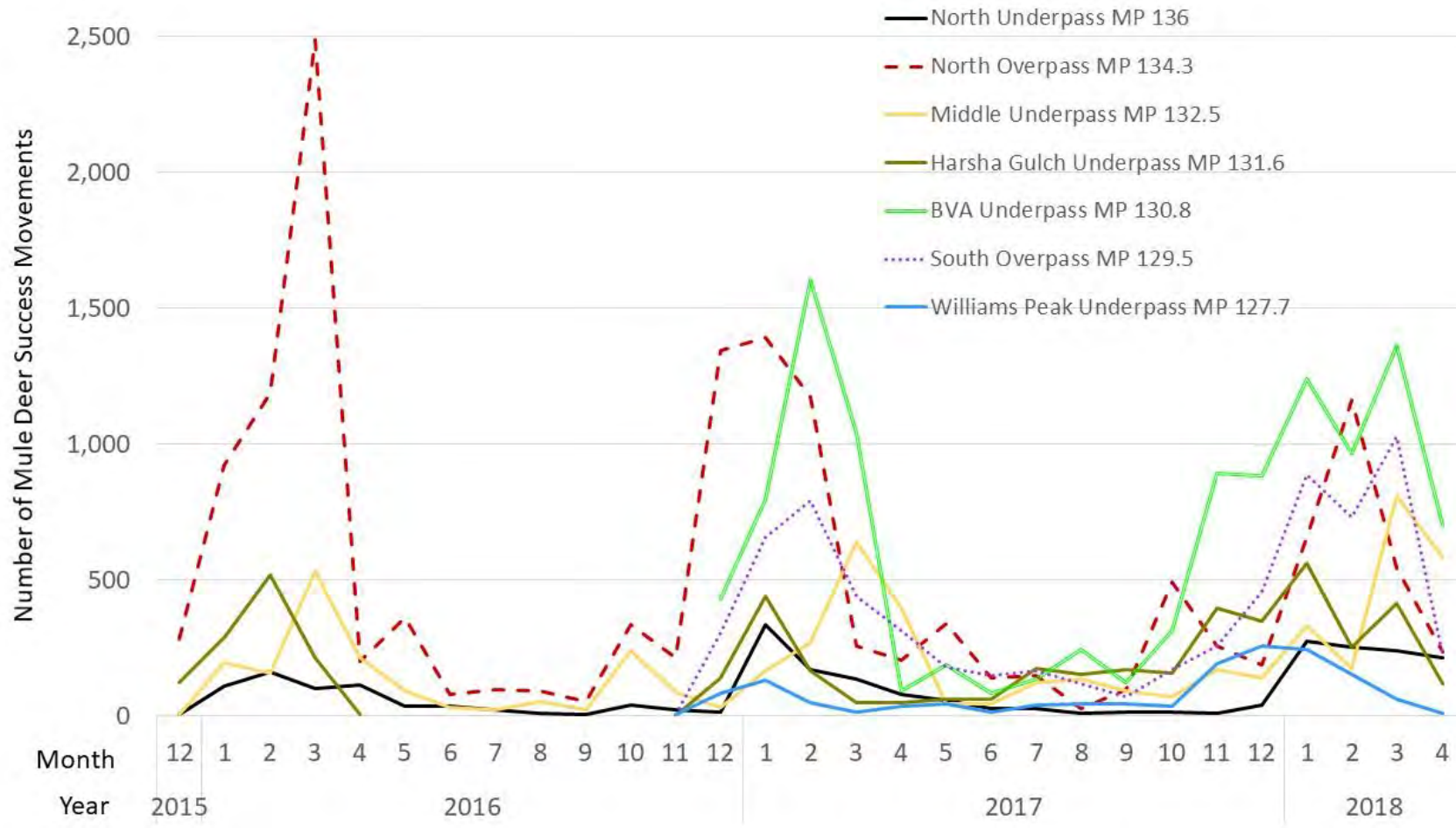


Figure 6. Mule deer success movements by month at each of the wildlife crossing structures from December 2015 through April 2018.

The following subsections describe the camera monitoring results at each crossing structure location. For each crossing structure, the total number of mule deer movements detected relative to mule deer success movements by month of the year is presented (note that the y-axis scale varies for each graph). For a given month, the closer the paired orange and blue bars are in height, the greater the success rate for that month. Mule deer activity was recorded at each structure every month of the year when cameras were active.

*Williams Peak Underpass, Milepost 127.7*

Figure 7 presents mule deer total movements and success movements by month at the Williams Peak Underpass. Winter movements increased at this structure from Year 2 to Year 3 of this research with the highest peak in Winter 2017-2018 occurring in December and January. Mule deer use continued through the summer months.

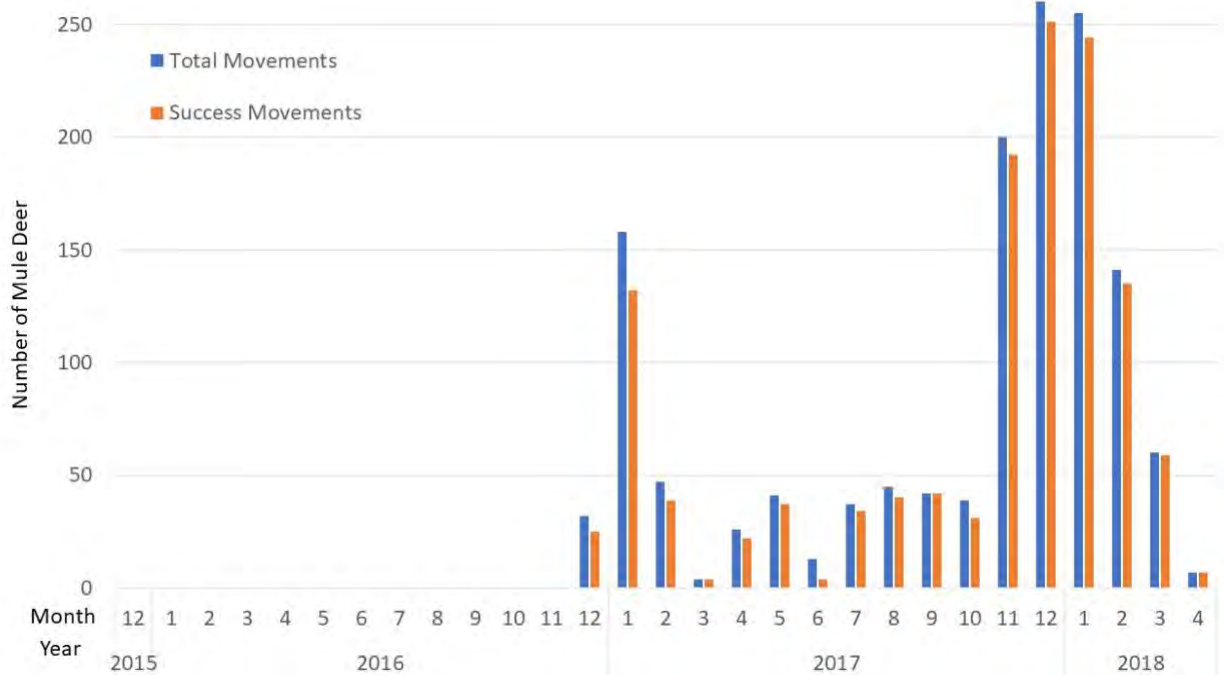


Figure 7. Mule deer total movements and success movements by months of the year at the Williams Peak Underpass (MP 136). Note y-axis scale is 0 – 250.



*South Overpass, Milepost 129.5*

Figure 8 presents mule deer total movements and success movements by month at the South Overpass. The peak in monthly movements in Year 2 was nearly as high as the peaks observed in Year 3; however, in Year 2 this peak occurred in February, while in Year 3, two peaks were observed in January and March, with a dip in activity in February. Mule deer use continued through the summer months.

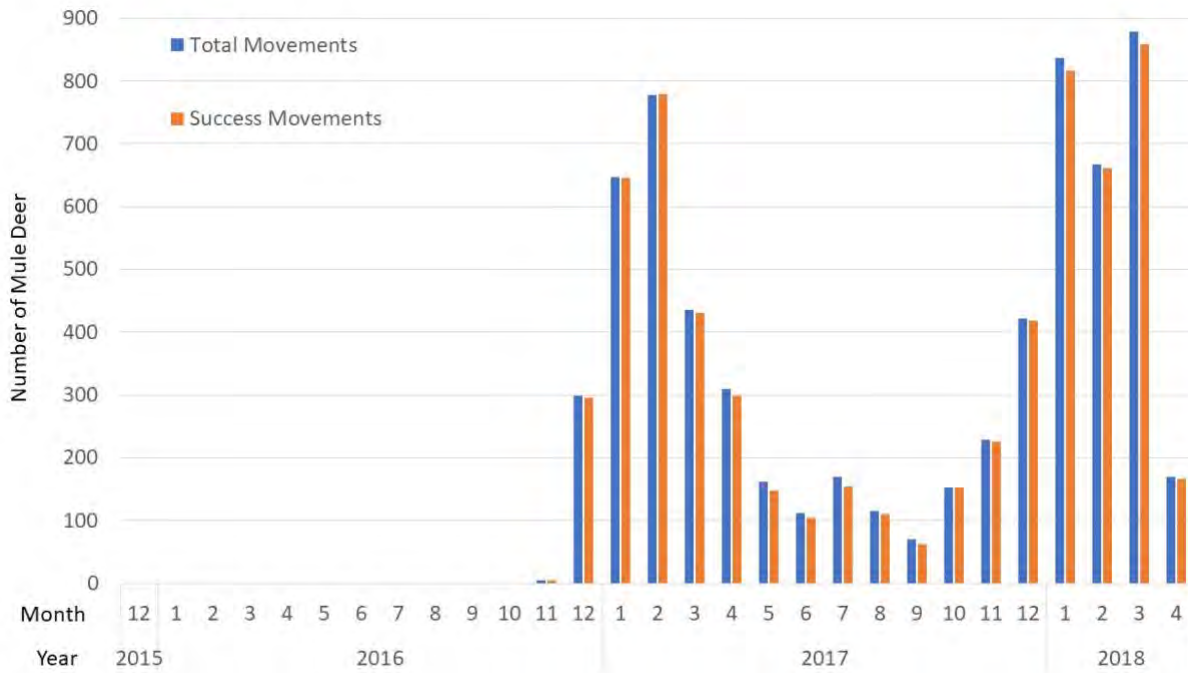


Figure 8. Mule deer total movements and success movements by months of the year at the South Overpass (MP 136). Note y-axis scale is 0 – 900.

*BVA Underpass, Milepost 130.8*

Figure 9 presents mule deer total movements and success movements by month at the BVA Underpass. The peak in monthly movements in Year 2 was higher than the peak in Year 3; however, in Year 2 there was a single peak in February, while in Year 3, two peaks were observed in January and March, with a dip in activity in February and overall activity was higher throughout the winter months. Figure 10 depicts a success movement at the BVA Underpass. Mule deer use continued through the summer months.

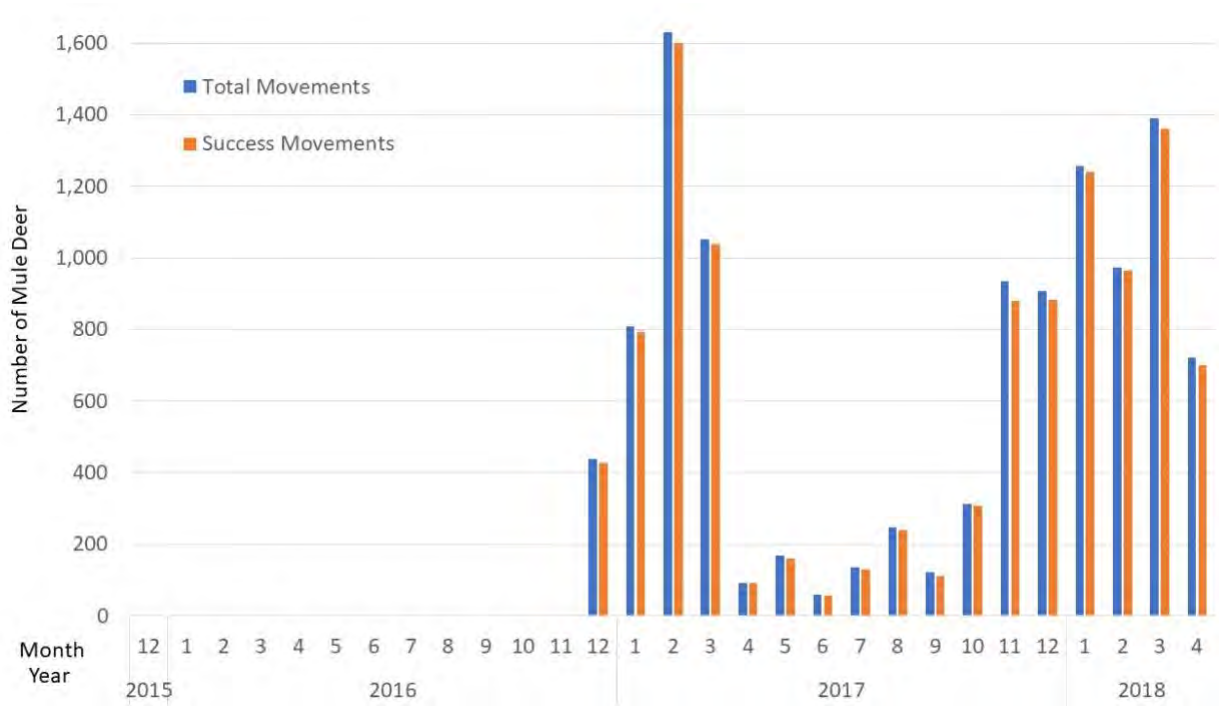


Figure 9. Mule deer total movements and success movements by months of the year at the BVA Underpass (MP 130.8). Note y-axis scale is 0 – 1,600.



Figure 10. Example of mule deer success movement at the BVA Underpass.

*Harsha Underpass, Milepost 131.6*

Figure 11 presents mule deer total movements and success movements by month at the Harsha Underpass. Winter movements increased each year at this structure with the highest activity recorded in January 2018. The lack of mule deer activity during the non-winter months of 2016 is attributed to ongoing construction activities at this location. In 2017, mule deer movements decreased from March through June and increased in July and again in November.

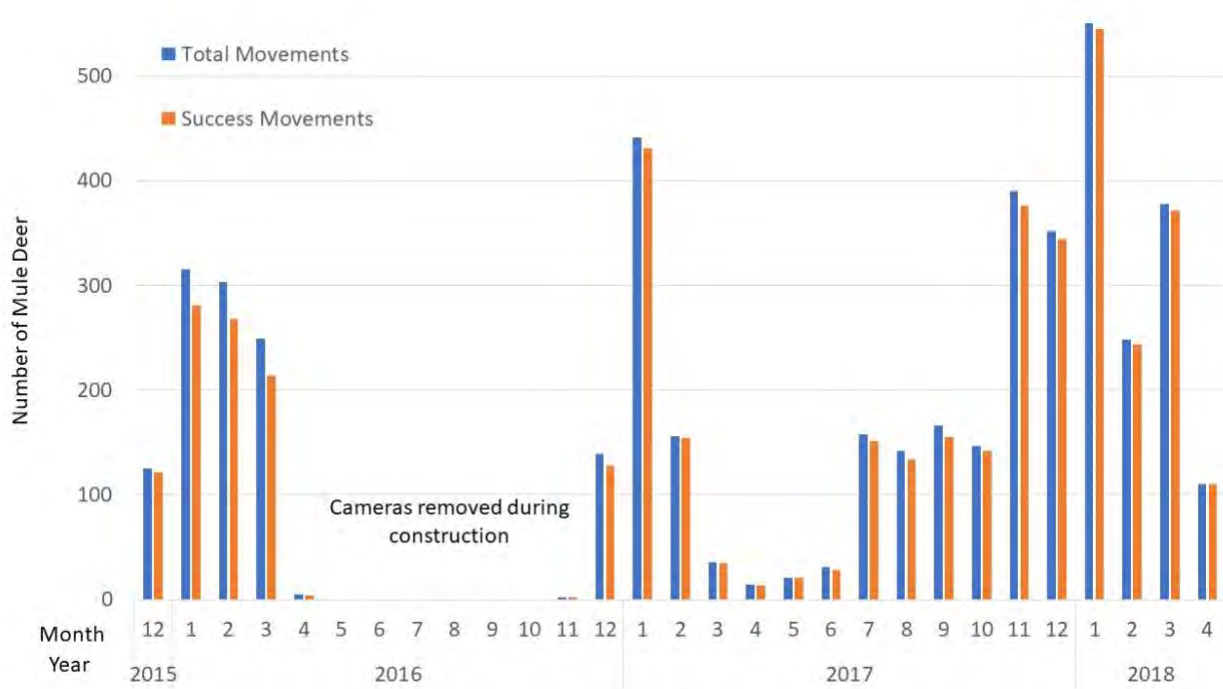


Figure 11. Mule deer total movements and success movements by months of the year at the Harsha Underpass (MP 131.6). Note y-axis scale is 0 – 500.

*Middle Underpass, Milepost 132.5*

Figure 12 presents mule deer total movements and success movements by month at the Middle Underpass. Winter movements increased each year at this structure with the highest activity recorded in March 2018. Mule deer use during the summer months was greater in 2017 than in 2016.

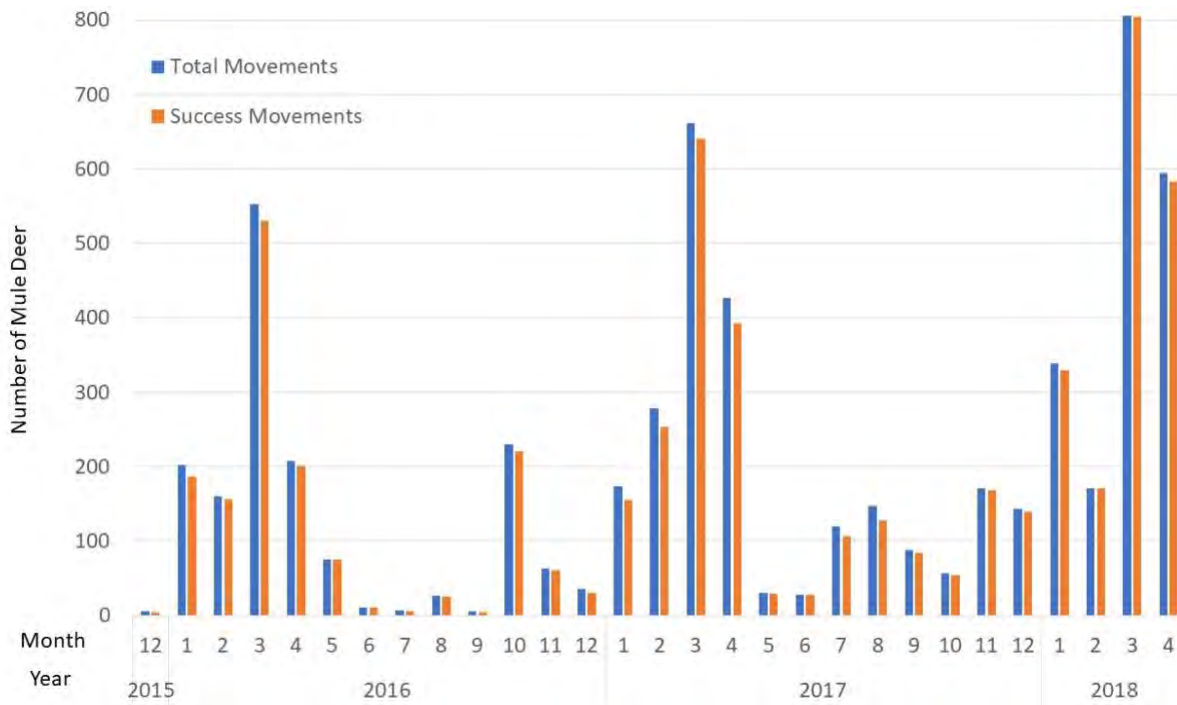


Figure 12. Mule deer total movements and success movements by months of the year at the Middle Underpass (MP 132.5). Note y-axis scale is 0 – 800.

*North Overpass, Milepost 134.3*

Figure 13 presents mule deer total movements and success movements by month at the North Overpass. This is the only location where mule deer activity decreased from Year 1 to Year 3. The highest peak in success movements occurred in March 2016. Wintertime peaks in activity in Years 2 and 3 were substantially lower, although overall activity at this structure remained high. Mule deer use continued through the summer months. Figure 14 depicts a mule deer success movement at the North Overpass.

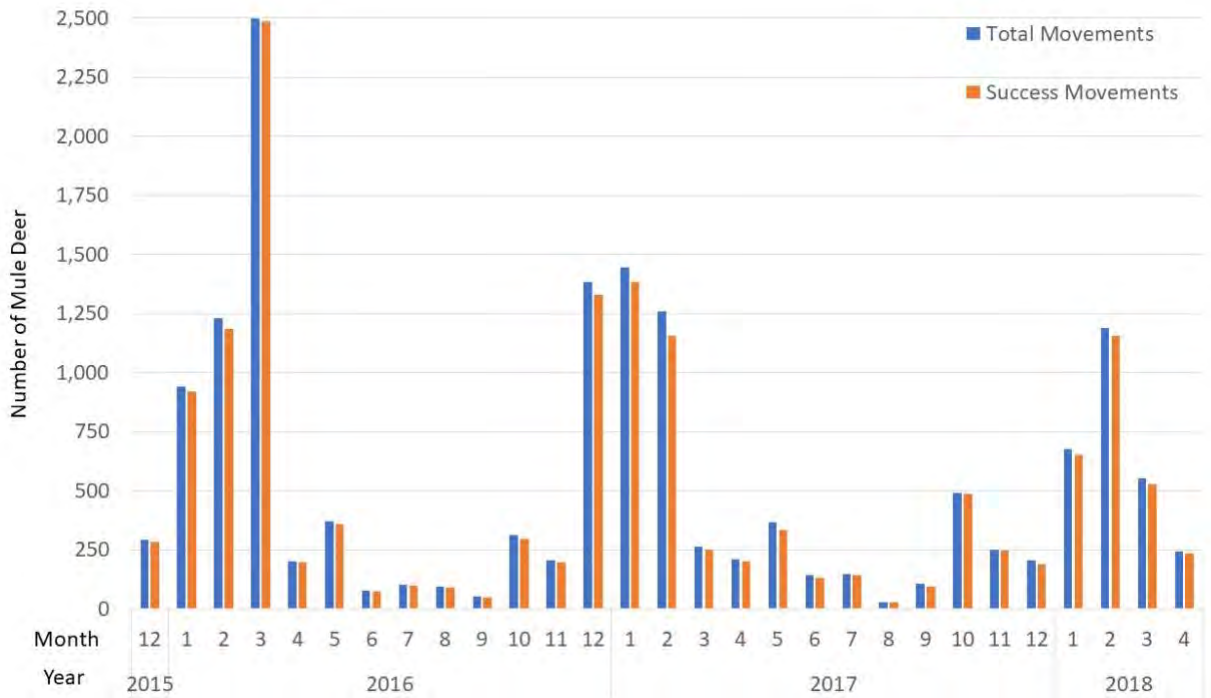


Figure 13. Mule deer total movements and success movements by months of the year at the North Overpass (MP 134.3). Note y-axis scale is 0 – 2,500.



Figure 14. Mule deer doe with two fawns crossing the North Overpass.



*North Underpass, Milepost 136.0*

Figure 15 presents mule deer total movements and success movements by month at the North Underpass. Mule deer success movements increased from Years 1 to 2 at this location and, while there was not a peak in activity as observed in Year 2, overall activity remained high throughout Winter 2017-18. Each year, mule deer movements sharply increased at this structure in January. Mule deer use of the structure continued during the summer months in low numbers.

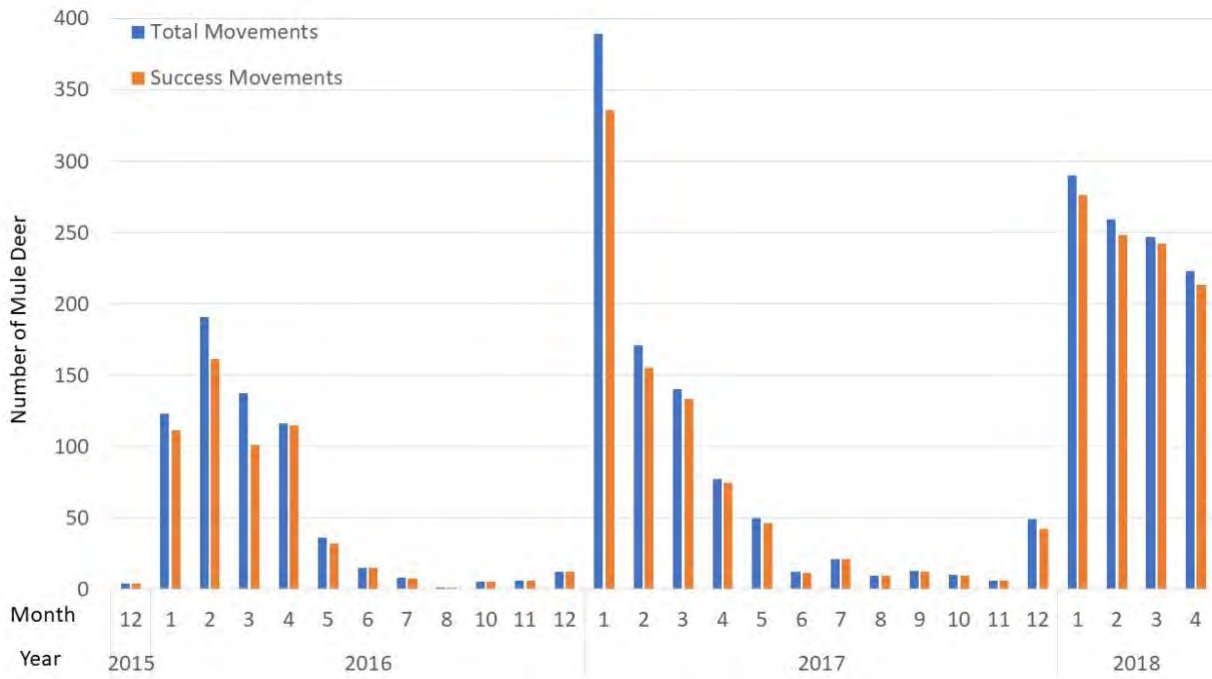


Figure 15. Mule deer total movements and success movements by months of the year at the North Underpass (MP 136). Note y-axis scale is 0 – 400.

## Other Species Use of Wildlife Crossing Structures

In addition to mule deer, a variety of other species were documented using the wildlife crossing structures. Table 4 lists the total number of success, repel and parallel movements for each species across all crossing structures and the corresponding success and repel rates for those species. Success rates for all species ranged from 81-100%.

**Table 4.** Movements by species other than mule deer at wildlife crossing structures, Years 1-3. Success, repel, and parallel movements are the total number of each movement across crossing structures. Success and repel rates are calculated for each species.

Species	Total Movements	Success Movements	Repel Movements	Parallel Movements	Success Rate	Repel Rate
Bighorn Sheep	13	13	0	0	100%	0%
Black Bear	140	139	1	0	99%	1%
Bobcat	85	75	6	4	88%	7%
Coyote	861	820	14	27	95%	2%
Elk	76	69	6	1	91%	8%
Fox, Red	200	161	9	30	81%	5%
Moose	38	33	3	2	87%	8%
Mountain Lion	69	68	1	0	99%	1%
Pronghorn	52	51	1	0	98%	2%
White-tailed Deer	39	36	2	1	92%	5%

Ungulate passage through and over the crossing structures for species other than mule deer remained roughly consistent or increased from Year 2 to Year 3. The number of success movements increased for bighorn sheep (from 2 to 11); moose (from 7 to 22); and pronghorn (from 9 to 42). For elk and white-tailed deer the number success movements decreased slightly between Years 2 and 3. While success rates are high for all of these ungulate species (87% or greater), the total number of movements for these species remains relatively low.

Elk passage continued to be highest at the North Overpass ( $n=12$ ) in Year 3. Elk success movements were observed at most crossing structures, with the exception of the BVA and Williams Peak Underpasses, the two southern-most underpasses in the study area (Fig. 16). Overall in Year 3, elk successfully used the overpasses and underpasses equally (15 each),

although more repels were documented at the underpasses (5) than at the overpasses (1). In contrast with years prior, in Year 3, all elk movements occurred during the non-winter months.

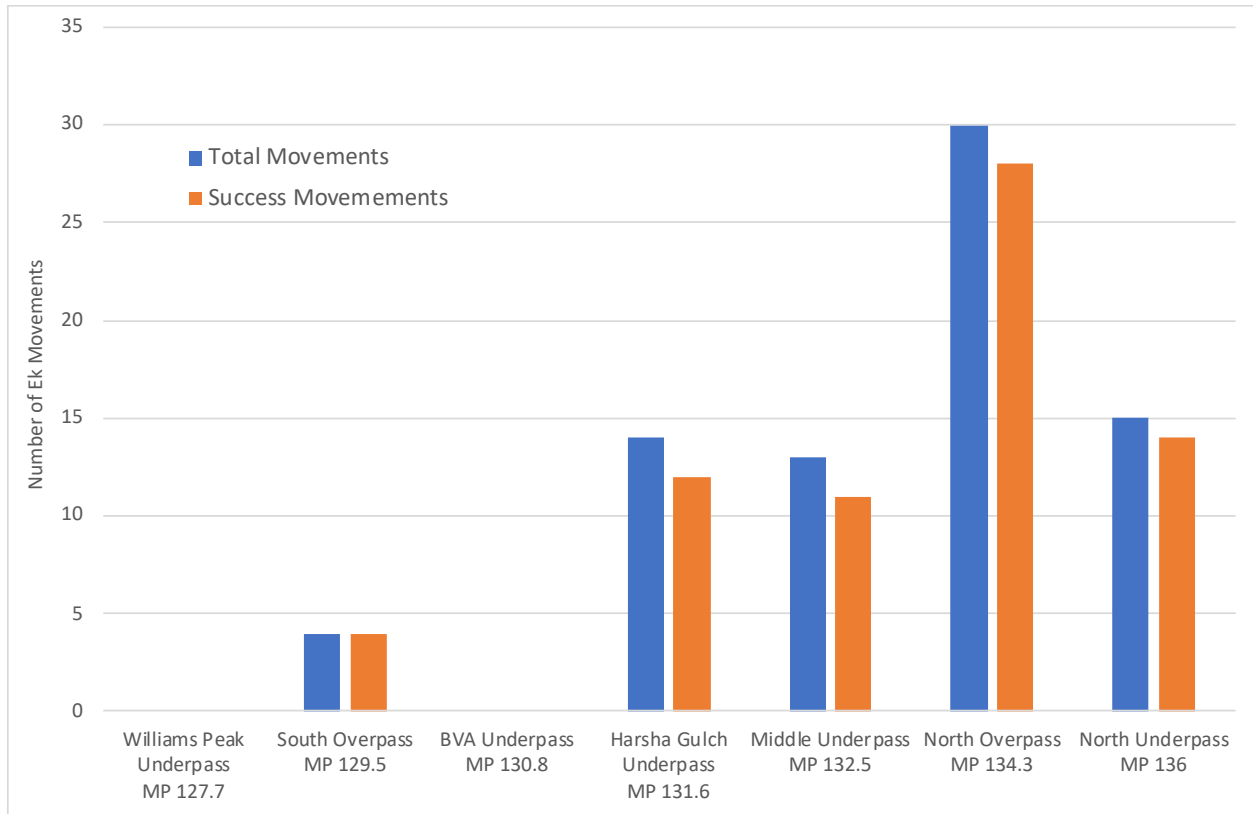


Figure 16. Elk total and success movements detected at wildlife crossing structures, Years 1-3.

Since the onset of this research, pronghorn and white-tailed deer have only been documented using the underpass structures. The majority of pronghorn success movements occurred at the BVA Underpass, while the majority of white-tailed deer success movements occurred at the North Underpass. Moose and bighorn sheep have made success movements at both underpasses and overpasses. The majority of bighorn sheep success movements occurred at crossing structures located in the southern portions of the project area, specifically, at the South Overpass and the Williams Peak Underpass. Of eight total success movements at the South Overpass, four of them were part of a single event by a family group (Fig. 17).

Success movements by a variety of other large and medium-sized mammals were also documented at each of the crossing structures (Fig. 18). Black bears were detected primarily during the warmer months, while mountain lions were primarily detected during the winter months. The other mammal species were detected year-round. Coyote and red fox were the only species other than mule deer documented using every crossing structure. Coyote activity increased markedly in Year 3 at both overpass and underpass structures, although the heaviest use occurred at the two overpasses. Red fox activity also increased in Year 3.



*Figure 17.* Bighorn sheep ewe, lamb, ram and yearling crossing the South Overpass.

Black bear have not crossed over either of the overpass structures to date and were observed primarily at the Middle Underpass. Other species documented at crossing structures include badger, bird, hare, raccoon, skunk and domestic animals (cats, dogs and cows).

Lower numbers of wildlife have been documented making successful passages under the Colorado River Bridge, including mule deer, moose, bobcat, red fox, mountain lion and white-tailed deer.

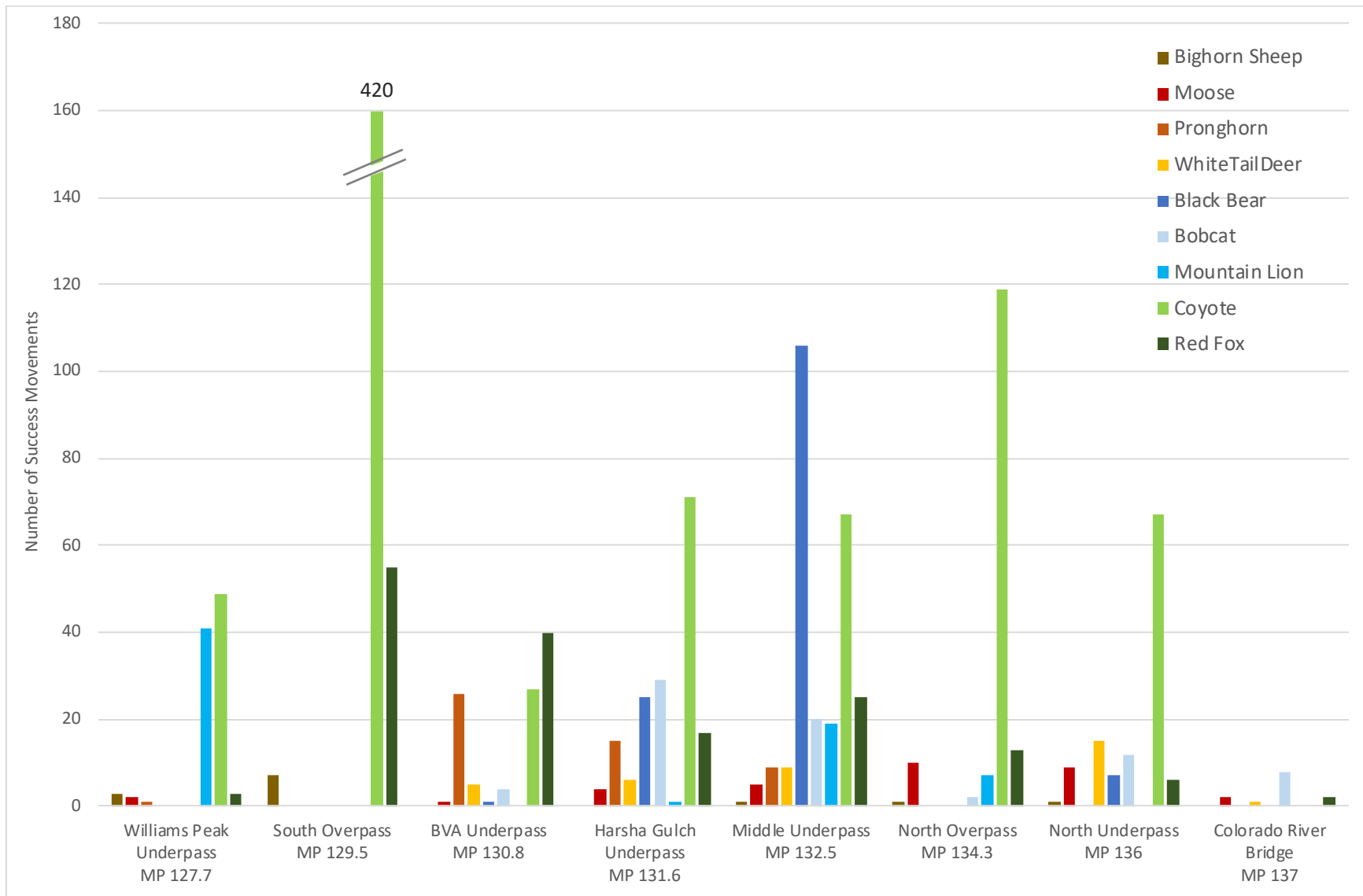


Figure 18. Success movements by medium and large-sized mammals other than mule deer and elk at each wildlife crossing structure from the onset of the study in December 2015 through April 2018.



Habitat cameras were placed approximately 100 feet away from the structure entrances facing outwards to capture wildlife movements in the adjacent habitat. Wildlife movements at habitat cameras relative to movements at crossing structures for species other than mule deer are reported in Table 5. In general, wildlife that were captured at habitat cameras were also captured at crossing structures, although species captured at both locations were not necessarily part of the



*Figure 19.* Mountain lion with 3 kittens approaching the Williams Peak Underpass.

same individual movement. Figure 19 depicts a mountain lion with three kittens approaching the habitat camera on the east side of the Williams Peak Underpass. In a few cases wildlife that were not captured at the habitat cameras were documented at the structure. However, these events occurred in low numbers and are expected as the habitat cameras are only able to capture a portion of the wildlife activity occurring in the vicinity of a structure.

Humans were recorded at each of the crossing structures; this does not include researchers conducting camera checks. Human activity was most common at the Harsha Gulch Underpass, where, during the winter months, humans were documented on average once every ten days in Winter 2017-18. During the first two years of the study some human activity may be attributed to ongoing construction and construction review activities, particularly during the non-winter months.

**Table 5.** Comparison of species presence (other than mule deer) at wildlife crossing structures and habitat camera locations adjacent to wildlife crossing structures, Years 1-3. Note that movements at structures is the sum of all success, repel and parallel movements. Presence at habitat cameras does not imply that animals were moving to or from a crossing structure.

Species	Monitoring Location	Williams Peak UP	South OP	BVA UP	Harsha UP	Middle UP	North OP	North UP
Bighorn Sheep	Structure	3	7	0	0	1	1	1
	Habitat	1	0	1	0	0	0	0
Black Bear	Structure	0	0	1	25	107	0	7
	Habitat	0	1	0	0	103	2	3
Bobcat	Structure	0	0	5	29	25	5	12
	Habitat	0	1	0	0	74	5	0
Coyote	Structure	52	440	28	74	70	123	74
	Habitat	45	117	19	5	326	325	9
Elk	Structure	0	4	0	12	13	30	15
	Habitat	0	20	7	4	9	103	31
Moose	Structure	2	0	1	4	7	11	10
	Habitat	2	1	1	4	7	2	6
Mountain Lion	Structure	41	0	0	1	19	7	0
	Habitat	21	1	0	0	2	2	0
Pronghorn	Structure	1	0	26	16	9	0	0
	Habitat	0	0	22	0	2	1	0
Red Fox	Structure	4	73	47	22	26	19	7
	Habitat	6	21	6	0	5	46	2
White-tailed Deer	Structure	0	0	5	7	9	0	17
	Habitat	0	0	0	0	18	2	5

UP = underpass

OP = overpass

#### Wildlife Movements at Small Culverts

The three small culverts were monitored for varying lengths of time. Monitoring at the BVR Pipe Culvert began at the onset of monitoring in December 2015 and continued into October 2016.

The Culbreath Box Culvert was monitored from October 2016 through April 2018 and the BVR Box Culvert from March 2017 through April 2018.

Wildlife activity at these small culvert locations occurred primarily during the non-winter months. Figure 20 displays success movements at each small culvert location. Mule deer were documented and made success movements at all three culverts, ranging from one through-

passage at the Culbreath Box Culvert to 17 at the BVR Box Culvert. However, less than a third of the mule deer that approached any of these small culverts successfully crossed through.

Black bear, bobcat and coyote were the most common species documented using the small culverts, with much of this activity occurring at the BVR Box Culvert. Domestic dogs and cats were most common at the Culbreath Box Culvert and may have deterred some wildlife activity at this location. Success movements at small culverts were also made by red fox, American badger and northern raccoon.

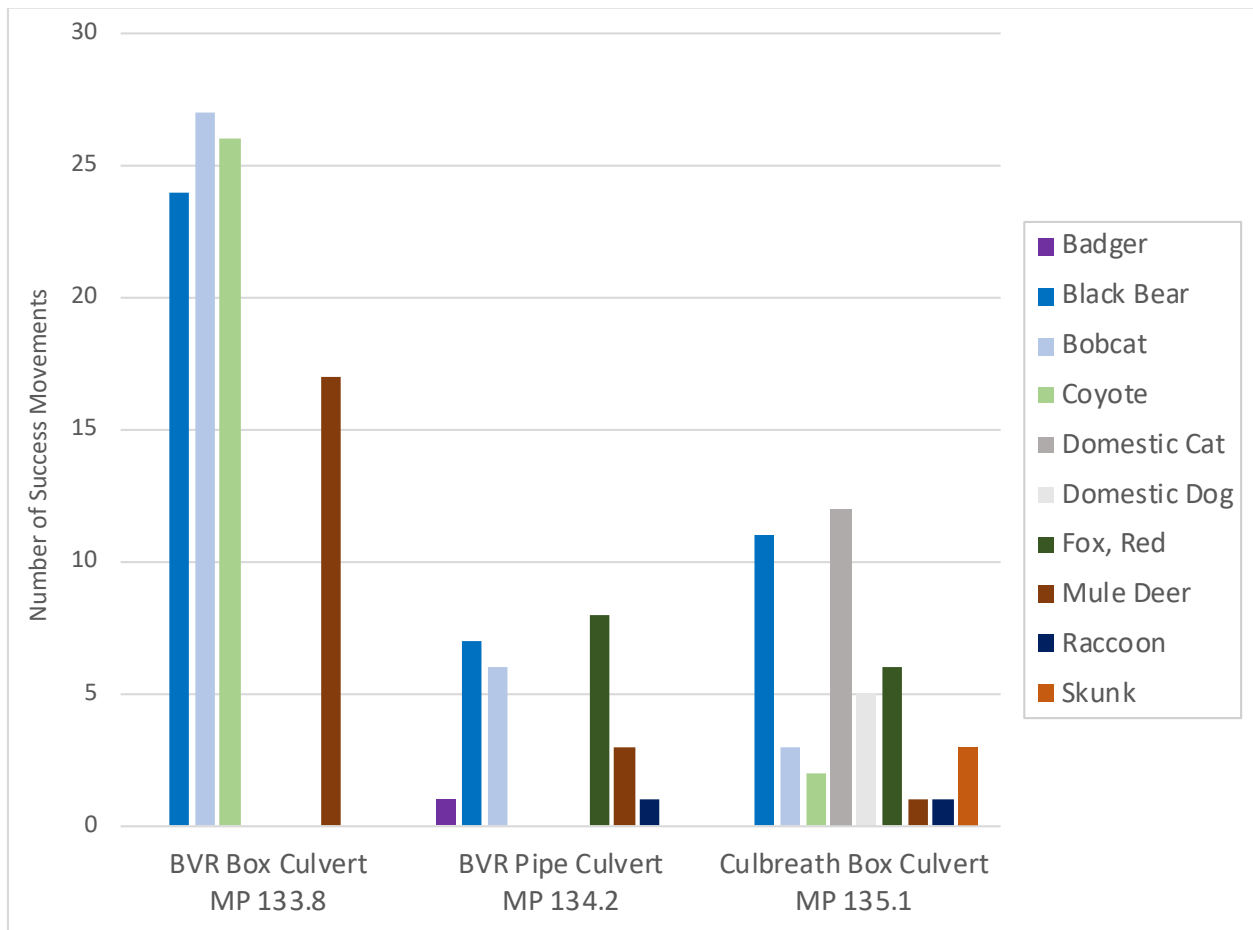


Figure 20. Success movements by species at each of the small culverts. Total monitoring days at each location are: BVR Box Culvert – 408 days; BVR Pipe Culvert – 306 days; Culbreath Box Culvert – 474 days.

## Wildlife Movements at Other Mitigation Features

### *Wildlife Guards*

Since the onset of this research, ungulates have made a total of 138 breach movements at wildlife guards. The vast majority of wildlife guard breaches by mule deer, elk and white-tailed deer were from the habitat side into the fenced right-of-way. In general, wildlife guards deterred ungulates from entering the fenced right-of-way 83% of the time. The total number of breach movements by mule deer decreased from 71 breaches in Year 2 to 23 breach movements Year 3.

Table 6 displays the number of breaches and repels, as well as breach rates and repel rates for each species. The flat bar guards were 78% effective in preventing mule deer breaches, while the round bar guards were 90% effective. Elk had a higher repel rate at flat bar guards (81%) than at round bar guards (67%), but the total number of movements by elk at round bar guards was only six, compared 16 at the flat bar guards. White-tailed deer had a higher repel rate at round bar guards (75%;  $n=8$ ) than at flat bar guards (67%;  $n=3$ ). Moose and bighorn sheep repelled from both guard types 100% of the time ( $n=9$  and  $n=2$ , respectively).

Black bear ( $n=6$ ), bobcat ( $n=21$ ) and mountain lion ( $n=1$ ) were infrequent visitors to the guards but breached the guards 100% of the time when they did approach. Red fox ( $n=240$ ) and coyote ( $n=84$ ) approached the guards more frequently, with breach rates ranging from 74-100% depending on the guard type. The breach rate for red fox was the same at both round bar and flat bar guards (92%) and nearly the same for coyote (75% at round bar and 74% at flat bar guards). These species were also observed breaching the guards in either direction. In one instance, a bobcat was documented descending into the vault at the County Road 33 Wildlife Guard (Fig. 21). Mountain lion, raccoon, skunk, hare and domestic dogs and cats were also recorded at the wildlife guards.



*Figure 21.* Bobcat entering into the vault at the County Road 33 Wildlife Guard.

**Table 6.** Breach and repel rates for each species at wildlife guards with flat bars (8 locations) versus round bars (4 locations).

Species	Wildlife Guard Type	Total Approach Movements	Breach Rate	Repel Rate
Badger	Flat Bar	1	0%	100%
	Round Bar	0	n/a	n/a
Bighorn Sheep	Flat Bar	1	0%	100%
	Round Bar	1	0%	100%
Black Bear	Flat Bar	3	100%	0%
	Round Bar	3	100%	0%
Bobcat	Flat Bar	15	100%	0%
	Round Bar	6	100%	0%
Coyote	Flat Bar	76	74%	26%
	Round Bar	8	75%	25%
Elk	Flat Bar	16	19%	81%
	Round Bar	6	33%	67%
Moose	Flat Bar	5	0%	100%
	Round Bar	4	0%	100%
Mountain Lion	Flat Bar	1	100%	0%
	Round Bar	0	n/a	n/a
Mule Deer	Flat Bar	372	22%	78%
	Flat Bar with Pedestrian Grate	30	40%	60%
	Round Bar	368	10%	90%
Red Fox	Flat Bar	173	92%	8%
	Flat Bar with Pedestrian Grate	1	100%	0%
	Round Bar	66	92%	8%
White-tailed Deer	Flat Bar	3	33%	67%
	Round Bar	8	25%	75%

Ungulate breach rates varied depending on the guard type. The flat bar guard with a pedestrian grate was only monitored for a short period before it was gated but was breached the most often (12 breaches total for a rate of 0.047 breaches per monitoring day). The flat bar guards were breached on 84 occasions for a rate of 0.026 breaches per monitoring day, and the round bar guards 42 times for a rate of 0.017 breaches per monitoring day. For mule deer, breach movements by walking over snow packed in-between the bars at flat bar guards were the most common breach type in Year 2, while in Year 3, no breaches occurred at any of the guard types by walking on snow (Table 7). In Year 3, mule deer breaches were higher at round bar guards than at flat bar guards, accounting for 74% of all breach movements ( $n=17$ ). The most common



method of breaching, regardless of guard type, was jumping. On several occasions, deer were captured breaching a round bar guard by attempting to walk on top of the bars (Fig. 22) or walking on the support beams despite the presence of angle iron on the beams to prevent these types of breaches (Fig. 23).

**Table 7.** Comparison of breach type for Mule Deer in Winter 2016-17 and Winter 2017-18 at wildlife guards with flat bars (7 locations), flat bars with a pedestrian grate (1 location), and round bars (5 locations).

Wildlife Guard Type	Study Year	Walk on Top	Walk on Support Beams	Walk on Snow	Jump	Walk on Grate
Flat Bar (n=77)	Year 1	11	3	7	5	n/a
	Year 2	10	1	29	5	n/a
	Year 3	0	0	0	6	n/a
Flat Bar with Pedestrian Grate (n=18)	Year 1	5	0	0	3	3
	Year 2	1	0	0	3	3
	Year 3	n/a	n/a	n/a	n/a	n/a
Round Bar (n=37)	Year 1	n/a	n/a	n/a	n/a	n/a
	Year 2	0	1	2	18	n/a
	Year 3	4	2	0	10	n/a



*Figure 22.* Mule deer breaching the Badger Road Wildlife Guard by attempting to walk on top of the round bars.



*Figure 23.* Mule deer breaching the County Road 1002 Wildlife Guard (round bar) by walking on the support beams.

Mule deer breaches were recorded at all monitoring locations but occurred most frequently at County Road 1000 (flat bar), with 29% of all breaches occurring at this location. This was also the location with the highest occurrence of breaches by walking on snow. Breaches by walking

on snow also occurred at the Trough Road Wildlife Guard (flat bar) and County Road 1002, which was the only round bar guard location with the breach type. In this case, snow plowing created a snow berm along the side of the guard and the deer used this berm to breach the guard. Walking on top of the guard was the most common method of breaching at County Road 33 and Spring Creek, both flat bar locations. Walking on top was also the most common breach type at the Culbreath Wildlife Guard during Year 1, despite the presence of a pedestrian grate on this guard. Breaches by jumping were documented at nearly all of the guard locations regardless of guard type, and this was the most common method of breaching at the four round-bar locations.

Several wildlife guard monitoring locations were included in a paired analysis, i.e., adjacent locations with different guard types (flat bar versus round bar) in Year 3. The paired locations included in this analysis were the Thompson (round bar) and County Road 33 (flat bar) wildlife guards; Triangle Road (round bar) and Spring Creek Road (flat bar) wildlife guards; and County Road 1002 (round bar) and County Road 1000 (flat bar). The paired analysis included only movements by ungulate species, and only events that occurred between dusk and dawn the following day to equalize the sampling effort among those cameras that are programmed to be off during the daytime due to higher traffic volumes and those that are not. Breach and repel movements for guards in the paired analysis are presented in Table 8.

**Table 8.** Breach and repel movements at wildlife guards included in the Year 3 paired analysis.

Monitoring Location	Breach Movements	Repel Movements	Walk on Top	Walk on Support Beams	Walk Snow	Jump
Thompson (round bar)	1	14	0	0	0	1
CR 33 (flat bar)	0	2	0	0	0	0
Triangle Rd (round bar)	5	36	0	0	0	5
Spring Creek Rd (flat bar)	3	40	1	0	0	2
CR 1002 (round bar)	6	48	0	2	0	4
CR 1000 (flat bar)	6	34	2	0	0	4

Across all of the pairs, jumping the guard was the most common breach type and occurred at the flat bar and round bar guards in nearly equal numbers for each of the pairs. Walking on top of the

bars was recorded only at flat bar guards in this paired analysis, while walking on the support beams was recorded only at one of the round bar guards.

### *Escape Ramps*

Since the onset of this research, cameras have recorded a total of 171 elk and 645 mule deer movements at escape ramps on the right-of-way side of the fence. Elk and mule deer movements at escape ramps occurred mostly from December through March. In Year 3, no elk were documented inside of the right-of-way fence at the escape ramps and 279 mule deer movements were recorded – slightly fewer than in Year 2. Mule deer have been documented at each of the 13 monitored escape ramp locations, with the highest frequencies at the East Fence End Escape Ramp at MP 126.7, Badger Road Escape Ramp at MP 129.1 (both 3:1 slope with no rail fence) and the North Overpass Escape Ramp at MP 134.3 (2:1 slope with no rail fence).

When an animal approached an escape ramp on the right-of-way side of the fence, it either walked around the ramp or ascended (intercepted) it. Table 9 summarizes elk and mule deer approaches and intercept rates for the different escape ramp types. For elk, 3:1 slope ramps without perpendicular rail fence had the highest intercept rate (54%). For deer, ramps without perpendicular rail fence (both 2:1 and 3:1 slopes) had the highest intercept rates (72% and 55%, respectively).

**Table 9.** Intercept rate by elk and mule deer at escape ramps with 2:1 versus 3:1 slopes and with or without perpendicular rail fence through Year 3. Intercept rate is the percentage of the total movements by animals that ascended the ramp relative to the total number of movements by animals that approached the ramp.

Species	Escape Ramp Type	Total Approaches	Intercept Rate
Elk	2:1 slope with rail fence (n=5)	3	33%
	2:1 slope without rail fence (n=1)	0	n/a
	3:1 slope with rail fence (n=2)	0	n/a
	3:1 slope without rail fence (n=5)	168	54%
Mule Deer	2:1 slope with rail fence (n=5)	65	43%
	2:1 slope without rail fence (n=1)	106	72%
	3:1 slope with rail fence (n=2)	126	34%
	3:1 slope without rail fence (n=5)	348	55%

Animals whose movements were intercepted by a ramp either walked up and turned around or jumped down to the habitat side. Table 10 summarizes jump down (escape) rates for deer and elk at each of the different escape ramp types. The highest number of mule deer escapes were at the North Overpass Escape Ramp (2:1 slope without rail fence;  $n=14$ ) and the Badger Road Escape Ramp (3:1 slope without rail fence;  $n=12$ ), with escape rates of 18% and 26%, respectively. All of the other ramps recorded four or fewer escape movements. For example, the Culbreath 3:1 Escape Ramp (no rail fence) had the highest escape rate of 33% but only twelve total movements were recorded at this location including four successful jump downs. The East Fence End Escape Ramp (3:1 slope ramp without rail fence) had the highest number of mule deer walk up the ramp ( $n=83$ ), but none of these deer jumped down to the habitat side.

In Year 3, bighorn sheep were recorded ascending the South Spring Creek Escape Ramp (3:1 slope with rail fence), but no successful escape movements were recorded. Moose, pronghorn and white-tailed deer were not recorded at any of the ramps. Humans were recorded in low numbers at most of the ramps, and in most cases appear to be curious passersby, including people on foot, dirt bikes, ATVs, and snowmobiles.

**Table 10.** Escape rates by elk and mule deer at escape ramps with 2:1 versus 3:1 slopes and with or without perpendicular rail fence through Year 3. Escape rate is the percentage of the total movements by animals that escaped to the habitat side of the fencing relative to the total number of movements by animals that ascended the ramp.

Species	Escape Ramp Type	Total Ascend Ramp	Escape Rate
Elk	2:1 slope with rail fence ( $n=5$ )	1	100%
	2:1 slope without rail fence ( $n=1$ )	n/a	n/a
	3:1 slope with rail fence ( $n=2$ )	0	n/a
	3:1 slope without rail fence ( $n=5$ )	90	8%
Mule Deer	2:1 slope with rail fence ( $n=5$ )	28	11%
	2:1 slope without rail fence ( $n=1$ )	76	18%
	3:1 slope with rail fence ( $n=2$ )	43	14%
	3:1 slope without rail fence ( $n=5$ )	192	11%

A number of ungulates, other wildlife and domestic cows were documented on the habitat side of the escape ramps. No ungulates attempted to jump up onto the ramp from the habitat side. On one occasion a bighorn sheep ewe appeared to investigate the ramp from the habitat side of the fence but made no attempt to jump up. Bobcat is the only species captured climbing up the backside of a ramp from the habitat side to enter into the fenced right-of-way.

#### *Pedestrian Walk-Through Gates*

All of the pedestrian walk-through gates in the study area were gated by CPW in Summer 2017 and monitoring ceased. Monitoring results for the pedestrian walk-through gates are available in the *State Highway 9 Wildlife Crossings Monitoring Year 2 Progress Report* (Kintsch et al. 2018).

#### *South Fence End*

Wildlife exclusion fence runs along the right-of-way line throughout the project area. The northern terminus ties into the Colorado River Bridge south of Kremmling. The southern terminus is at MP 126.6. At this fence end the fence line angles in towards the pavement, ending 20' from the pavement edge so that it is not inside the clear zone. Monitoring at the south fence end commenced on October 10, 2016 and will continue through the duration of this research.

A total of 777 movements were recorded of deer and elk at the south fence end. Movements into the fenced right-of-way occurred when animals moved from the habitat side of the fence and either walked around the fence end into the right-of-way on the same side of the road or crossed the road and entered the right-of-way on the opposite side. Movements out of the fenced right-of-way occurred when animals already inside the fenced area of the right-of-way moved out to the habitat side of the fence. Movements beyond the fence include movements where animals crossed the road beyond the fence end as well as those where the animal did not cross the road but repelled from the road and remained beyond the fence end. The majority of movements for all species occurred beyond the fence end without movements into or out of the fenced right-of-way, including 91% of all deer movements and 62% of all elk movements. Some human movements were documented at the fence end, primarily involving ATVs, dirt bikes or snowmobiles driving around the fence end on the west side.



The total number of ungulate movements at the south fence end increased from Winter 2016-17 to Winter 2017-18 by 40% and the majority of all movements continue to occur beyond the fence end (Fig. 24). Total movements decreased during the non-winter months as migratory herds moved out of the study area to high elevation summer ranges.

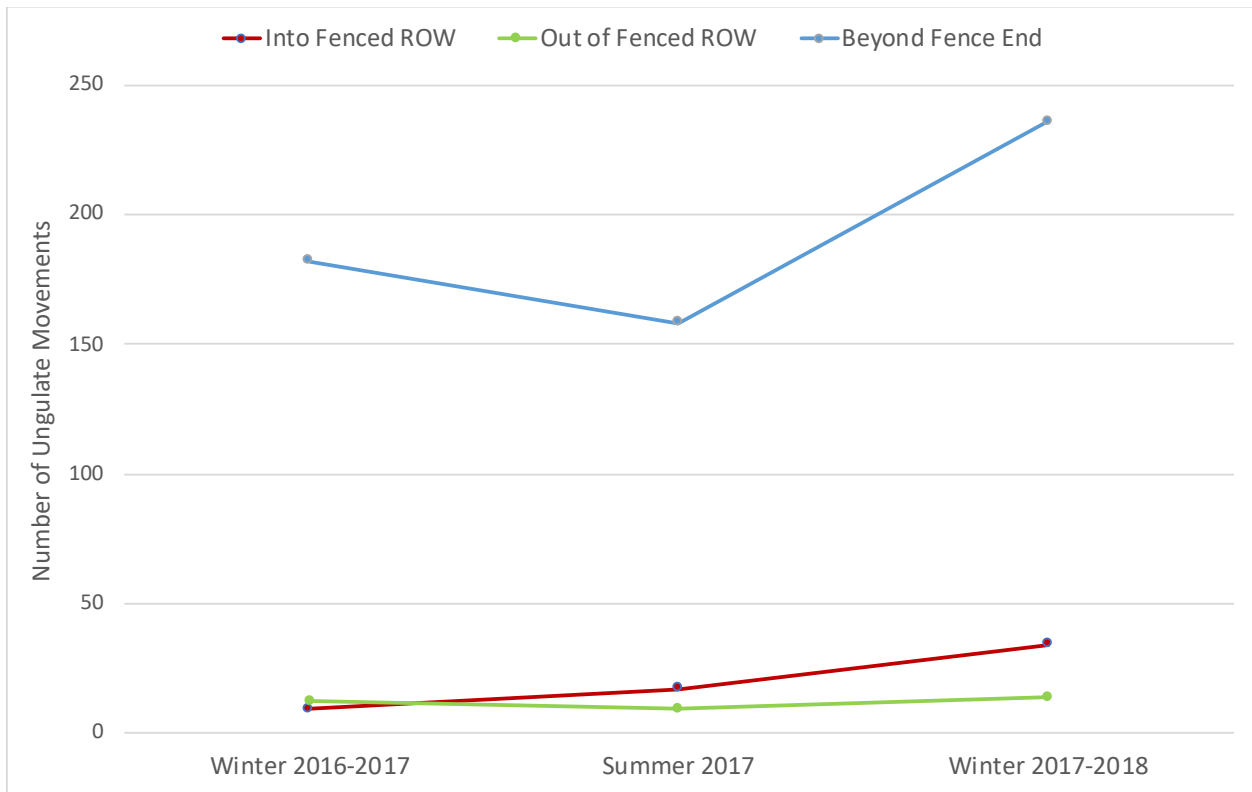


Figure 24. Ungulate movements at the south fence end.

### Wildlife-Vehicle Collision Rates

#### BVR/CPW Carcass Data

In Winter 2017-18, six mule deer and no elk carcasses were reported inside the project area, for a decrease of 89% relative to the pre-construction average (Fig. 25). This decrease was slightly greater than Winter 2016-17 which saw a decrease of 86% (eight carcasses reported). In Winter 2016-17, three additional deer carcasses were reported within a mile south of the south fence end, while in Winter 2017-18, this number increased to six. Four of these WVC carcasses were located less than 30 meters from the fence end. At the north end of the study area, one deer

carcass was reported within a mile of the north fence end in Winter 2017-18; no elk or pronghorn carcasses were recorded.

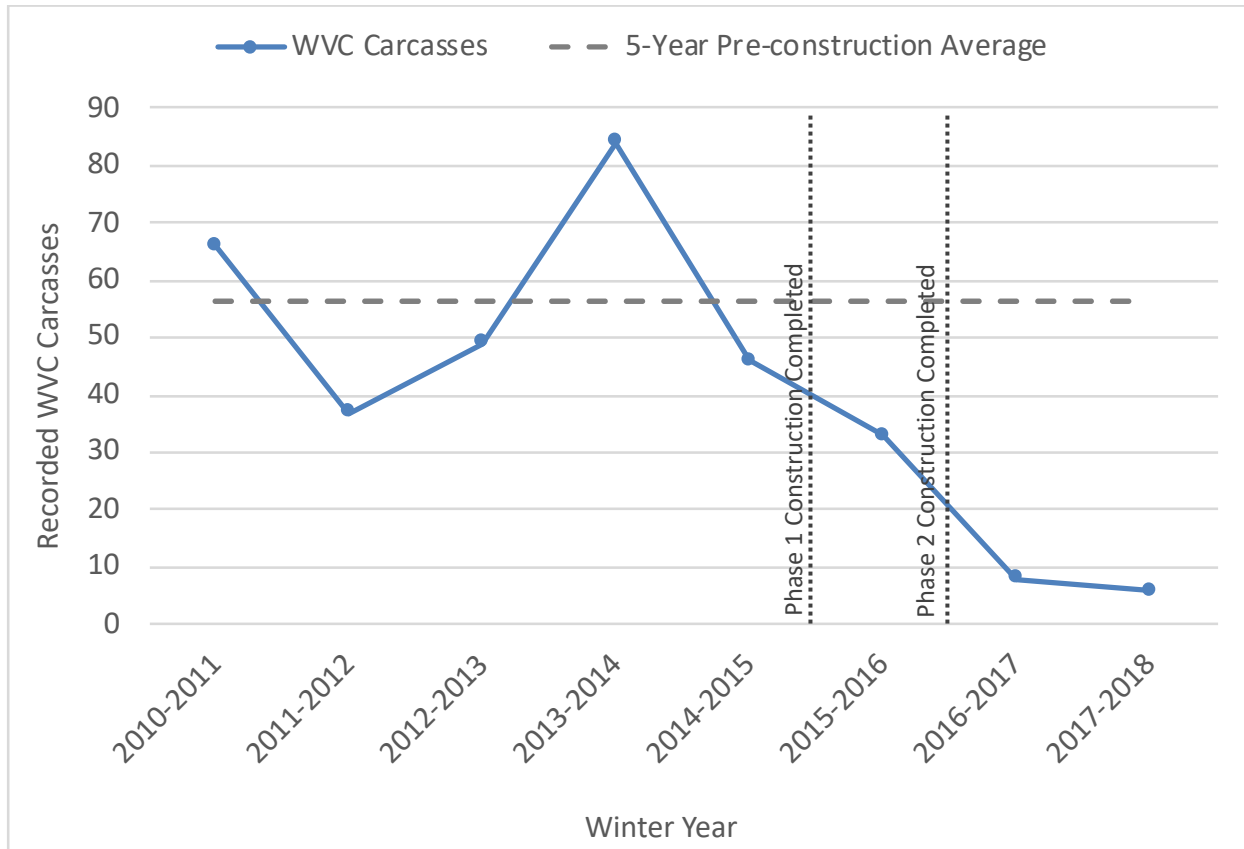


Figure 25. Mule deer and elk carcass counts recorded by BVR and CPW compared to the five-year pre-construction average of 56.4 carcasses per year.

#### CDOT Maintenance Carcass Data

In Winter 2017-18, no WVC carcasses were reported by CDOT Maintenance patrols inside the project area; nor were any reported the previous winter (Fig. 26). Since construction was completed, one carcass was reported during the non-winter months inside the project area – this WVC event occurred near the south fence end in late November 2017, during the fall migration. However, carcasses continue to be recorded beyond the fence ends, particularly south of the project area (Fig. 27). Since construction was completed, 12 WVC carcasses have been reported within 1.5 miles of the south fence and one WVC carcass was reported north of the project area.

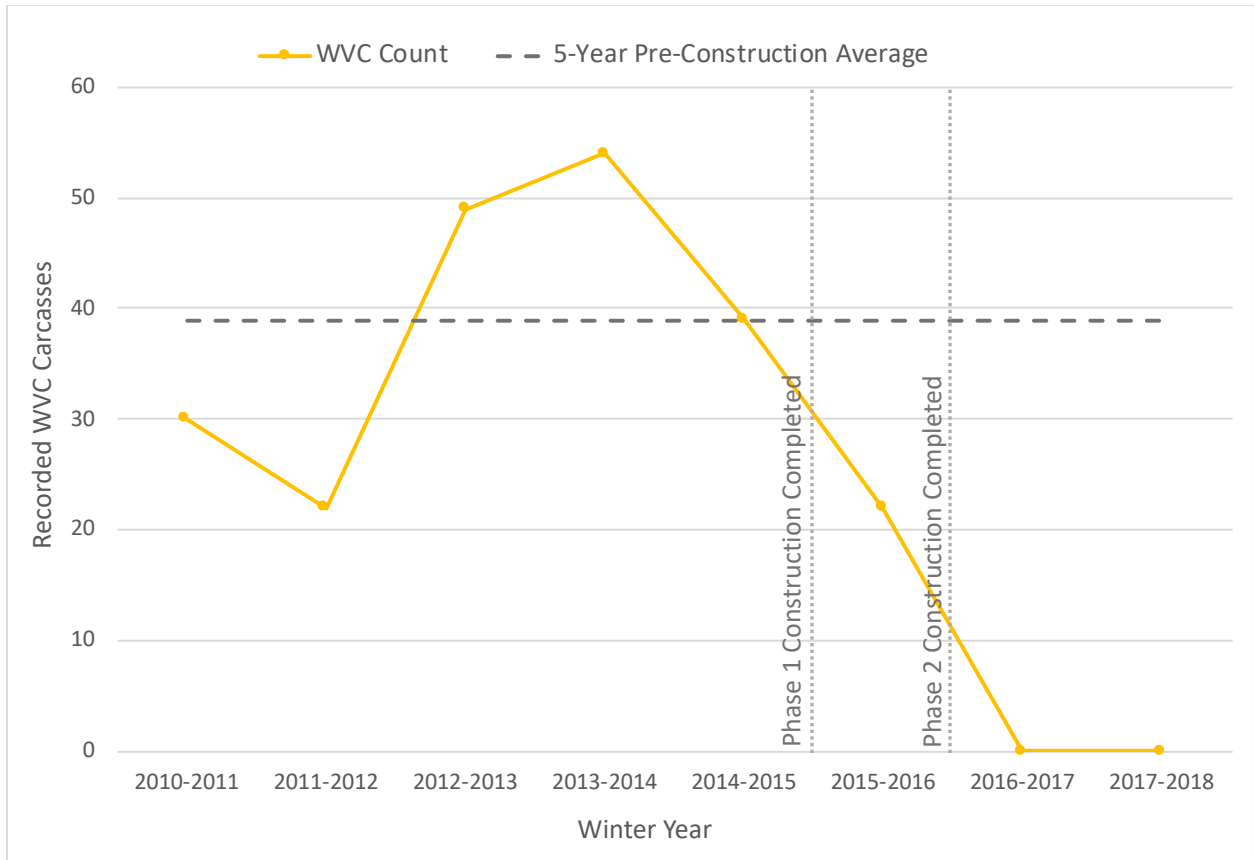


Figure 26. Wintertime mule deer and elk carcass counts recorded by CDOT Maintenance within the project area (MP 216.6 – 137.0) compared to the five-year pre-construction average of 38.8 carcasses per year.

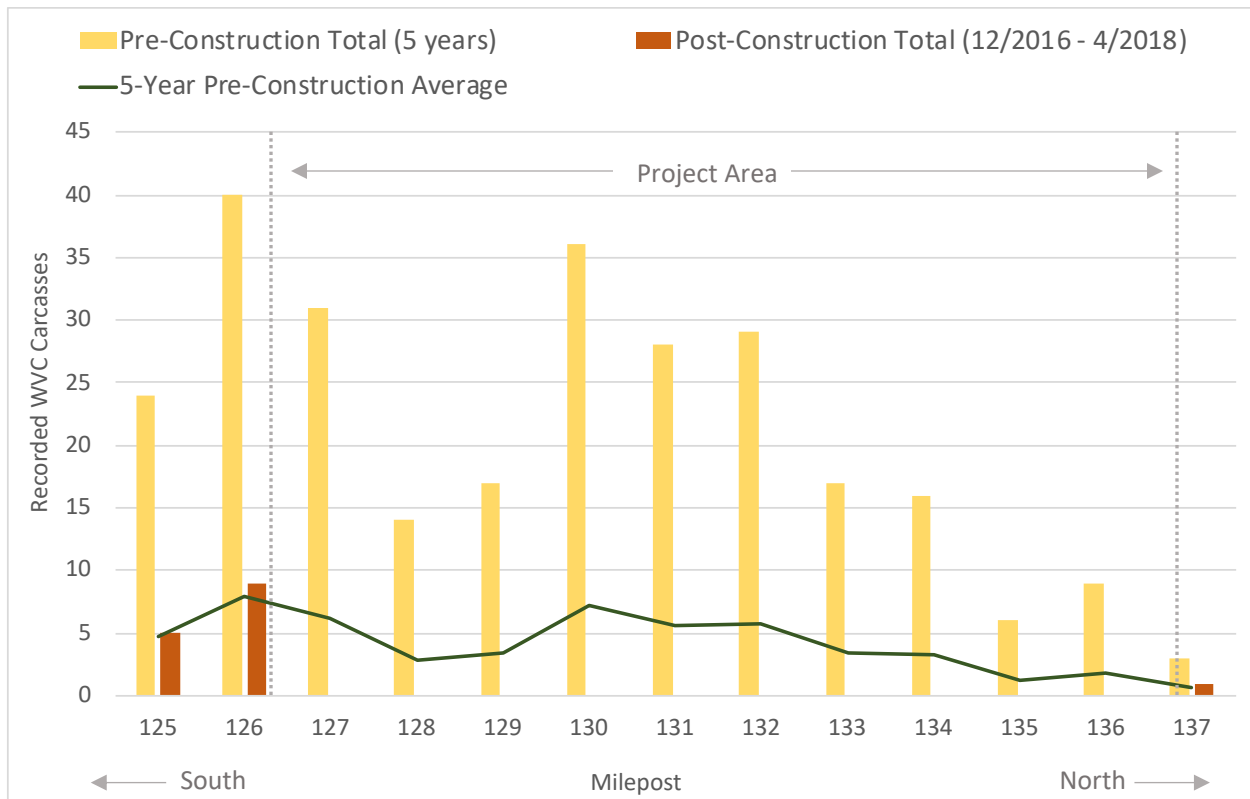


Figure 27. Mule deer and elk carcass counts recorded by CDOT Maintenance by milepost. Pre-construction totals comprise 5 years; post-construction totals comprise two winters and the intervening non-winter months. The 5-year pre-construction average was calculated for each one-mile segment.

#### CDOT Traffic and Safety Accident Report Data

Within the project area, the number of reported WVC accidents dropped 100% in Winter 2016-17, the first winter following construction of the entire mitigation project. During the five winters prior to mitigation construction (Winter 2010-11 through 2014-15), WVC were the most common accident type on this segment of highway, accounting for 60% ( $n=51$ ) of all accidents reported to law enforcement. These data demonstrate that WVC accidents occur year-round, with the highest WVC rates occurring during the winter months (Fig. 28). No WVC accidents were reported immediately north or south of the project area since construction was completed. Post-construction data for April 2017 through April 2018 were not available at the time of this analysis.

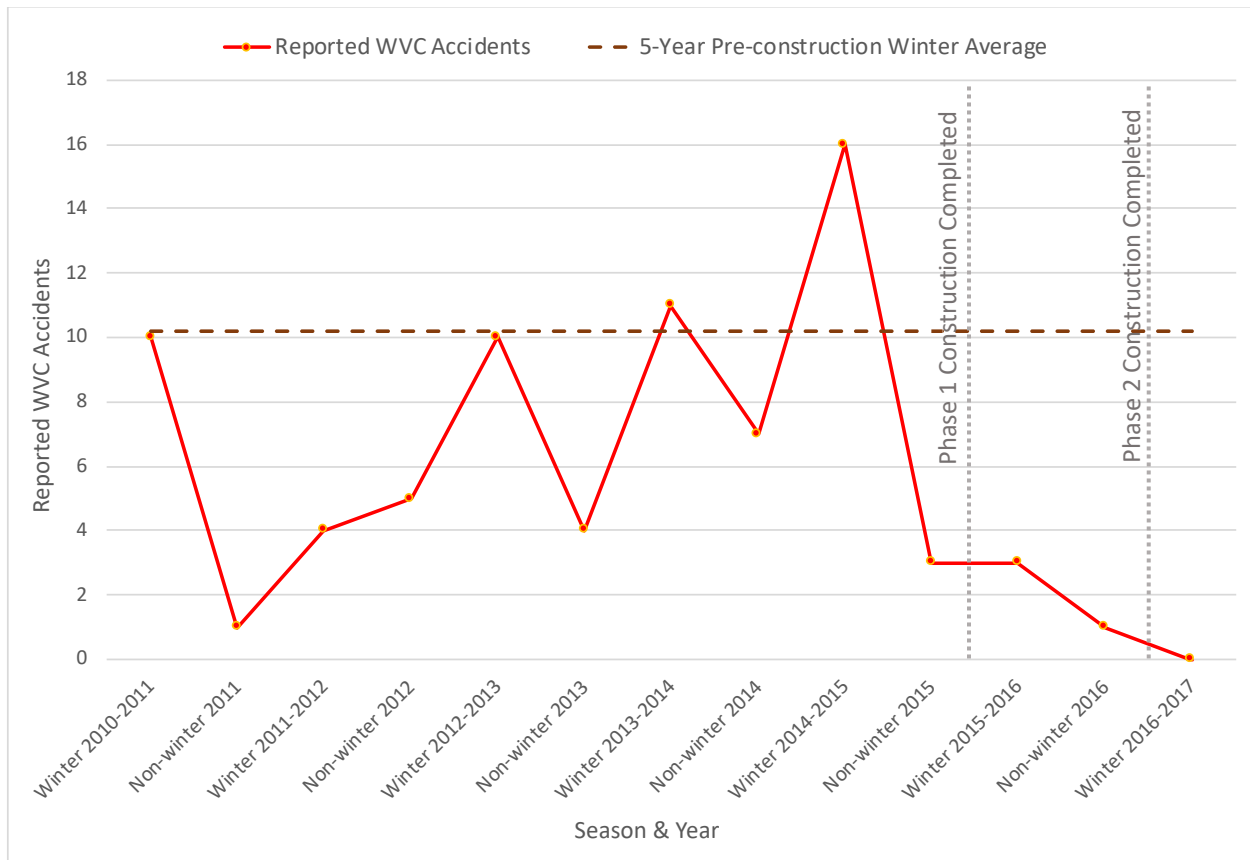


Figure 28. Wildlife-vehicle collision accidents within the project area (MP 216.6 – 137.0) reported to law enforcement involving mule deer or elk compared to the 5-year pre-construction average of 10.2 reported accidents, which is calculated for the winter months only so that it may be compared to the BVR carcass data.

#### Wildlife-vehicle Collision Rates on US 40

In addition to WVC rates on SH 9, the researchers also analyzed the CDOT Maintenance carcass dataset for US 40 from MP 182-190, an east-west highway that runs through the town of Kremmling, north of the project area. Comparisons were made between the number of ungulate (mule deer, elk and pronghorn) carcasses five-years pre-construction and two years post-construction (Fig. 29). Data from Winter 2015-16 were excluded from the analysis as this corresponds with the timeframe during which only the Phase 1 portion of the project area had been constructed. The purpose of this analysis was to determine whether the mitigation on SH 9 may have contributed to a shift in wildlife movements, particularly elk, from SH 9 north across US 40, with a resulting increase in WVC on US 40. During the five years pre-construction, 28 deer carcasses and eight elk carcasses were recorded. Post-construction, four carcasses of each species have been recorded during Winter 2016-17 and Winter 2017-18.



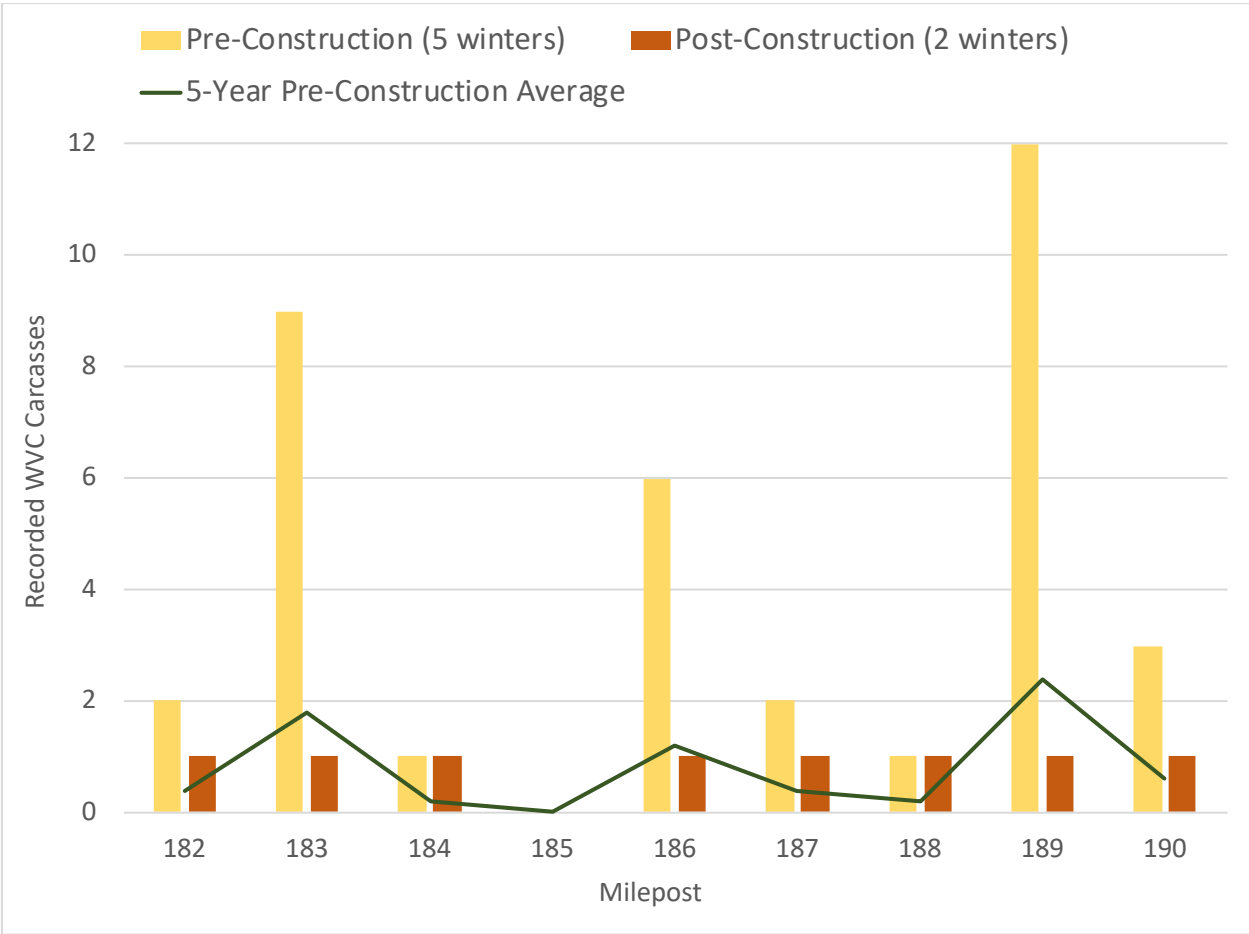


Figure 29. Ungulate carcass counts recorded by CDOT Maintenance on US 40 east and west of Kremmling (MP 185) for five winters prior to mitigation construction and two winters post-construction. The 5-year pre-construction winter average was calculated for each one-mile segment.

## Discussion

### Wildlife Use of Crossing Structures

Mule deer activity and success movements through or over the crossing structures increased each year of this research. The 45,759 mule deer success movements at wildlife crossing structures in addition to the mule deer success rates ranging from 95% to 98% demonstrate the success of this mitigation system for mule deer. The 89% reduction in WVC carcasses collected by BVR and CPW in addition to the reduction in WVC carcasses reported by CDOT Maintenance and WVC accidents reported to law enforcement further attest to the success of the mitigation in reducing wildlife hazards for motorists. The observed changes in the number of success movements by mule deer and other species over time, as well as variations in the patterns of use across the seven structures can inform a greater understanding of wildlife movements in the study area and the effectiveness of the different wildlife crossing structure types.

### Mule Deer Structure Use and Periods of Peak Activity

The 17% increase in mule deer movements in Winter 2017-18 relative to the winter prior suggests that the mitigation is succeeding in improving connectivity for mule deer across SH 9. The high number of mule deer movements and the high success rates at each of the crossing structures reflect regular movements that appear to have been made by many of the same individuals on winter range. Periods of peak mule deer activity varied among crossing structures and from one winter to the next. In general, activity increased in October, marking the onset of migratory herds arriving on winter range, and began decreasing again in April as these herds moved to high elevation summer ranges. While in Winter 2016-17 peak activity was concentrated in January and mid-February, in Winter 2017-18, peak activity at several locations didn't occur until March. Given that crossing structures in the Phase 2 segment were completely new in Winter 2016-17, shifts in peak activity are expected in the first few years of post-construction monitoring. Fluctuations in snowfall is another likely contributor to annual variability.

In addition to movements by migratory mule deer on winter range, resident mule deer continued to use the crossing structures during the non-winter months with an overall success rate of 95%. Mule deer success movements were recorded at all of the wildlife crossing structures during the non-winter months of 2017 and accounted for 29% of all movements at crossing structures in

Year 3. These results demonstrate that the wildlife-highway mitigation provided safe passages for resident herds as well as wintering migratory herds. The mitigation has also successfully reduced WVC conflicts for resident herds, as no WVC crashes or carcasses were reported during the non-winter months in Year 3 (based on CDOT Maintenance carcass reports and CDOT Traffic and Safety accident reports; BVR does not collect carcass data during the non-winter months).

#### Variations in Mule Deer Structure Use from Prior Winter

Mule deer activity varied substantially among the wildlife crossing structures during Winter 2017-18, and patterns in crossing structure use also varied relative to the previous winter. While the number of mule deer success movements at the North Overpass remained high relative to other crossing structures through both post-construction winters, this was the only location where a decrease in success movements was observed in Winter 2017-18. Meanwhile, success movements at the two adjacent structures to the north (North Underpass) and south (Middle Underpass) increased by 44% and 37%, respectively. The highest levels of mule deer activity occurred at the BVA Underpass ( $n=5,246$ ), which, in Winter 2017-18 surpassed the North Overpass as the crossing structure with the greatest number of success movements. Regardless of this variation, success rates were high at all locations and during all monitoring periods, indicating that mule deer have adapted quickly to these mitigation features.

Landscape factors may influence wildlife crossing structure use. Given the relatively homogenous nature of the project area (rolling terrain and sagebrush vegetation) and that the structure designs for the two overpasses and five underpasses were the same throughout the project, spatial variations in mule deer use of crossing structures may be due to a combination of factors, such as the location of each structure relative to where mule deer wintered, local terrain features at each structure, winter severity and snow accumulations, or variability in mineral composition and forage quality (e.g., Peterson 2008). A comparison of mule deer activity at overpass structures versus underpasses in the project area further suggest a leveling out of mule deer activity based on structure type. Whereas in Winter 2016-17 overall mule deer success movements were 138% greater at overpass structures than at underpasses on a per unit basis, in Winter 2017-18 success movements at overpasses were only 34% greater than at underpasses on a per unit basis. Overall, mule deer success movements were high at overpasses and underpasses,

and both structure types appear to function well for mule deer passage within the project area. Mule deer were also documented making success movements at all three small culverts ( $n=17$ ), although the majority of mule deer approaches to small culverts were parallel ( $n=46$ ) or repel movements ( $n=39$ ).

#### Mule Deer Preferences with Respect to Gender and Age Class

Gender and age status appeared to affect mule deer use of underpass versus overpass structures, Male mule deer may have a potential preference for underpass structures – while buck movements comprised 11-24% of total mule deer movements at the five underpass structures, bucks were only 4-7% of movements on the two overpasses. In Year 3, the research team began recording fawns as a separate category. Accordingly, the percentage of deer categorized as unknown gender decreased in Year 3. Fawn movements were recorded at all of the crossing structures and were highest at the BVA underpass ( $n=1,127$ ) and the North Overpass ( $n=734$ ) and lowest at the North Underpass ( $n=170$ ). The final report for this study will compare the ratio of bucks and does in the population to the buck:doe ratios at the crossing structures, based on photographic data taken from when antler growth is sufficient to determine gender.

#### The Diversity of Species

Movements by other ungulate species occurred in much lower numbers than mule deer. Success movements by species such as bighorn sheep, moose and pronghorn increased from Year 2 to Year 3 but decreased slightly for elk and white-tailed deer. These numbers reflect the relative proportion of these species in this landscape but are expected to increase through the duration of this research as individual animals become more comfortable with the crossing structures and as more individuals learn to use the structures. Overall success rates at wildlife crossing structures for these ungulate species ranged from 87% for moose ( $n=38$ ); 91% for elk ( $n=76$ ); 92% for white-tailed deer ( $n=39$ ); 98% for pronghorn ( $n=52$ ); and 100% for bighorn sheep ( $n=13$ ). Success movements by other large and medium-sized mammals were also detected at all the wildlife crossing structures.

Elk were photographed primarily in the northern portions of the study area, with the highest number of elk detected at the North Overpass ( $n=30$ ). In the Phase 2 segment, elk were only documented at the South Overpass ( $n=4$ ). In pre-construction monitoring, the greatest number of

elk were documented in the Phase 2 segment ( $n=66$ ) and only one elk was detected in the Phase 1 segment. Elk were not detected as often at the cameras in Year 3 when compared with the previous year and winter. In Year 3, 32 elk were detected, but none occurred during the winter months, whereas in Year 2, 34 elk were detected, and 22 of those were during the winter months. Notably, Winter 2017-18 was a mild winter and fewer elk may have been present on winter range in the lower Blue River valley. The majority of elk success movements at crossing structures have been made by individual animals or, in some cases, small groups of up to four animals. Across crossing structure locations, elk have used overpasses and underpasses in nearly equivalent numbers ( $n=32$  and  $n=37$ , respectively), although underpass structures outnumber overpasses in the study area. At this stage of the research and given the low amount of overall elk activity and the complete absence of larger groups of elk at the crossing structures, a preference for underpasses versus overpasses cannot be assessed.

Since the onset of this research, pronghorn and white-tailed deer were documented using only underpass structures, although the overall number of movements by these species are still low ( $n=52$  and  $n=39$ , respectively). Both species have been detected by the habitat camera at the North Overpass, although neither has been observed using the structure. Moose and bighorn sheep successfully used both underpass and overpass structures throughout the study area. Moose used overpasses 10 times, and underpasses 21 times. Moose movements were most common in the northern portion of the project area, with the most success movements occurring at the North Overpass and North Underpass. Bighorn Sheep movements were most common in the southern portion of the study area with most movements occurring at the South Overpass and the Williams Peak Underpass. Bighorn sheep used both overpasses a total of eight times and used underpass structures five times. Success movements at the crossing structures by bighorn sheep included both movements by individuals and use by a family group, documenting use by both genders and all age groups.

In addition to ungulates, a diversity of carnivore species was also photographed using the crossing structures and provide some evidence of taxa-specific preferences. Coyote and red fox were the only species other than mule deer documented using every crossing structure. The high number of coyote passages at the South Overpass ( $n=420$ ) may suggest that one or several

individuals have incorporated the overpass into their home ranges and are making regular movements to either side of the highway, although such use cannot be confirmed by this study.

Black bear activity was concentrated at the Middle Underpass, with 106 success movements – it is likely these were primarily by the several individuals moving regularly back and forth at this location. This structure is located in an ephemeral drainage with a more diverse and complex vegetation component than the other crossing structures. This diversity may help explain why this structure had the highest level of carnivore species use of all the structures. No black bear movements were detected at either of the overpass structures, suggesting a potential preference for the underpass structures.

Success movements at the small culverts were made primarily by carnivore species, including black bear, bobcat, coyote and red fox. The greatest species diversity is documented at the Culbreath Box culvert; however, the greatest number of success movements occurred at the BVR Box Culvert ( $n=94$ , including black bear, bobcat, coyote and mule deer). Domestic cats and dogs were most commonly photographed using the Culbreath Box Culvert, which is near a private ranch and home site, and may affect wildlife use of this culvert.

## Wildlife Activity at Other Mitigation Features

### Wildlife Guards

From Year 2 to Year 3, the total number times mule deer attempted to breach the wildlife guards decreased by 30% and the number of successful breaches decreased 68% to a total of 23 breaches at all guard types. In Year 3, breach rates were nearly the same at both guard types (9% for round bar guards and 8% for flat bar guards), although the total number of breaches by ungulate species was higher at round bar guards ( $n=20$ ) than at flat bar guards ( $n=9$ ). In addition, regardless of guard type, jumping the guard was the most common method of breaching a guard, both in the general analysis and in the paired guard analysis. In contrast with Year 2, walking on snow packed in-between the bars was the most common method of breaching a guard, yet in Year 3, no breach events of this type were recorded. This may be attributed to more mild winter conditions or to conversations with plow drivers to bring their attention to this issue. In the Year 2 progress report the authors speculated that the round bars may prevent deer from breaching by



walking on top of the bars. However, in Year 3, four breach movements were documented of deer walking on top of the round bars and two of deer walking on the support beams, despite the presence of angle iron on the support beams of the round bar guards.

Carnivore species continued to have the highest breach rates regardless of guard type. The wildlife guards are designed to primarily target ungulates (the species most frequently involved in WVC) to prevent them from entering the fenced right-of-way, and breaches by non-ungulate species are unsurprising, as their paws can more easily traverse the guards. In addition, these species were more likely to be documented breaching the guards both to get into or out of the right-of-way.

#### Escape Ramps

While fewer mule deer movements were detected in Year 3 than in Year 2 inside of the right-of-way at the escape ramps and no elk movements were detected, there were still 279 mule deer movements at the ramps in Year 3, demonstrating that animals continued to get on the right-of-way side of the wildlife exclusion fence. Mule deer were documented at all 11 monitored ramp locations across the project area in Year 3, suggesting that there were multiple points of entry into the fenced right-of-way in different portions of the project area.

Overall, there was a large variation in mule deer activity ( $n=1-135$ ) and intercept rates (0-100%) by location. Ramps without perpendicular rail fence had a higher intercept rate (61%) than ramps with perpendicular rail fence (36%), while ramp slope appeared to have less influence on mule deer intercept rates. As elk were not detected at most ramps and were only present in high numbers at one escape ramp, ramp location relative to elk presence in the landscape appears to be the greatest factor influencing intercept rates for elk.

Mule deer and elk escape rates off the ramps were comparatively low, and results were mixed with respect to the two different slope designs and the presence of perpendicular rail fences. The presence of perpendicular rail fence regardless of ramp slope did not have a discernable influence on escape rates for mule deer as both ramps with and without rail fence had escape rates of 13%. However, in the paired ramp analysis, both intercept rates and escape rates for

mule deer were higher at the two new 3:1 slope ramps without rail fence than at the two older 2:1 slope ramps with rail fence. Overall, these preliminary results suggest that multiple variables may influence both intercept rates and escape rates, including 1) species; 2) species activity in the landscape; 3) ramp location; 4) landscape situation relative to the roadway; 5) ramp slope; and 6) presence or absence of perpendicular rail fence. These variables will continue to be evaluated through this research.

The number of times mule deer and elk used the monitored escape ramps to escape to the habitat side of the wildlife exclusion fence, ( $n=53$ ), was a small fraction of the total number of times they were photographed at the ramps in the right-of-way ( $n=816$ ). These results are typical of other study results (Cramer, unpublished data; Arizona Game and Fish Department, unpublished data). As time goes on, mule deer and elk may adapt to the ramps and use them more often, but the best result would be a lowered number of deer in the right-of-way.

In addition to mule deer and elk, bighorn sheep, moose and white-tailed deer were documented by the cameras on the habitat side of the fence line. The high number of parallel movements by these species indicate that animals had many opportunities to breach the wildlife exclusion fencing by jumping up from the back side of a ramp, but no such attempts were made, suggesting that the ramp height of six feet is sufficient in discouraging a jump up attempt by deer or elk. However, given the low escape rates even at ramps with higher intercept rates, the six-foot ramp height may be too high to encourage successful escapes.

#### South Fence End

Mule deer and elk movements captured by the cameras at the fence end indicate there may still be a problem with animals moving into the fenced right of way section of the highway, and with animals in this area finding and using the wildlife crossing structures farther to the north. The total number of ungulate movements at the south fence end increased 40% from Winter 2016-17 to Winter 2017-18. While the total number of ungulate movements into the fenced right-of-way were low in Winter 2017-18 ( $n=34$ ), in Winter 2016-17 there were only nine such movements, representing a 278% increase. More mule deer were documented entering the fenced right-of-

way than were captured exiting it, although some of these movements in both directions appear to have been made repeatedly by the same individuals.

As in the previous year, the vast majority of ungulate movements at the south fence end occurred beyond the fence end (91%); that is animals that approached and potentially crossed the highway at-grade without entering into the fenced right-of-way. Most of these movements were made by mule deer ( $n=619$ ), although elk were also photographed beyond the fence end ( $n=95$ ). In several cases, the cameras documented a group of animals approaching the road and repelling several times before either finally making a successful at-grade highway crossing or completely repelling from the highway.

Ongoing and increasing ungulate activity at the south fence end may indicate that wildlife-highway mitigation is not fully capturing the wildlife crossing zone on SH 9. These findings are consistent with CPW's understanding of wildlife movements in the lower Blue River valley prior to the mitigation construction; however, there was no obvious location for an additional wildlife crossing structure south of this location, so the design team opted to end the wildlife fence at MP 126.6 rather than risk blocking wildlife movements with additional wildlife exclusion fencing along this section of SH 9.

### Wildlife-vehicle Collisions

Each of the WVC carcass and accident datasets demonstrate a decreasing trend in WVC following the completion of mitigation construction in the SH 9 project area, although accident data through Winter 2017-18 are not yet available from CDOT Traffic and Safety. Within the project area, WVC carcasses decreased 89% in Winter 2017-18 compared to the five-year pre-construction average (based on BVR/CPW carcass data). This decrease is slightly greater than the 86% decrease reported the previous winter. These results support the assertion that wildlife crossing structures and other mitigation features have been effective in reducing WVC along SH 9, while also providing wildlife connectivity across the highway.

The BVR/CPW carcass reporting is the only source to document WVC carcasses inside the project area during Winter 2017-18. No WVCs were documented in either the CDOT

Maintenance carcass dataset or the CDOT Traffic and Safety accident database. However, as described in the Year 2 progress report (Kintsch et al. 2018), only 18% of the WVC carcasses recorded by BVR/CPW were captured in Traffic and Safety accident reports, and 68% were captured in the CDOT Maintenance carcass database.

The CDOT Maintenance carcass databased demonstrates that WVCs continued to occur beyond the fence ends, particularly south of the project area, but do not appear to be increasing. These results may suggest that wildlife-highway mitigation on SH 9 is not completely capturing the WVC hotspot. Still, there was no increase in WVC carcasses at the south fence end and terminating the mitigation at this location does not appear to have affected WVC rates south of the project area. Further analysis through the next two years of this research study will help to determine whether there are additional mitigation needs south of the project area.

As of Year 3 of this research, the wildlife-highway mitigation on SH 9 does not appear to be influencing WVC rates on US 40. Wildlife-vehicle collision carcasses on US 40 were relatively high in Winter 2010-11 and again in Winter 2015-16, the latter timeframe corresponding with construction of Phase 1 mitigation on SH 9. However, in Winter 2016-17 and Winter 2017-18 WVC rates on US 40 dropped again. These variations in WVC rates on US 40 may be due to a number of factors, such as annual weather and snow depths, traffic volumes and human activity in the landscape.

### Next Steps

The results from the first three years of monitoring on SH 9 are promising and several performance measures for the mitigation project regarding mule deer use of crossing structures have already been achieved. Other objectives, for example, regarding elk use of crossing structures or mule deer use of escape ramps, have not yet been achieved, but will continue to be monitored and evaluated. The research team will continue post-construction monitoring through Winter 2019-20 and will continue to provide recommendations to adaptively manage the mitigation as appropriate. The results of this study are expected to inform future wildlife-highway mitigation projects in Colorado and beyond.

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## APPENDICES

### Appendix A: Monitoring Methods

Mitigation effectiveness was measured with two general types of measures: the number of movements made by mule deer, elk and other wildlife through the crossing structures and success vs. repel rates for each species; and the reduction in WVC. The research methods used to evaluate these measures are presented below.

#### Camera Monitoring

Monitoring locations are listed in Table 1; Figures 1 & 2 depict the locations of all monitoring sites across the project area. Monitoring was conducted in three discrete phases:

*Pre-construction:* From November 2014 to the onset of mitigation construction in April 2015. Pre-construction camera monitoring was conducted by CPW at all crossing structure locations. At each location, a camera was set up on either side of the highway.

*Pre-completion:* From the onset of this research study (December 2015) through the completion of Phase 2 construction (November 2016). Pre-completion monitoring involved the deployment of 40 cameras at 24 locations. Pre-completion monitoring was conducted by the ECO-resolutions team with support from CPW.

*Post-construction:* Following the completion of all construction activities (December 2016) through Winter 2019-20. During Year 3, post-construction monitoring involved the deployment of 62 cameras at 49 locations. Post-construction monitoring is being conducted by the ECO-resolutions team with support from CPW.

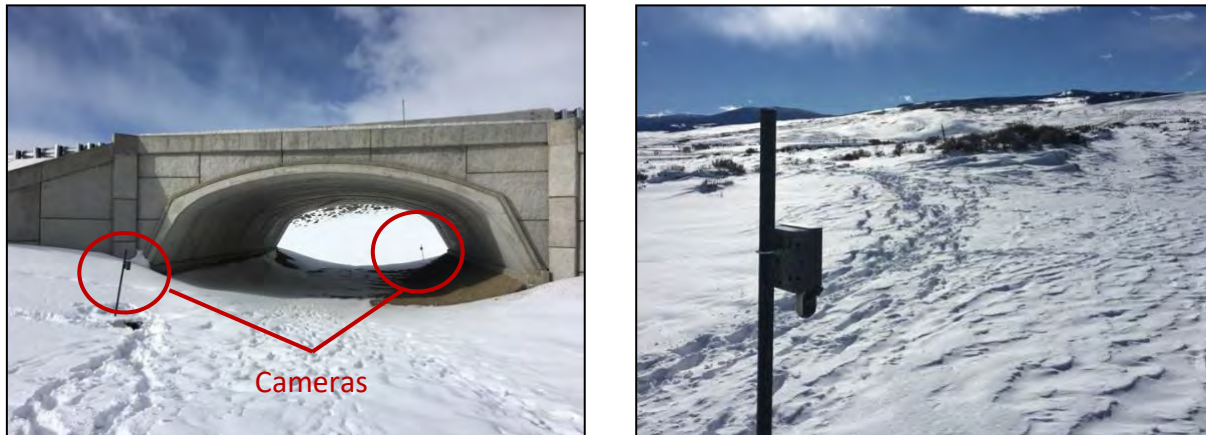
Monitoring was conducted using motion-triggered Reconyx Professional Series cameras (PC800 and PC900). Cameras were installed on T-posts using a U-bolt system and Reconyx security boxes. Where cameras were placed in areas with human activity or visible from the roadside, the cameras were mounted inside metal utility boxes to disguise the camera. All cameras were code-



locked and secured with master locks and/or cable locks. The cameras were motion-triggered and took photos day and night with a rapid-fire setting and no down time. Cameras were set to take burst of 10 photos per trigger and continued triggering as long as movement was detected. Exceptions were at wildlife guards with heavy traffic, where cameras were set to 3 or 5 photos per trigger and were scheduled to trigger only between before dusk to after dawn (from 4:30pm to 8am).

Fourteen pre-construction cameras documented species presence and relative abundance of non-mule deer species at future wildlife crossing locations during Winter 2014-15. At each future structure location, a camera was deployed on either side of SH 9 approximately 50' (15 m) from the highway. Prior to the construction of the wildlife crossing structures and wildlife exclusion fence, wildlife could cross SH 9 at any point along the highway rather than at discrete crossing locations. Therefore, pre-construction monitoring could only capture a snapshot of this dispersed wildlife activity near the roadway. The objective of pre-construction monitoring was to compare species that were present near the roadway prior to mitigation construction with their relative abundance post-mitigation construction. Accordingly, species presence for all non-mule deer species was tallied without a categorization of animal behavior. Movements across SH 9 or repel movements from the highway right-of-way were not captured in pre-construction monitoring.

For post-construction monitoring, cameras were set up at each monitoring location to maximize capture rates and wildlife responses to the mitigation features. At crossing structures, cameras were placed to capture wildlife behavior at the entrance of the structure to distinguish success movements (passage through a crossing structure) from repels and parallel movements. Two cameras were placed at each arch underpass, at opposite corners. In addition, a habitat camera was placed on one side of each underpass, 50-100 feet from the structure entrance, directed toward the habitat facing away from the road (Fig. A-1). The two overpass structures have steep entrance slopes leading to the top of the structures, so in addition to the two cameras on top of each structure, additional cameras were placed at the bottom of the slopes on either side of the structure. These 'entrance' cameras were more likely to capture repels and parallel movements, while the structure cameras could be used to confirm through-passage. Habitat cameras were placed on each side of the overpass facing outward to capture wildlife movements in the adjacent habitat.



*Figure A-1.* Two cameras were positioned at each underpass at opposite corners (left). Habitat camera placed 50-100 feet in front of a structure, facing out into the adjacent habitat (right).

Cameras at other monitoring locations were positioned to capture specific wildlife behaviors. At wildlife guards and pedestrian walk-through gates, cameras were placed to capture wildlife behavior in front of the guard or walk through gate (e.g., approaches, repels and breaches). All wildlife guard cameras were set to 5 pictures per trigger and locations with high vehicular traffic were programmed to be off from 8am – 4:30pm Mountain Standard Time year-round.

Cameras were deployed at 13 wildlife guard locations for varying amounts of time. Flat bar guards were installed at all locations during Phase 1 construction. In Phase 2, round bar guards were installed at five locations, including replacement of two flat bar guards that had been previously installed in the Phase 1 segment. Flat bar guards were installed at all remaining sites. Four round bar wildlife guards were installed at locations in close proximity to flat bar wildlife guards. These pairings will help in evaluating wildlife responses to the wildlife guards where the motivations for breaching or repelling from the guards are expected to be similar, thereby helping to minimize confounding factors that may influence guard effectiveness. Wildlife guards are just under 16' long with the bars spaced 4" apart, and of varying widths, corresponding to the width of the road or driveway. The size of the wildlife guards and the spacing between bars is the same for both the flat bar and round bar designs.

Two cameras were set up at each monitored escape ramp, one at the base of the ramp to capture wildlife approaching the ramp or walking around the ramp; and one on the habitat side to capture

wildlife at the top of the ramp, including successful jump downs as well as jump up attempts from the habitat side onto the ramp. Through Year 3, 13 escape ramps have been monitored for varying lengths of time. In the Phase 1 (north) segment, all ramps were constructed with a 2:1 slope and perpendicular rail fence, except for the North Overpass Escape Ramp, on which rail fence was not constructed. Based on preliminary observations and recommendations by the research team, during Phase 2 construction all ramps were constructed with a 3:1 slope instead of a 2:1 slope (Fig. 24). In general, ramps were constructed with perpendicular rail fence, except for select locations where rail fence was omitted per the request of the researchers, who wanted to evaluate the effectiveness of ramps with and without perpendicular rail fence. In addition, two new 3:1 slope escape ramps were constructed in the Phase 1 segment near existing 2:1 slope ramps. These two ramps are also situated at lower topographic positions relative to the roadway, while the 2:1 slope ramps are at higher topographic positions above the roadway. All of the ramps built in both construction phases are six feet high at the jumping off point, with a 16' wide fence gap.



*Figure 30.* Example of an escape ramp with a 2:1 slope with perpendicular rail fence (left) and a ramp with a 3:1 slope with no rail fence (right).

At the south fence end, cameras were positioned to capture both wildlife movements into and out of the fenced right-of way, as well as movements that occurred beyond the fence end.

## Photo Analysis

Cameras were visited every 4-5 weeks during the winter months and every 6-8 weeks the rest of the year to exchange memory cards and batteries. Photo data were systematically processed to identify movement events every time a camera is triggered. Events are defined by the movements of individuals or groups at crossing structures, wildlife guards, escape ramps, pedestrian gates, and the fence end. Events were defined as 15-minute time periods based on the methodology developed by Cramer (2012) because animals typically leave the camera area within 15 minutes. For each 15-minute timeframe, if an animal approached a structure multiple times without crossing, this was considered a single event until the animal crossed, repelled, or the 15-minute period ended, in which case a new event would be recorded. Events at all monitoring locations were recorded in a SQL database created for this research.

All events were categorized by time of day according to three time periods: day, night, and dawn/dusk. To account for the changes in the timing of dawn and dusk throughout the year, time of day was determined by the images themselves – color photos are taken during the day; black and white photos are taken at night; and black and white photos taken at dawn and dusk appear with a lighter background.

For each event at a crossing structure, the researchers identified, by species, the number of individuals and their gender (if possible), the direction of the movement, and their response to the crossing structure: through passage (success), repel or parallel movement. These were defined as follows:

*Success* – Movement all the way through the crossing structure.

*Repel* – Initial movements near the entrance to the crossing structure that resulted in the animal turning away from the structure rather than passing through.

*Parallel* – Animals moved near the structure but were either headed in a direction beyond the structure entrance or were grazing on vegetation, with behaviors that were not indicative of attempts to use the structure.

Total Movements were calculated for each wildlife crossing structure as,

$$\text{Total Movements} = \text{Success Movements} + \text{Repel Movements} + \text{Parallel Movements}$$

Unique movements by individual deer were tallied only once, even when two cameras recorded the movement. Individual repel and parallel movements were tallied only once when the same deer moved in front of a camera multiple times in a 15-minute event period.

Numbers for all non-mule deer species were tallied at the habitat cameras directed toward the habitat facing away from the road. Tallying species presence at habitat cameras allows comparisons of species composition and abundance in the habitat near a crossing structure with the species successfully using the crossing structure. Since these cameras are only meant to document species presence and abundance, the photos are analyzed without a categorization of animal behavior.

Three small culverts were monitored, including two 8' x 8' box culverts and one 8' diameter concrete pipe culvert. The pipe culvert also had an open-top concrete trench at the outlet, effectively increasing the structure length. One camera was placed at either the east or west entrance of each culvert. Success movements at small culverts were tallied when an animal entered and did not reemerge from the culvert within 15 minutes, or when an animal emerged from the culvert without previously having entered it.

At wildlife guards, animal movements were categorized as a breach, repel or parallel movement. A breach movement occurred when an animal jumped or walked over the guard or, by another method, was able to move from the habitat side of the guard into the highway right-of-way or vice versa. At escape ramps, four different types of movement were recorded, 1) animals walking along the fence line inside the right-of-way that did not ascend (intercept) the ramp, but instead walked around the base of the ramp; 2) animals that ascended the ramp and then turned back down the ramp inside the right-of-way; 3) animals that ascended the ramp and jumped down (escaped) to the habitat side; and 4) animals that attempted to climb or jump up to the top of the ramp from the habitat side. At the fence end, individual movements were categorized as movements into the fenced right-of-way, movements from the fenced-right-of way out to the adjacent habitat, or movements that occurred beyond the fence end.

The following indices were calculated for each monitoring location, as applicable. These indices were then used to evaluate performance as described below under *Performance Measures*.

- **Success rate** – For each species at a given crossing structure location, the total number of individual movements of the species that were recorded moving through the structure divided by the total movements by that species.
- **Repel rate** – For each species at a given crossing structure location, the total number of individual movements of the species that were recorded being repelled at a structure divided by the total movements by that species. Repel rate was also calculated for deer and elk at wildlife guards, pedestrian walk-through gates and fence ends. In these cases, a repel movement is the desired wildlife behavior response to the mitigation features, i.e., the total number of times deer/elk were repelled divided by the total number of times deer/elk approached the mitigation feature.
- **Parallel rate** – For each species at a given monitoring location, the total number of individual movements of the species that were recorded moving parallel to the mitigation feature divided by the total movements by that species. This metric is calculated for crossing structures, escape ramps, and pedestrian walk-through gates.
- **Intercept rate** – This metric is calculated for deer and elk at escape ramps. It is the total number of times deer/elk were recorded ascending an escape ramp divided by the number of times deer/elk approached an escape ramp.
- **Escape rate** – This metric is calculated for deer and elk at escape ramps. It is the total number of times deer/elk were recorded successfully jumping down from an escape ramp divided by the number of times cameras captured deer/elk walking up the escape ramp.
- **Breach rate** – This metric is calculated for deer and elk at wildlife guards, escape ramps, pedestrian walk-through gates, and fence ends. It is the total number of times individual deer/elk breached the mitigation feature divided by the total number of times deer/elk approached that mitigation feature. For example, at a wildlife guard, breaches occur when animals cross over the guard; at escape ramps, breaches occur when animals jump up onto an escape ramp from the habitat side of the wildlife exclusion fencing; at a pedestrian walk-through gate, breaches occur when animals pass through the gate; at the fence end, breaches occur when animals enter into the fenced right-of way from beyond the fence end.



- **Average deer per day** – The total number of unique deer movements (not individuals) observed at the structure divided by the sampling effort. Sampling effort is calculated as the number of days a camera was in operation (or the average number of days for locations with two cameras) and is useful for standardizing the number of mule deer photographed when there is variation in the number of days that cameras were in operation at different monitoring locations. Deer per day may also be calculated for wildlife guards.
- **Average successful deer passages per day** – The total number of times deer successfully used a structure divided by sampling effort.

### Wildlife-Vehicle Collision Data Analysis

Wildlife-vehicle collision rates were analyzed using three independent datasets – WVC carcass data compiled by BVR and CPW; WVC carcass data recorded by CDOT maintenance patrols; and WVC accident reports compiled from law enforcement by CDOT Traffic and Safety. Blue Valley Ranch staff have recorded WVC carcass data north of Spring Creek Road (MP 128.5) to the town of Kremmling (MP 138) since 2005 and will continue to report these data through the duration of this research study; however, the 2005 data do not include month or day, and these data were excluded from further analysis. To complement these data, in 2013 CPW also began collecting carcass data south of Spring Creek Road to the southern end of the project area (MP 126). Carcass data were collected daily from November through April, when WVC are most common, with incidental reports compiled through the remainder of the year. Data collection included all species, with a focus on ungulates and large and medium-sized animals.

CDOT maintenance patrols have been recording carcasses due to WVC since 2005. Carcass reporting by maintenance personnel is non-compulsory. It is likely that reporting effort in the first years of the program was inconsistent. As the program became more established, reporting effort is believed to have become more consistent. WVC carcass pickups are reported year-round for all species, although the majority of carcass reports are deer and elk.

The study is also examining WVC accident reports compiled by CDOT Traffic and Safety. Wildlife-vehicle collision crashes, while underreported, are reported statewide and offer a useful standard for comparing WVC accident rates inside the project area with those outside of the

project area pre- and post-mitigation construction. The Year 3 progress report includes WVC accident data analysis through April 2017, as data for late 2017 and 2018 were not available at the writing of this report.

Winter was defined as the months of December through April for all analyses. Analyses of all three datasets focused on the winter timeframe; however, non-winter months were included in the analysis of reported WVC accidents to demonstrate the seasonality of WVC in the project area. Each WVC dataset was analyzed with respect to the date and location of WVC, and the species involved in these collisions. For this progress report, the researchers compared the five-year pre-construction WVC averages (Winter 2010-11 through Winter 2014-15) for each dataset with post-construction WVC rates.

Because CDOT maintenance reports are collected statewide, this dataset was selected for additional analyses of SH 9 one mile north and south of the project area and on a nearby segment of US 40 to identify a potential influence of the project on WVC rates beyond the project area. Both segments of highway are maintained by the same CDOT patrol eliminating potential data collection variations that may occur between patrols. Comparing WVC rates inside the project area with those beyond the project area, but within habitat used by the same ungulate herds and affected by the same weather patterns, helped the researchers to generalize reasons for potential changes in WVC in time and space, and the extent to which these changes may be due to the mitigation project. An increase in WVC from an annual baseline outside of the project area with a corresponding decrease in the mitigated area may suggest a shift in wildlife movement around the mitigated segment.

### Performance Measures

Performance measures allow an evaluation of how well the wildlife mitigation accomplishes stated objectives of a highway improvement project. These measures help agencies take adaptive management actions to increase the effectiveness of the mitigation, or to inform future mitigation projects in other locations. It is essential to define measurable performance measures at the outset of a project to objectively evaluate project success. The wildlife mitigation system on SH 9 is evaluated with respect to wildlife connectivity and traffic safety. Specifically, wildlife

connectivity performance measures address how well the crossing structures allow wildlife populations to access habitat on both sides of the highway; and traffic safety performance measures address how well the mitigation reduced WVC. Performance measures were generated by the researchers in conjunction with the research Study Panel.

The research team and study panel re-evaluated the performance measures following the first winter of post-construction monitoring (Winter 2016-17) in light of preliminary research results and recently published reports from comparable studies. No alterations were made to success thresholds established in Year 1 of the study. The team considered adding a measure evaluating intercept rates at escape ramps, but ultimately declined to do so; however, the team will report on intercept rates and escape rates at escape ramps. Performance Measure #12, which evaluates pedestrian walk-through gates, was eliminated as the walk-through gates were closed off with swing gates in Fall 2017. The research team observed deer breaching the gates – in some cases moving back from the ROW side to the habitat side, as well as breaches into the ROW – and CPW determined that these gaps should be closed. No additional changes to the performance measures will be made for the duration of the study to ensure that the measures remain unbiased by the study results.

#### Wildlife Connectivity Performance Measures

Wildlife connectivity is assessed for large and meso mammal species. To evaluate how well the wildlife crossing structures facilitate species' use, performance measures are based on two rates: 1) success rates, and 2) the number of movements recorded through or over structures per year for each species (movements/year).

#### *Success Rates*

*1. Mule deer success rate at each structure will be a minimum of 60%, and have a goal of 80% success during the final year of the study (based on Montana - Cramer and Hamlin 2016; Utah – Cramer 2014, 2016; Wyoming – Sawyer et al. 2012).*

*2. Elk success rate at each structure will be a minimum of 60%, and have a goal of 75% success during the final year of the study (based on Arizona – Gagnon et al. 2011).*

3. *Success rate for all meso to large mammal species (other than deer and elk) detected near each structure will be a minimum of 60%, and have a goal of 80% success for each structure during the final year of the study (based on Montana – Purdum 2013).*

#### *Movements per Year*

4. *By the end of the study, male and female mule deer movements through all crossing structures will be in the same male:female proportions as are estimated for the local population (based on population estimates as determined by CPW).*

5. *By the end of the study, male and female elk movements through all crossing structures will be in the same male:female proportions as estimated for the local population (based on population estimates as determined by CPW).*

6. *By the end of the study, the number of elk success movements at all structures annually, will be at least 50% of the number of elk movements captured at associated habitat cameras (i.e., documenting animals in the vicinity of the structures, but not necessarily using structures), irrespective of season (based on Arizona – Gagnon et al. 2011).*

7. *Each year there will be an increase in the number of mule deer movements at wildlife crossing structures annually until an overall equilibrium/plateau is reached (based on Arizona – Gagnon et al. 2011; Dodd et al. 2012; Utah – Cramer 2016; Montana – Cramer and Hamlin 2016).*

8. *Each year there will be an increase in the number of elk movements at wildlife crossing structures annually until an overall equilibrium/plateau is reached (based on Arizona- Gagnon et al. 2011; Dodd et al. 2012; Utah - Cramer 2016; Montana - Cramer and Hamlin 2016).*

9. *Each year, there will be at least one to several successful movements through or over crossing structures for every one of the less common species of large ungulates and carnivores in the study area that are documented by the habitat cameras. This may include bighorn sheep, pronghorn, moose, white-tailed deer (*Odocoileus virginianus*), mountain lion, black bear, bobcat, and other species (Utah – Cramer 2016; Montana – Cramer and Hamlin 2016).*

10. *By the end of the study, at least 80% of the individual mule deer, elk and other ungulate approaches to each wildlife guard will be deterred from entering the road right-of-way (based on Utah – Cramer and Flower 2017; Flower 2016).*

*11. By the end of the study, 50% of the individual mule deer and elk that ascend an escape ramp will escape to the habitat side, and no animals will jump up onto the ramp from the habitat side. (based on Arizona – Arizona Game and Fish Department, unpublished data; Colorado – Siemers et al. 2015).*

*12. By the end of the study, 100% of the individual mule deer and elk approaches to each pedestrian walk-through gate will be deterred from entering the road right-of-way. This performance measure will no longer be evaluated. In Year 2, breach rates for mule deer at the pedestrian walk-through gates ranged from 5-21% (Kintsch et al. 2018). In total, 32 breaches were made by mule deer and 2 by elk out of total of 304 and 47 movements, respectively. CPW determined that these breaches – and potential WVC – could be eliminated entirely with the installation of swing gates across the gate openings. By September 2017, all of the pedestrian walk-through gates in the project area were equipped with swing gates to block ungulate movements and monitoring activities ceased at these locations.*

*13. By the end of the study, the proportion of ungulate movements at the south fence end that enter into the fenced right-of-way will decrease to 20% or less (based on Utah – Cramer unpublished data, 2016).*

#### Traffic Safety Performance Measures

Traffic safety performance measures evaluate how well the wildlife mitigation reduced wildlife-vehicle collisions. This is measured with reported crashes and carcasses.

*14. The annual average number of WVC reported crashes (CDOT Traffic and Safety data) within the mitigated area of the study will decrease by at least 80% during the final two years of the study when compared to the five-year pre-construction average (based on Alberta, Canada – Clevenger and Barrueto 2014; Wyoming – Sawyer et al. 2012; compiled study – Huijser et al. 2009).*

*15. The annual average number of wildlife carcasses reported by Blue Valley Ranch and Colorado Parks and Wildlife within the mitigated area of the study will decrease by at least 80% during the final two years of the study when compared to the five-year pre-construction average (based on Alberta, Canada - Clevenger and Barrueto 2014; Arizona – Gagnon et al. 2015; Washington – McAllister et al. 2013).*

16. *By the last year of the study, the average annual number of WVC reported crashes within one mile south of the south fence end will not increase over the five-year average annual pre-construction crash rate for this section of road (based on Arizona – Gagnon et al. 2015; Wyoming – Sawyer et al. 2012).*

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## Appendix B: Pre-Construction Monitoring Results

Mule deer were observed at all locations during pre-construction monitoring. Given their pervasiveness in the project area, mule deer presence and abundance was not tallied. Of all other wildlife species, elk and coyote were the most commonly documented species (Table B-1). Elk were most common in the southern portions of the project area, at the future sites of Williams Peak Underpass and the South Overpass. In the northern portion of the project area, bobcat was the most commonly documented species (other than mule deer) and occurred only at the future North Underpass site. Other species detected during pre-construction monitoring included red fox, American badger, hare/rabbit, striped skunk, and domestic dogs and cats.

**Table B-1.** Wildlife presence by species other than mule deer during pre-construction at future wildlife crossing structure locations. Pre-construction monitoring was conducted at all locations from November 2014 – March 2015. Additional pre-construction monitoring was conducted in the Phase 2 (south) segment during Winter 2015-16.

Monitoring Location	Elk	Moose	Pronghorn	Mountain Lion	Bobcat	Coyote
<b>Phase 1 (North) Segment</b>						
MP 136.0 – North Underpass	1	0	0	0	26	10
MP 134.3 – North Overpass	0	0	0	0	0	0
MP 132.5 – Middle Underpass	0	0	0	0	0	0
MP 131.6 – Harsha Gulch Underpass	0	0	0	0	0	3
<b>Total Non-Mule Deer Wildlife</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>26</b>	<b>13</b>
<b>Phase 2 (South) Segment</b>						
MP 130.8 – BVA Underpass	0	1	0	2	1	8
MP 129.5 – South Overpass	25	0	1	0	1	50
MP 127.7 – Williams Peak Underpass	41	0	0	0	0	8
<b>Total Non-Mule Deer Wildlife</b>	<b>66</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>66</b>

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# Effects of Road Networks on Bird Populations

A. V. KOCIOLEK,\*‡ A. P. CLEVENGER,\* C. C. ST. CLAIR,† AND D. S. PROPPE†

\*Western Transportation Institute, Montana State University, 2327 University Way, Bozeman, MT 59715, U.S.A.

†Department of Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9, Canada

**Abstract:** *One potential contributor to the worldwide decline of bird populations is the increasing prevalence of roads, which have several negative effects on birds and other vertebrates. We synthesized the results of studies and reviews that explore the effects of roads on birds with an emphasis on paved roads. The well-known direct effects of roads on birds include habitat loss and fragmentation, vehicle-caused mortality, pollution, and poisoning. Nevertheless, indirect effects may exert a greater influence on bird populations. These effects include noise, artificial light, barriers to movement, and edges associated with roads. Moreover, indirect and direct effects may act synergistically to cause decreases in population density and species richness. Of the many effects of roads, it appears that road mortality and traffic noise may have the most substantial effects on birds relative to other effects and taxonomic groups. Potential measures for mitigating the detrimental effects of roads include noise-reduction strategies and changes to roadway lighting and vegetation and traffic flow. Road networks and traffic volumes are projected to increase in many countries around the world. Increasing habitat loss and fragmentation and predicted species distribution shifts due to climate change are likely to compound the overall effects of roads on birds.*

**Keywords:** bird populations, roads, road mortality, roadway lighting, surface transportation, traffic noise

Efectos de las Redes de Caminos sobre Poblaciones de Aves

**Resumen:** *El incremento en la prevalencia de caminos, que han tenido varios efectos negativos sobre aves y otros vertebrados, es un potencial contribuyente a la declinación mundial de poblaciones de aves. Sintetizamos los resultados de estudios y revisiones que exploran los efectos de los caminos sobre las aves, con énfasis en caminos pavimentados. Los bien conocidos efectos directos de los caminos sobre las aves incluyen la pérdida y fragmentación de hábitat, mortalidad causada por vehículos y envenenamiento. Sin embargo, los efectos indirectos pueden ejercer una mayor influencia sobre poblaciones de aves. Estos efectos incluyen ruido, luz artificial, barreras al movimiento y bordes asociados con caminos. Más aun, los efectos indirectos y directos pueden actuar sinérgicamente para causar decrementos en la densidad poblacional y en la riqueza de especies. De los muchos efectos de los caminos, parece que la mortalidad y el ruido del tráfico tienen los efectos más significativos sobre las aves en relación con otros efectos y grupos taxonómicos. Las medidas potenciales para mitigar los efectos perjudiciales de los caminos incluyen estrategias de reducción de ruido y cambios en la iluminación y vegetación de los caminos y en el flujo de tráfico. Se proyecta que las redes de caminos y los volúmenes de tráfico incrementen en muchos países en el mundo. Es probable que el incremento en la pérdida y fragmentación de hábitat y los cambios pronosticados en la distribución de especies debidos al cambio climático compliquen los efectos de los caminos sobre las aves.*

**Palabras Clave:** caminos, iluminación en caminos, poblaciones de aves, mortalidad en caminos, ruido de tráfico, transportación terrestre

## Introduction

Bird populations are declining around the world (BirdLife International 2008a). In North America the abundances

of at least 20 species previously categorized as common have declined more than 50% in the last 40 years (Butcher & Niven 2007; BirdLife International 2008b). Additionally, abundances of over half the species of Neotropical

‡email [angela.kociolek@coe.montana.edu](mailto:angela.kociolek@coe.montana.edu)

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migrants have declined substantially. The reasons for these declines are not fully understood (Butcher & Niven 2007; BirdLife International 2008c). One likely contributor is the expansion of paved roads, mostly in terms of widening (National Research Council 2005), and corresponding increases in the speed and volume of vehicles on those roads (Ritters & Wickham 2003). We synthesized these effects on birds to balance the much greater attention that has hitherto been paid to the effects of roads on mammals and to examine the potentially negative effects of roads on birds worldwide.

Reduced breeding success is correlated with proximity of birds to roads and road density for species ranging from passerines (Catchpole & Phillips 1992; Reijnen & Foppen 1994) to vultures (Donazar et al. 1993). In some cases, avian communities adjacent to roads differ from nearby avian communities (Glennon & Porter 2005), presumably because of some combination of the direct and indirect effects of roads on animals in general (Forman & Alexander 1998; Trombulak & Frissell 2000; Fahrig & Rytwinski 2009).

There is a little understanding of whether declines in persistence of birds are more affected by direct or indirect effects. If this could be determined in urban areas, it may be possible to increase bird abundance and species richness. It is also important to identify and mitigate any negative road effects in protected areas, which are assumed to buffer populations of wild animals from human activities.

Many of the negative effects of roads on other vertebrates (e.g., mortality, habitat fragmentation, and audiovisual disturbance, chemical pollution) also apply to birds (Forman et al. 2003; Jacobson 2005). There are a few ways roads can benefit birds. For example, roads retain heat that can reduce metabolic costs for birds that rest on road surfaces (Whitford 1985), associated road infrastructure (e.g., poles and bridges) can create nesting sites (Forman 2000), and verges increase availability of food sources (Lambertucci et al. 2009) and link patches of habitat (Meunier et al. 1999; Huijser & Clevenger 2006; Reijnen & Foppen 2006). We reviewed recent reports and peer-reviewed articles focused primarily on direct and indirect negative effects of roads on bird populations and identified some potential forms of mitigation. Much of the literature we reviewed concerns paved roads because they have been the subject of more study and because their ecological effects are assumed to be greater than gravel, dirt, or ice roads (Forman et al. 2003; National Research Council 2005).

## Direct Threats Posed to Birds by Roads and Traffic

For bird populations the most visible direct negative effects of roads are habitat loss and mortality due to collisions

with vehicles. Because the effects of habitat loss on birds have been comprehensively reviewed elsewhere (Andren 1994), we did not focus on this effect here. Nonetheless, roads have other effects that are related to habitat loss. For example, maintenance activities in the right-of-way can further reduce habitat quality and destroy nests, which may reduce population viability for rare species (e.g., Burrowing Owl [*Athene cunicularia*]) (Catlin & Rosenberg 2006). We focused on the negative effects associated with vehicular traffic.

### Vehicle-Caused Mortality

For individual birds and other vertebrate groups, a direct threat of roads is death due to collisions with vehicles (Erritzoe et al. 2003). In the United States, vehicles are estimated to cause approximately 80 million bird fatalities each year (Erickson et al. 2005). Despite the high number of mortalities each year, vehicle-caused mortality has been assumed to have less of an effect on persistence than some indirect effects of roads (Forman & Alexander 1998; Reijnen & Foppen 2006). Only three bird species found in the United States appear to suffer population declines as a result of them: Florida Scrub-Jay (*Aphelocoma coerulescens*) (Mumme et al. 2000; IUCN 2008), Audubon's Crested Caracara (*Polyborus plancus audubonii*), and Hawaiian Goose (*Branta sandvicensis*) (Huijser et al. 2007; IUCN 2008). A greater understanding of what makes some species more susceptible to vehicle collision and population decline as a result of vehicle-caused mortality is needed, but some generalities emerge from the literature.

First, birds are more likely to collide with vehicles if they forage, roost, or nest near roads (Erritzoe et al. 2003; Huijser et al. 2007). Collision frequency can increase near watercourses (Erritzoe et al. 2003; Ascensao & Mira 2006) and houses (Ascensao & Mira 2006). Collisions are also more likely to occur at lower elevations (Clevenger et al. 2003) and in open areas than in forests (e.g., Clevenger et al. 2003; Ascensao & Mira 2006; Ramp et al. 2006).

Several other factors have less consistent effects on vehicle-induced bird mortality. For many species, vehicle-induced mortality increases during breeding and migration (Fulton et al. 2008; Gryz & Krause 2008), but for other species it increases during winter (Loos & Kerlinger 1993; Boves 2007). Collisions can increase (Jackson 2003) or decrease as roadside lighting increases (Hernandez 1988). Roadside trees, hedgerows, and other features that cause birds to fly higher across roads typically decrease collision frequency (Pons 2000; Bard et al. 2002; Clevenger et al. 2003; Erritzoe et al. 2003; Taylor & Goldingay 2004; Orłowski 2005), but they can also increase it (Ramp et al. 2006; Varga et al. 2006). Birds also vary in their responses to roads. Some individuals appear to learn to avoid vehicles (Mumme et al. 2000), whereas others do not (Loos & Kerlinger 1993; Jackson 2002).

It is difficult to measure the true extent of vehicle-induced mortality because estimates are typically far lower than the actual number of birds killed (Erickson et al. 2005). Estimation accuracy is reduced by variation in searcher efficiency, scavenger bias (Erickson et al. 2005; Boves 2007), and incorrect attribution of cause of death (Kerlinger & Lein 1988). Even long-term studies in which 100% of individuals are marked, researchers can fail to detect all instances of vehicle-caused mortality (Mumme et al. 2000). Vehicle collisions may also cause nonfatal injuries that increase the probability birds will die from other causes (Orlowski & Siembieda 2005). In addition, inaccurate estimates of vehicle-induced mortality can result if only carcasses are studied in the absence of data on species abundance (Hernandez 1988; Aebischer et al. 2005). Missing information about population size makes it difficult to compare rates of mortality in different areas, especially on different continents (Erritzoe et al. 2003).

### Pollution and Poisoning

Deicing agents, petroleum-based organic compounds, nutrients, sediments, agricultural chemicals, and other substances regularly run off paved roads during construction, maintenance, and use (Buckler & Granato 1999). Road salt is a common deicing agent that attracts birds. Its ingestion can lead to death, which dispels the notion that road salt has a negative effect only because it attracts birds to the road surface, making them subject to collisions with vehicles (Mineau & Brownlee 2005). Dust on unpaved roads can change the composition of vegetation (Walker & Everett 1987), which can affect birds (Kalisz & Powell 2003). Gravel roads are frequently treated with dust suppressants, the environmental and toxicological effects of which are not well understood (Fay & Kociolek 2009). Despite the ubiquity of road contaminants from vehicles and maintenance activities, toxic effects of roads appear to be rare, even in areas with high traffic volumes (Buckler & Granato 1999), and pollution appears to have fewer effects on birds than other road-related effects (Reijnen & Foppen 2006).

### Indirect Threats Posed to Birds by Roads and Traffic

Even in the absence of direct deleterious effects, many bird species appear to avoid roads purposely (e.g., Bollinger & Gavin 2004; Balbontin 2005; Gavashelishvili & McGrady 2006). Some species may be present near roads for a time, but they are more likely to abandon nests near roads (Gorog et al. 2005). For birds, road avoidance appears to be associated with the physical barrier to movement roads present, noise, artificial light, and edge effects.

### Physical Barriers

Of the indirect threats of roads, the barriers to movement roads present may have the greatest effect on vertebrates (Forman & Alexander 1998). Several forest-dwelling bird species are unlikely to cross gaps in forest cover  $\geq 50$  m in areas dominated by agriculture (Desrochers & Hannon 1997), timber harvesting (Awade & Metzger 2008), and urban infrastructure (Tremblay & St. Clair 2009). Some species exhibit reluctance to cross dirt roads that are 10–30 m wide (Develey & Stouffer 2001). Nonetheless, the barriers caused by roads may be a simple function of the width of the gap they create in the surrounding habitat, unless the roads are also noisy (St. Clair 2003; Tremblay & St. Clair 2009) or are associated with tall features such as power lines (Pruett et al. 2009).

### Noise

Traffic noise probably has the most widespread and greatest indirect effect on birds (Reijnen et al. 1995 (Table 1). Noise likely causes reductions in population densities that have been reported for several bird species that are present near roads (Reijnen & Foppen 2006; Patricelli & Blickley 2006). In grasslands the effects of noise appear to extend farther from roads than in forests (Forman et al. 2002), perhaps because grasslands have less vegetation to absorb sound. In addition to the effects of traffic volume and its associated noise, there may be synergistic effects of noise, habitat loss and fragmentation (Forman & Deblinger 2000), and edge effects (Habib et al. 2007).

Birds may be affected by anthropogenic noise because they rely extensively on acoustic communication (Table 1). Chronic industrial noise can reduce species richness, alter population age structure, and change avian predator-prey dynamics (Francis et al. 2009). Like industrial noise, chronic traffic noise appears to produce younger age structures and reduces population densities in several bird species (Reijnen & Foppen 2006). These effects may occur because anthropogenic noise masks the frequencies of calls used to attract mates (Rheindt 2003; Pohl et al. 2009), communicate with flock members (Lohr et al. 2003; Slabbekoorn & Ripmeester 2008) or offspring (Leonard & Horn 2005), defend territories (Habib et al. 2007; Mockford & Marshall 2009), and detect predators (Slabbekoorn & Ripmeester 2008; Francis et al. 2009) (Table 1). Effects of noise on both birds and anurans seem to depend on the frequencies and amplitudes of species-specific signals (Lengagne 2008; Slabbekoorn & Ripmeester 2008; Hu & Cardoso 2009). Some species seem unaffected by roads or traffic (Kaselloo 2005; Reijnen & Foppen 2006), and others may not come near roads when traffic volume is high (Bautista et al. 2004). Several urban-dwelling songbird species appear to counteract the masking effects of traffic noise (Table 1) by singing at a higher pitch (Slabbekoorn & Peet 2003), increasing song amplitude (Brumm 2004b), or singing



**Table 1. The effects of anthropogenic noise on avian communities and communication.**

<i>Category</i>	<i>Effect</i>	<i>References</i>
Community		
species richness	reduced as noise increases	Stone 2000
density & abundance (all species)	reduced as noise increases	Reijnen et al. 1995, 1996; Kuitunen et al. 1998; Bayne et al. 2008
	no overall reduction	Peris & Pescador 2004
densities & abundance (specific species)	reduced as noise increases	Reijnen & Foppen 1994; Reijnen et al. 1995, 1997
	dependent on species	Kuitunen et al. 1998; Peris & Pescador 2004
	higher abundance of birds with higher song pitch near roads	Rheindt 2003
age structure	younger at noisy sites	Reijnen & Foppen 1994; Habib et al. 2007
physiology	increased stress at higher noise levels	Campo et al. 2005
	no stress difference at higher noise levels	Byers et al., unpublished data
Breeding cycle		
pairing and mate retention	decreased time devoted to courtship behavior	Goudie & Jones 2004
	reduced pairing success	Habib et al. 2007
	reduced mate preference	Swaddle & Page 2007
territory and nest-site selection	farther from noise sources	Francis et al. 2009
nest success	increased as noise increases for some species	Francis et al. 2009
Foraging		
begging calls	reduced parental discrimination in noisy locations	Leonard & Horn 2005
prey location and probability of predation	predator reduction increases nest success in noisy locations	Francis et al. 2009
	potential alterations to interspecies interactions	Slabbekoorn & Halfwerk 2009
	increased vigilance as noise increases	Quinn et al. 2006
Communication		
temporal adjustment	sing more at night in noisy locations	Fuller et al. 2007
amplitude increase	sing louder as noise increases (Lombard effect)	Cynx et al. 1998; Brumm 2004a, 2004b; Brumm et al. 2009; Osmanski & Dooling 2009
	louder begging calls in noisy locations	Leonard & Horn 2005
pitch modification	increased pitch in noisy locations	Slabbekoorn & Peet 2003; Fernandez-Juricic et al. 2005; Slabbekoorn & den Boer-Visser 2006; Wood & Yezerinac 2006; Parris & Schneider 2009; Kirschel et al. 2009; Nemeth & Brumm 2009
redundancy	no correlation between pitch and road noise	Skiba 2000
detection of con- and heterospecific vocal signals	more repetition in noisy locations	Brumm & Slater 2006
	reduced detection probability of signals in noisy locations	Langemann et al. 1998; Lohr et al. 2003
response to signals	strongest response to played-back signals when ambient noise levels are similar to local environment	Mockford & Marshall 2009
reviews	effects of noise and implications	Patricelli & Blickley 2006; Slabbekoorn & Ripmeester 2008; Barber et al. 2010
Brain response		
gene activation	immediate early-gene ZENK expression in the neural pathway of the avian brain not modified by noise playback	Vignal et al. 2004

during periods of low traffic noise (Fuller et al. 2007). Other species may be unable to adapt their songs to accommodate chronic noise (Slabbekoorn & Ripmeester 2008; Barber et al. 2010), and pairing success of birds with relatively high amplitude songs is reduced when they are exposed to high levels of chronic noise (Habib et al. 2007).

### Artificial Light

Light from roadways can have negative effects on many animals (Rich & Longcore 2006), including birds (Ogden 1996; Van De Laar 2007). Some lighting structures attract migrating bird species, which increases the probability they will be preyed on or collide with structures and often causes them to redirect flight paths and thus deplete energy stores (van de Laar 2007). Artificial lighting can also affect avian patterns of nestling development, singing, breeding, molting, and migration (De Molenaar et al. 2006). There is some evidence that roadway lighting may reduce habitat quality and change the timing of breeding for the Black-tailed Godwit (*Limosa limosa*), a species associated with grasslands in Africa, Europe, and Asia (De Molenaar et al. 2006). American Robins (*Turdus migratorius*) sing earlier in the morning in areas with more anthropogenic light (Miller 2006), but this response may be difficult to disentangle from the associated effect of road noise, which is more important than light for explaining nocturnal singing by European Robins (*Erithacus rubecula*; Fuller et al. 2007).

### Edge Effects

Positive and negative effects of edges on breeding birds have been documented in many studies (Stephens et al. 2003). The edge effects of roads may be particularly acute when introduced species, such as rats (*Rattus rattus*), prey on ground-nesting birds (Delgado et al. 2001) or parasitic species, such as Brown-headed Cowbirds (*Molothrus ater*), target the nests of species of conservation concern (Chace et al. 2003). In some cases, these edge effects are contradictory (Bergin et al. 2000; Lariviere 2003).

### Mitigation

Paved roads are a pervasive feature across much of North America, and existing roads are being widened, new roads are being built, and, and traffic volume is increasing (Forman et al. 2003; National Research Council 2005) throughout the world (Urban Land Institute 2007; Bhattacharya 2008). Efforts to mitigate road effects are most likely to increase probabilities of persistence of birds when applied across extensive areas (Stutchbury 2009).

New information about the ubiquity of the effects of noise on birds suggests reducing road noise may be

cost-effective because it can benefit both birds and humans (Bluhm et al. 2007; Slabbekoorn & Ripmeester 2008; Barber et al. 2010). Promising measures to reduce road noise include temporal adjustments to traffic flow (Reijnen & Foppen 2006) and increased reliance on mass transit (Barber et al. 2010). The unvegetated area created by light-rail train tracks is more permeable to bird movement than roads of equivalent sizes, perhaps because they are quieter (Tremblay & St. Clair 2009). New tire designs (Carstens 2003) and noise-absorbing porous asphalt (Piepers 2001) can substantially reduce levels of highway noise (Elvik & Greibe 2003). Other noise-reducing strategies include the use of earth berms and vegetation that, unlike walls (Varga et al. 2006), do not create vertical barriers to animal movement, although this may depend on the animal. These features typically also increase quality of life and property values for human residents.

Changing roadway lighting may also benefit both birds and people through reductions in energy consumption and increases in safety (De Molenaar et al. 2006). Replacing red or white lights with green lights greatly reduces the negative effect of artificial lights on oil platforms on birds (van de Laar 2007). Such lighting could be used on highway (Poot et al. 2008).

Edge effects might be partially mitigated with vegetation management and restoration. Poisoning and non-point source pollution can be mitigated, in part, by policy aimed at encouraging use of nontoxic agents to maintain safe driving conditions. A practice that would reduce vehicle-induced bird mortality would be to refrain from planting along roadsides fruit-bearing vegetation that attracts birds.

### Future Implications

In the United States road area is expected to increase by 27,900 km<sup>2</sup> by 2030, and lanes added to existing roadways to accommodate increased traffic volume is projected to increase road area by an additional 94,100 km<sup>2</sup> (Theobald 2010). Exponential increases in the road network and traffic volume are anticipated to occur in large, densely populated, countries such as China and India (Bhattacharya 2008). Among the factors studied to date, it appears that traffic noise has the greatest potential to reduce population abundance and species richness of birds (Reijnen & Foppen 2006; Barber et al. 2010). Although vehicle-caused mortality does not appear to affect persistence for most populations, it is a problem for some species (Huijser et al. 2007) and may exacerbate other anthropogenic threats to birds (Erickson et al. 2005). Given global traffic projections and in light of losses due to collisions, road-induced mortality of birds should be examined more systematically and comprehensively. Other road-related disturbances such as light and chemical

pollution appear to have minor effects at the population level, but their spatial extent may still generate a large collective effect on birds. Finally, increasing habitat loss and fragmentation, in addition to predicted species distribution shifts due to climate change, are likely to compound the overall effect of roads (Heller & Zavaleta 2009).

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RESEARCH ARTICLE

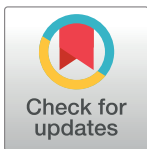
# Identifying riparian climate corridors to inform climate adaptation planning

Meade Krosby<sup>1\*</sup>, David M. Theobald<sup>2</sup>, Robert Norheim<sup>1</sup>, Brad H. McRae<sup>3†</sup>

**1** Climate Impacts Group, College of the Environment, University of Washington, Seattle, Washington, United States of America, **2** Conservation Science Partners, Fort Collins, Colorado, United States of America, **3** The Nature Conservancy, Fort Collins, Colorado, United States of America

† Deceased.

\* [mkrosby@uw.edu](mailto:mkrosby@uw.edu)



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## Abstract

Riparian habitats have been frequently identified as priority areas for conservation under climate change because they span climatic gradients and have cool, moist microclimates relative to surrounding areas. They are therefore expected to act as dispersal corridors for climate-induced species range shifts and to provide microclimatic refugia from warming. Despite recognition of these values, rigorous methods to identify which riparian areas are most likely to facilitate range shifts and provide refugia are currently lacking. We completed a novel analysis across the Pacific Northwest, USA, that identifies potential riparian corridors featuring characteristics expected to enhance their ability to facilitate range shifts and provide refugia. These features include large temperature gradients, high canopy cover, large relative width, low exposure to solar radiation, and low levels of human modification. These variables were used to calculate a riparian climate-corridor index using a multi-scale approach that incorporates results ranging in scale from local watersheds to the entire Pacific Northwest. Resulting index values for potential riparian corridors in the Pacific Northwest were highest within mountainous areas and lowest within relatively flat, lowland regions. We also calculated index values within ecoregions, to better identify high-value riparian climate corridors within the relatively flat, degraded areas where they may most contribute to climate adaptation. We found that high-value riparian climate-corridors are least protected in flat, lowland areas, suggesting that such corridors should be high priorities for future conservation effort. Our analysis provides critical information on valuable riparian climate-corridors to guide climate adaptation efforts (and riparian management and restoration efforts) in the Pacific Northwest, while offering a novel approach that may be applied to similar efforts in other geographies.

## Introduction

As climate change progresses and concern grows over the ability of species and ecosystems to adapt [1–2], considerable effort has been devoted to identifying areas on the landscape expected to promote biological resilience to change [3–5]. Riparian areas have been frequently

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identified as important features to conserve for climate adaptation [6–9], because they span the climatic gradients species are likely to follow as they track shifting areas of climatic suitability [10–12] and contain microclimates that are significantly cooler and more humid than immediately surrounding areas [13]. For these reasons, they are expected to provide dispersal corridors for species undergoing climate-induced range shifts [7,9] and microclimatic refugia from warming for species with limited movement capacities [14,5–6]. Riparian areas may also offer especially effective conservation umbrellas under climate change, because they disproportionately contribute to regional species richness [15–16], provide habitat for many upland species as well as riparian specialists [15–16], and directly contribute to the climate resilience of adjacent freshwater aquatic habitats [17–18]. Despite this recognition, few methods have been proposed for identifying priority riparian areas for climate adaptation.

Riparian areas are frequently prioritized in conservation planning efforts (e.g., [19–20]), but there are few examples of approaches aimed at identifying those that are most likely to promote climate adaptation. Available approaches for identifying riparian corridors to promote climate-induced range shifts include a conservation planning analysis for South Africa that included riparian corridors constructed by applying a fixed buffer around rivers connecting coastal to inland habitats to promote elevational species range shifts [21]. Similarly, riparian areas associated with 2<sup>nd</sup> order streams linking the Pacific Ocean to high elevations were prioritized in a climate adaptation analysis for California, USA [22]. In another analysis, a land facet corridor analysis aimed at promoting species range shifts in Arizona, USA, connected large blocks of natural habitat using riparian corridors identified by applying a fixed buffer around expert-identified streams and riparian habitats [23]. Most of these analyses used rivers as coarse proxies for riparian habitat, and none rigorously accounted for variability in riparian area quality, which we argue strongly influences the degree to which riparian areas may facilitate range shifts and provide refugia.

To address the need for a rigorous approach to identify priority riparian areas for climate adaptation, we completed a novel analysis that identifies potential riparian corridors expected to promote the ability of biodiversity to respond to climate change. Specifically, we developed a riparian climate-corridor index to quantify the degree to which riparian areas may promote range shifts and provide refugia, identifying those riparian areas that: 1) span large temperature gradients, 2) have high levels of canopy cover, 3) are relatively wide, 4) have low solar insolation, and 5) exhibit low levels of human modification. These variables were derived from the theoretical and empirical literature on species' responses to observed and projected climatic change. For example, riparian corridors that span large climatic gradients may help promote climate-induced range shifts from warmer to cooler areas [11–12]; riparian areas are already used as movement corridors for both riparian and upland species [24–26], and those spanning climatic gradients may offer particularly effective conduits for range migration, particularly across flat, degraded landscapes [27]. The effectiveness of such corridors would be further enhanced by high levels of canopy cover and greater riparian area width, features that have been shown to increase wildlife use of riparian areas as movement corridors [25], and to help moderate temperatures within riparian areas and promote the resilience of neighboring aquatic systems [17, 28]. Riparian corridors with lower exposure to solar insolation may also feature cooler temperatures and greater moisture [13, 29], increasing their value as microclimatic refugia [30–32]. Finally, riparian corridors with lower levels of human modification are likely to be more permeable to wildlife movement [33], while also being less vulnerable to exotic species invasion and other stressors that may inhibit species movements and reduce refugia quality [34].

Because these characteristics are likely to vary by the scale of analysis, and because scales of climate-induced range shifts and microclimatic refugia are likely to vary among species and

over time [35,14], we developed a multi-scale approach to calculating riparian climate-corridor index values that incorporates results ranging in scale from local watersheds to the entire Pacific Northwest, USA. We also evaluated the protected status of riparian climate-corridors to help inform potential conservation action for maintaining riparian climate-corridor networks. Our analysis may thus provide critical information for guiding riparian management and climate adaptation efforts in the Pacific Northwest, while offering a novel approach that may be applied to similar efforts in other geographies.

## Materials and methods

### Study area

We completed our analysis for the Pacific Northwest, USA (USGS Water Resource Region 17; Fig 1). The Pacific Northwest includes a relatively cooler, moister region between the Pacific Coast and Cascade Range that is dominated by evergreen temperate forest; and a relatively drier region between the Cascade Range and Rocky Mountains that experiences more pronounced seasonality in temperature and features more diversity in vegetation types, from mixed forest at higher elevations to sagebrush-steppe in more arid lowlands.



**Fig 1. Analysis extent.** We completed our analysis for the Pacific Northwest hydrologic region (Water Resource Region 17, in dark gray).

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### Analysis inputs

To identify high value riparian climate-corridors, we used a map of potential riparian areas identified by Theobald et al. [36], rather than a map of riparian vegetation. The potential riparian area map identifies the physical template where the dynamics of riparian vegetation are expected to occur, based on hydrological (stream discharge) and geomorphological (valley bottom shape) information rather than the (current) presence of riparian vegetation [36]. This 30 m data layer thus provides a comprehensive and consistent estimate of potential riparian area while avoiding many of the data gaps and inconsistencies [37] associated with existing maps of riparian vegetation derived from land cover (e.g., US LANDFIRE, US Fish & Wildlife Service National Wetland Inventory), which often have difficulty distinguishing riparian from non-riparian vegetation at 30 m resolution [37]. The potential riparian area dataset also provides key additional data layers (e.g., flow direction; see below) required by our analysis.

Our analysis aimed to identify the extent to which riparian corridors span large temperature gradients, have high levels of canopy cover, are relatively wide, have low exposure to solar radiation, and exhibit low levels of human modification. Our analysis thus included the following five variables (Table 1): mean annual temperature, canopy cover, riparian area width, potential relative radiation, and landscape condition.

We calculated mean annual temperature ( $T$ ) as the 30-year mean of mean annual temperatures from 1961–1990, using a 90 m digital elevation model and the ClimateWNA tool [38], which extracts and downscales PRISM [39] monthly data and calculates climate variables for specific locations based on latitude, longitude, and elevation. For canopy cover ( $C$ ), we used the percent tree canopy cover dataset for 2011 from the National Land Cover Dataset [40, 41]. We calculated potential riparian area ( $A$ ), a measure of the width of potential riparian areas, directly from the 30 m potential riparian area data layer from Theobald et al. [36]. We used the 30 m National Elevation Dataset [42] to calculate potential relative radiation ( $R$ ), a unitless measure of solar radiation that takes into account temporal changes in solar orientation as well as topographic shading from adjacent landforms [43]; such shading has been shown to contribute to lower temperatures in complex terrain [13–14]. We used the landscape condition ( $L$ ) model [44] as a measure of the degree to which potential riparian areas have been affected by human activities. Although a more recent and higher-resolution dataset on human modification was available [45], we used  $L$  to be consistent with the Western Association of Fish and Wildlife Agencies Crucial Habitat Assessment Tool [46].

Table 1. Analysis variables and source data.

Analysis Variable	Base Layer	Base Layer Resolution	Year Represented by Base Layer	Base Layer Sources
Mean Annual Temperature ( $T$ )	PRISM Mean Annual Temperature (downscaled using Climate WNA)	90 m	1961–1990 (mean historical temperature)	Daly et al. [39] ( <a href="http://prism.oregonstate.edu/">http://prism.oregonstate.edu/</a> ), Wang et al. [38] ( <a href="http://climawna.com/">http://climawna.com/</a> )
Canopy Cover ( $C$ )	NLCD Percent Canopy Cover	30 m (resampled to 90 m using bilinear interpolation)	2011	National Land Cover Dataset [40]
Riparian Area ( $A$ )	Potential Riparian Area	90 m	2009 (digital elevation model)	Theobald et al. [36]
Potential Relative Radiation ( $R$ )	Potential Relative Radiation (calculated using digital elevation model)	30 m (resampled to 90 m using bilinear interpolation)	2009 (digital elevation model)	This study, following methods of Pierce et al. [43], and using a digital elevation model from the National Elevation Dataset ( <a href="http://ned.usgs.gov/">http://ned.usgs.gov/</a> ).
Landscape Condition ( $L$ )	Landscape Condition	270 m (resampled to 90 m using bilinear interpolation)	2010 (roads); 2006 (development); 2001 and 2006 (landcover)	Western Association of Fish and Wildlife Agencies Crucial Habitat Assessment Tool [46], based on the NatureServe Landscape Condition Model [44]

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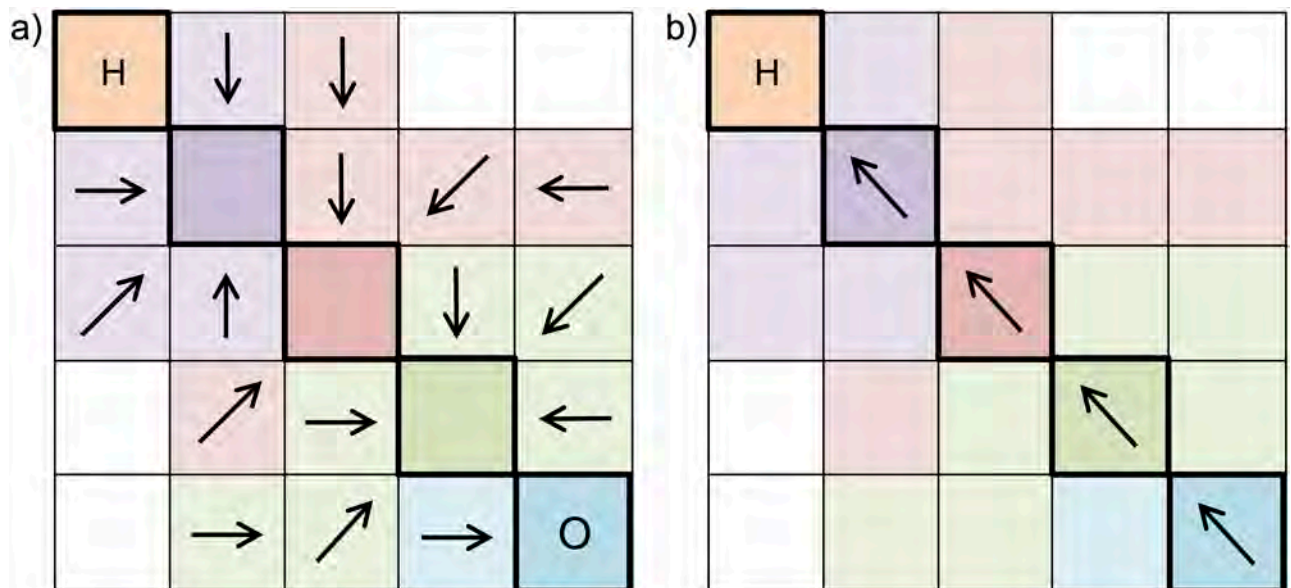


### Calculating a riparian climate-corridor index

We calculated an index of riparian climate-corridor quality for individual, ecologically-relevant spatial units that we call “potential riparian corridors,” which we define as the potential riparian area that runs longitudinally along a stream/river from the stream outlet (or mouth) up through the hydrologic network of a watershed, ending at the stream initiation point (or headwater). For each potential riparian corridor, we calculated a riparian climate-corridor index using three main steps.

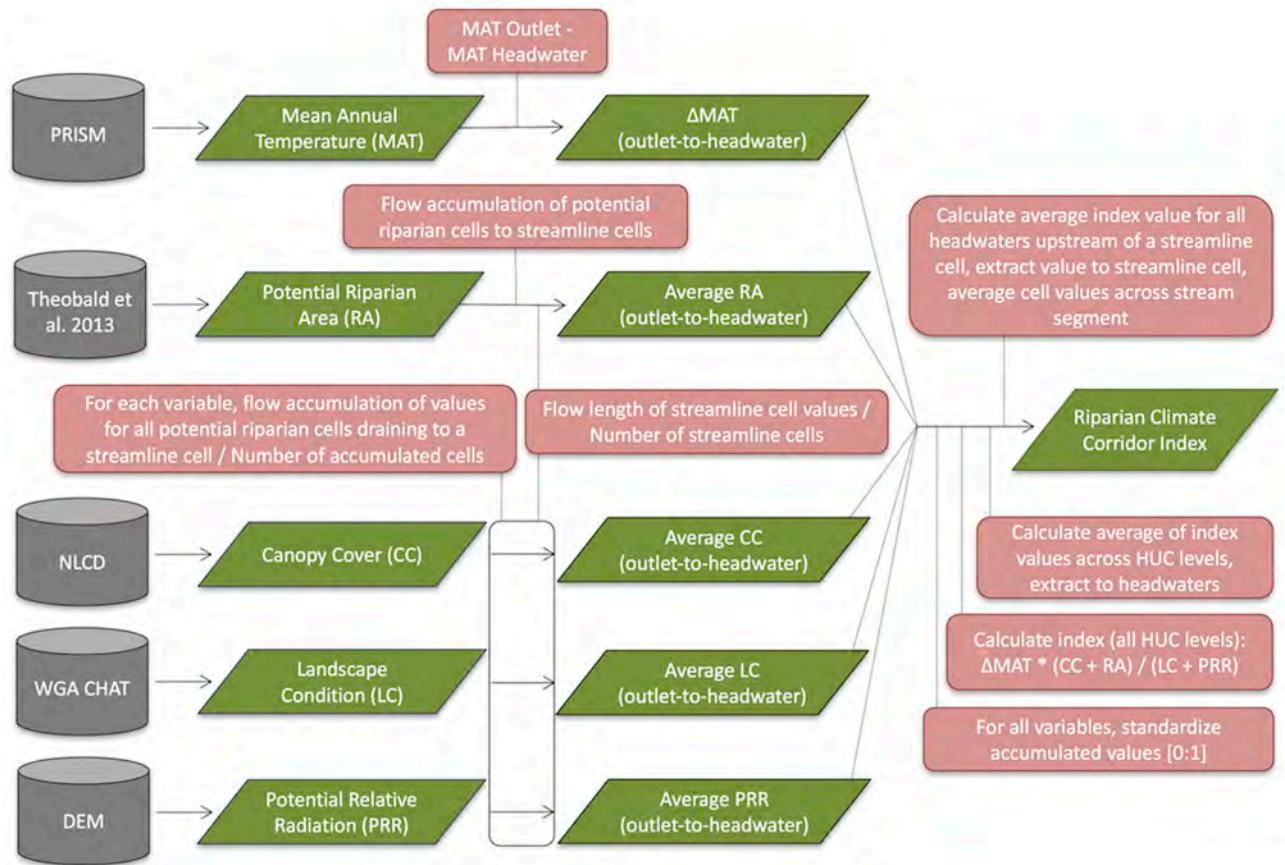
First, we accumulated the values of four variables (*C, A, R, L*) from locations (cells) within potential riparian areas laterally (i.e., orthogonal to the neighboring stream) to the nearest cell along the central flow path that follows the mid-line of streams/ivers (Fig 2a).

Second, we accumulated the values longitudinally along the central flow path within the stream/river, from its outlet to its headwater (Fig 2b). We accumulated values upstream rather than downstream to simulate the process of upward range movement along riparian corridors, from watershed outlets toward higher-elevation headwaters. Accumulating upstream also allowed us to calculate index values for individual riparian corridors adjacent to a stream/river reach running between its headwater and watershed outlet, because accumulating downstream would result in a single accumulated index value for an entire watershed. Third, we used these accumulated variable values to calculate an index of climate adaptation quality for the riparian climate-corridor from the outlet to headwater. Representing potential riparian corridors using a raster representation (rather than stream line vectors) allowed us to account for subtle gradients and variations within potential riparian areas—vital information lacking in previous



**Fig 2. Using Flow Direction, Flow Accumulation, Flow Length tools to calculate the riparian climate-corridor index for a potential riparian corridor.** a) For all potential riparian cells draining into a given cell in the streamline (outlined in bold, with it and all cells draining into it shown in the same color), we calculate, for each variable (*C, R, L*), the average value across the cells that contribute (accumulate) to the stream flow cell, and attribute this average value to the streamline cell (or the midline cell, for larger water bodies) using the Flow Direction and Flow Accumulation tools in ArcGIS. We calculate *A* as the number of potential riparian cells draining into the streamline cell. b) We then calculate, for each variable (*C, R, L, A*), the average value across all streamline cells from the outlet (*O*) to the headwater (*H*), and attribute this average value to the headwater using the Flow Length tool in ArcGIS. We also attribute a value for *T*, calculated as the absolute difference in temperature between the outlet and headwater cells. We then standardize (0–1) the average value for each variable (for equal weighting) and calculate the index, attributing this index value to the headwater cell. This is repeated for each downstream outlet until reaching the ocean, each time attributing the index value to the headwater cell. Each streamline cell is then given the average index value attributed to its upstream headwaters.

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**Fig 3. Summary of modeling approach, including key inputs, outputs, and analysis steps.** Data sources are shown in gray, processing steps in pink, and inputs and outputs in green.

<https://doi.org/10.1371/journal.pone.0205156.g003>

studies. For rivers wider than 90 m, we excluded water cells when calculating variable values. Note that we represented spatial features, such as elevation and land cover, at 30 m resolution, but accumulated the up-scaled data at 90 m for computational purposes. A more detailed description of our analysis is provided below, and summarized in Fig 3.

### 1. Accumulate values within potential riparian corridors laterally to the stream line.

We clipped the *C*, *R*, and *L* rasters to the extent of the potential riparian area. We then accumulated *C*, *R*, and *L* values along flow paths for all potential riparian cells draining into a given cell that represents the center of the stream line (i.e. the central flow path). That is, each cell located along the central flow path was attributed with the sum of the values for that variable for all the potential riparian cells that drain into it, using hydrologic tools in ArcGIS v10 software [47]. We then divided the accumulated value for each variable by the number of accumulated cells, so that, for each variable, each central flow path cell in the adjacent stream/river was ultimately attributed with the average variable value for its contributing potential riparian cells. The flow-accumulated area for the potential riparian area (*A*) was calculated in a similar manner, by accumulating the number of potential riparian cells draining into each central flow path cell in the adjacent stream/river. In cases where no potential riparian area cells drained into a central flow path cell, values for each variable were measured for only the central flow path cell itself, which was given an *A* value of 1.



**2. Accumulate values for each variable longitudinally from stream/river outlet to headwater.** We accumulated values along individual streamlines running from the watershed outlet to a stream's headwater, for each of the four variables ( $C$ ,  $A$ ,  $R$ ,  $L$ ). These accumulated values were then extracted to the central flow path cell at the stream/river's headwater, and divided by the number of contributing central flow path cells, to provide an average value for each variable for the associated potential riparian corridor. Mean annual temperature ( $T$ ) was also extracted at each watershed outlet (or sink, in the case of closed basins) and for each headwater, and the difference between the two calculated and extracted to each stream/river's headwater. The average value for each variable was then divided by the largest value for that variable within the full study region, to standardize values to the range 0:1.

**3. Calculate riparian climate-corridor index for each watershed-scale riparian corridor.** We used the averaged, standardized values for each variable to calculate a Riparian Climate-Corridor Index for each watershed-scale riparian corridor, using the following formula:

$$\text{Riparian Climate - Corridor Index} = \Delta T \times [(C + A)/(R + L)]$$

Index values will thus be highest for those riparian corridors with the largest change in temperature ( $T$ ) from outlet to headwater, highest percent canopy cover ( $C$ ), greatest width ( $A$ ), lowest exposure to solar radiation ( $R$ ), and lowest level of human modification ( $L$ ). Where  $\Delta T$  was negative (indicating a higher temperature at the headwater than at the outlet), the index value was set to 0, to maintain higher index values for corridors leading from warmer to cooler areas across scales (see description of multi-scale approach, below). Our analysis is thus similar to other climate-gradient corridor approaches [11–12] in that it prioritizes corridors connecting warm areas to cool (in this case, headwater and outlets) using pathways that follow monotonic gradients (i.e., moving along gradients in only one direction, from warm to cool). All index values were extracted to the headwater associated with each potential riparian corridor.

**4. Account for scale effects.** We calculated a multi-scale, riparian climate-corridor index using the above procedure for riparian corridors within 6<sup>th</sup>, 5<sup>th</sup>, 4<sup>th</sup>, 3<sup>rd</sup>, 2<sup>nd</sup>, and 1<sup>st</sup> field HUCs (i.e., nested watersheds, from smallest to largest, respectively). HUCs are hierarchical hydrologic unit codes (HUC) assigned to all watersheds in the US [48]; the watershed cataloging system nests watersheds into progressively larger units, similar to Pfafstetter codes that are also used globally. Our method should thus be applicable to any similar watershed cataloging system in other countries. This procedure resulted in up to six index values being extracted to each headwater, corresponding to the index values of progressively longer downstream potential riparian corridors adjacent to each stream/river from its headwater to its outlet for progressively larger watersheds, eventually terminating at the ocean (or sink, in the case of closed basins). We scaled each of these nested index values to the range (0:1) and averaged them (equally-weighted), so that the final index value extracted to each headwater would reflect the climate adaptation value of all of its downstream riparian corridors. Finally, we calculated, for each individual central flow path cell within streams/ivers, the average of the index values attributed to all of its upstream headwaters. The final index values for each flow path cell within streams/ivers thus reflect the degree to which its adjacent potential riparian area cells are expected to help facilitate range shifts and provide refugia, from local to regional scales.

We also calculated a measure of riparian climate-corridor quality for entire watersheds by calculating the average of index values for all riparian climate-corridors within a given HUC. To account for differences in index values among ecoregions, and to more easily identify the highest quality riparian climate-corridors within each ecoregion, we binned all index values into 5 equal-area quintiles within each Level III ecoregion [49].

## GAP analysis and sensitivity testing

We evaluated the degree to which high-value riparian climate-corridors identified by our analysis fall within currently designated protected areas by measuring the GAP status of riparian climate-corridors within 1) the top quintile of index scores, 2) the top two quintiles, and 3) all quintiles, for both the entire Pacific Northwest and within ecoregions. GAP status codes are provided by the US Geological Survey's Gap Analysis Program (GAP), and measure the degree to which lands in the US are managed for conservation [50]. Code 1 and 2 denote the highest degree of management for conservation (and meet the IUCN definition of protected), while Code 3 is given to lands that support multiple uses, including resource extraction. Code 4 lands are unprotected or have unknown management intent.

We also tested the sensitivity of the riparian climate-corridor index to the inclusion of individual input variables by removing individual variables one at a time, re-calculating the index, and measuring resulting differences across the study area. We also calculated correlation coefficients among these index values, as well as correlation coefficients among individual variables, to aid in interpretation of results.

## Results

### Riparian climate-corridor index values

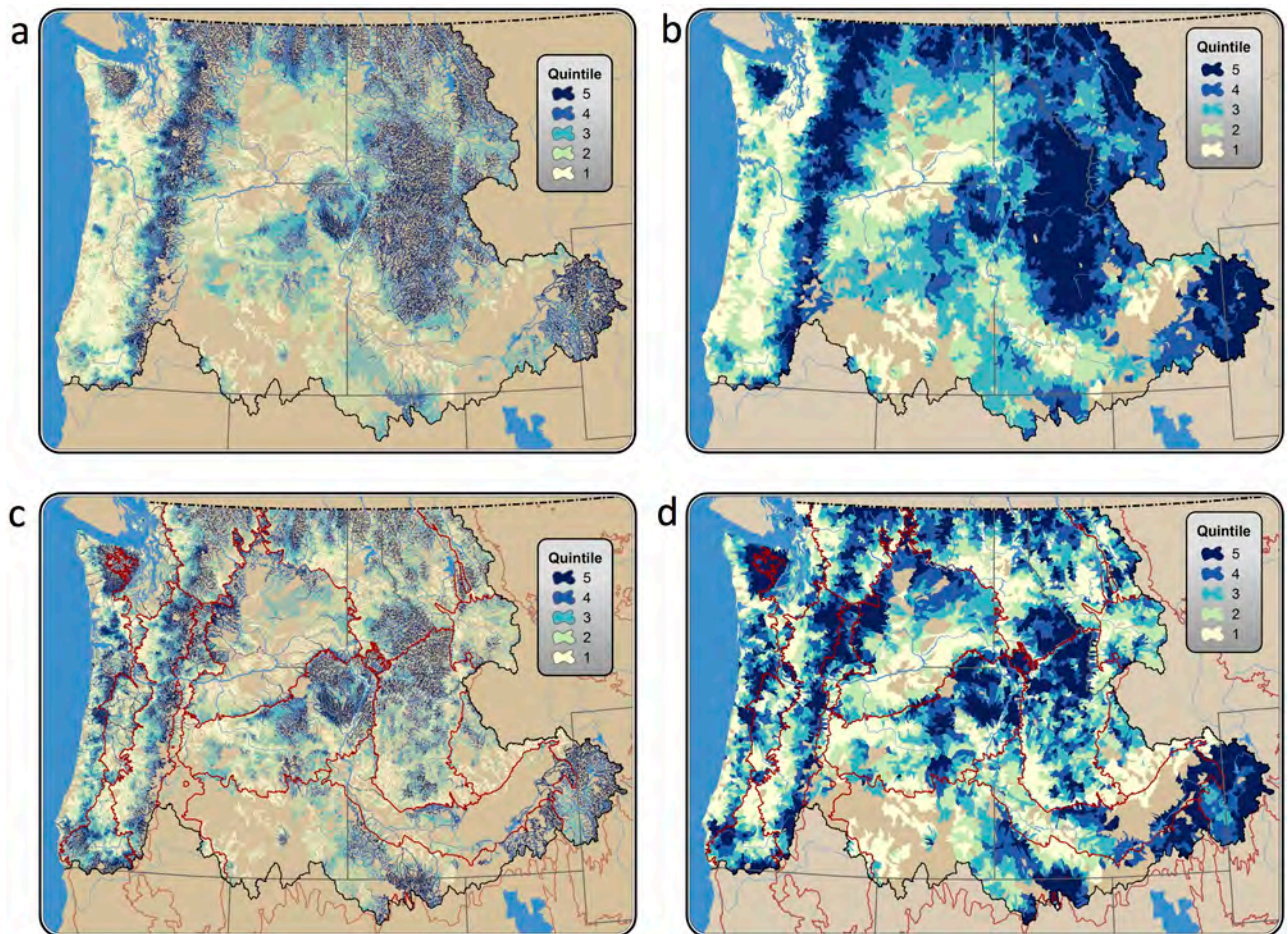
We found that the climate adaptation potential of riparian corridors varies considerably, both across the Pacific Northwest (Fig 4) and within individual watersheds (Fig 5). Index values ranged from 0 to 0.83 (Fig 6), with the highest index values found in mountainous areas (e.g., the Cascade Range), and the lowest index values found in relatively flat, lowland regions such as the Columbia Plateau. Mountainous areas exhibited higher  $\Delta T$  scores, on average, as well as higher canopy cover ( $C$ ), solar insolation ( $R$ ), and landscape condition (S1–S4 Figs). These effects were amplified by positive correlations among all input variables but riparian area (S5 Fig): relatively flat areas with low  $\Delta T$  tended to also have lower canopy cover ( $C$ ), were in poorer landscape condition ( $L$ ), and had higher solar insolation ( $R$ ). Indeed, removing  $\Delta T$  from the index calculation resulted in a spatial pattern similar to that seen when the calculation included  $\Delta T$  (Fig 7); including  $\Delta T$  generally reinforced the pattern of lower values in areas with gentler topographic relief (often near outlets) and higher values in mountains (often near headwaters).

Most potential riparian corridors had relatively low index values (Fig 6). The relatively high number of potential riparian corridors with index values equal to 0 is due in large part to the relatively cool temperatures of the Pacific Northwest coast; many interior headwaters have warmer mean annual temperatures than their streams' coastal outlets. Because negative  $\Delta T$  values were converted to zero and  $\Delta T$  is multiplied by the rest of the index, such potential riparian corridors receive a zero value, though they may otherwise be of high quality (Fig 7). For example, the low index scores received by otherwise high-quality riparian areas in the western Olympic Peninsula were due to negative or relatively low  $\Delta T$  between coastal stream outlets and headwaters (Fig 7, S1 Fig).

Areas with no headwaters (and thus no index scores) were seen in regions lacking surface water due to high aridity and/or high soil permeability (Fig 4).

## GAP analysis and sensitivity testing

We found that riparian climate-corridors varied regionally in their level of protection (Fig 8). For riparian climate-corridors with the highest 20% of index scores, 35.5% were fully protected (GAP status 1–2) and 50.4% were partially protected (GAP status 3) across the Pacific



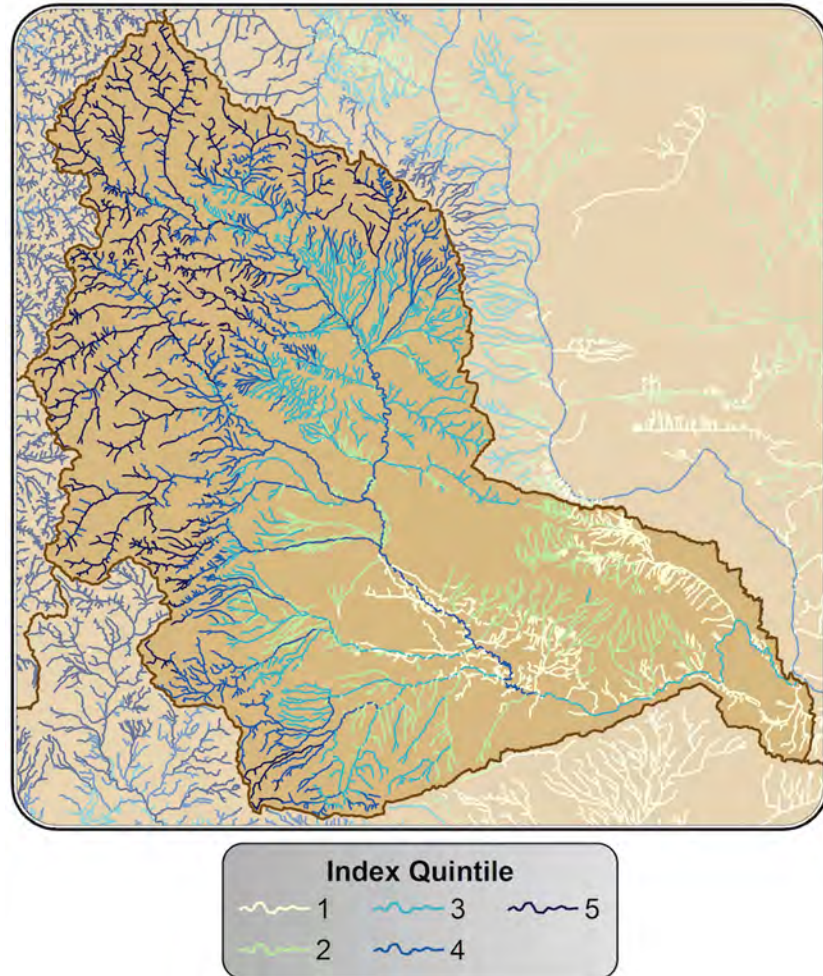
**Fig 4. Riparian climate-corridor index values for the Pacific Northwest.** Values are averaged across nested watershed scales (6<sup>th</sup> to 1<sup>st</sup> field HUCs), attributed to streamlines associated with potential riparian corridors. Values are shown by quintile for the Pacific Northwest, USA (panels a and b), and within ecoregions (panels c and d); and for both individual riparian corridors (panels a and c) and averaged across 6<sup>th</sup> field HUCs (panels b and d).

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Northwest. Within ecoregions, GAP status of riparian climate-corridors with the highest 20% of index scores varied from 83.8% fully protected and 14.6% partially protected in the North Cascades, to 1.3% fully protected and 18.8% partially protected in the Columbia Plateau.

We found that riparian climate-corridor index values were relatively insensitive to individual input variables (Fig 7). Removal of individual variables from the index calculation resulted in little change to index scores across the study area, resulting in an average change in index values of -0.0126 for removal of mean annual temperature ( $\Delta T$ ), +0.0051 for landscape condition ( $L$ ), -0.0168 for canopy cover ( $C$ ), -0.0607 for riparian area ( $A$ ), and -0.1154 for potential relative radiation ( $R$ ). Given the strong correlations among index variable values and elevation (i.e., that relatively flat areas with low  $\Delta T$  also have lower canopy cover ( $C$ ) and landscape condition ( $L$ ), and higher solar insolation ( $R$ )), variable exclusion generally resulted in decreased values in mountainous areas and increased values in lower-elevation areas. Exclusion of  $R$  had a slightly stronger effect on index values in mountainous areas (lowering index values), and exclusion of  $T$ ,  $C$ , and  $L$  had a slightly stronger effect on lower-elevation coastal areas (increasing values).



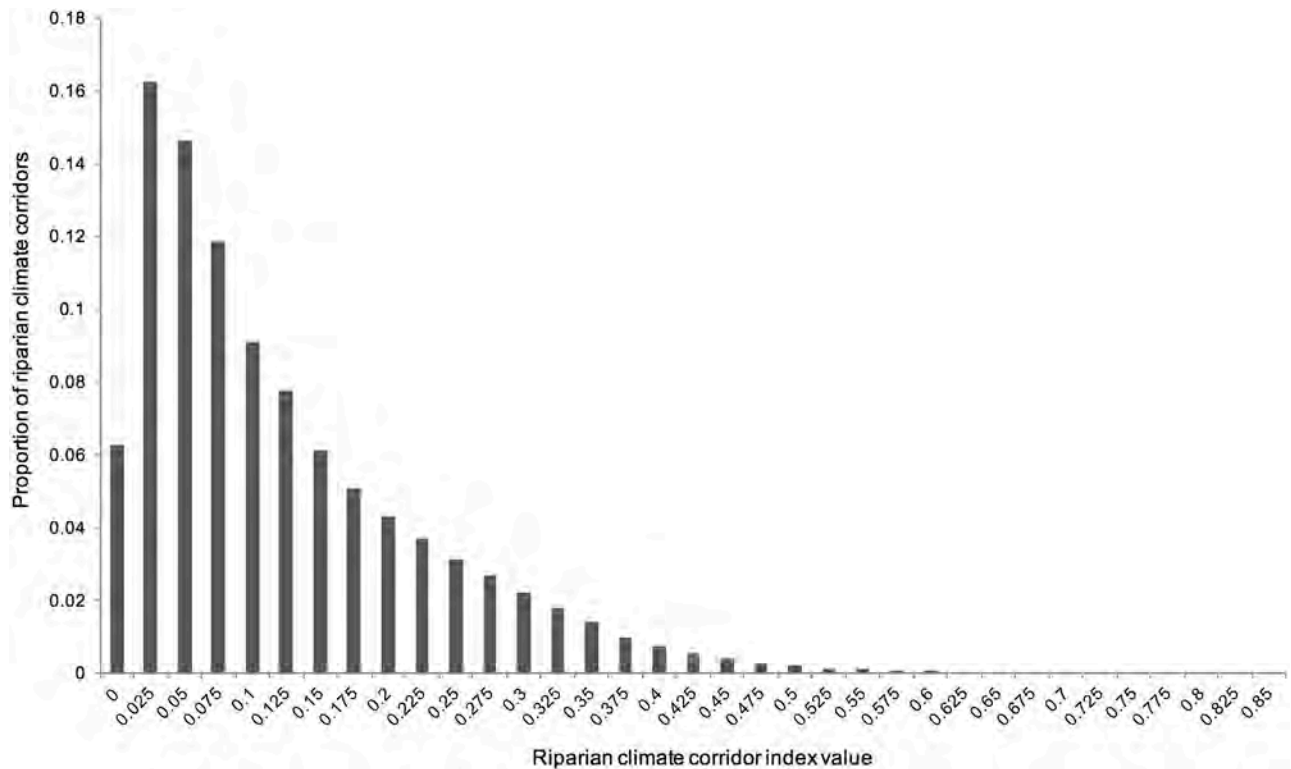


**Fig 5. Riparian climate-corridor index values shown for an individual watershed.** Values are shown by quintile and attributed to streamlines associated with potential riparian corridors.

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## Discussion

Our analysis identified potential riparian corridors that span climatic gradients, have high canopy cover, low levels of solar exposure, low levels of human modification, and are relatively wide—characteristics expected to facilitate climate-induced range shifts and provide micro-climatic refugia. Not surprisingly, we found that potential riparian corridors in mountainous regions—which tend to be steep, forested, topographically shaded, and have low levels of human modification—had the highest riparian climate-corridor index values. We also found that potential riparian corridors in lowland areas—which tend to be flat and have low canopy cover, less topographic shading, and high levels of human modification—had the lowest values (Fig 4a and 4b). Because of the correlations of temperature with other variables, change in temperature—which we had expected to be a key variable for identifying riparian corridors with strong climatic gradients—in fact had a relatively modest impact on index scores (Fig 7), generally reinforcing the pattern of lower index values in areas with gentler topographic relief and higher values in mountains. The index is thus robust to our coarse approach to measuring temperature gradients along riparian corridors.



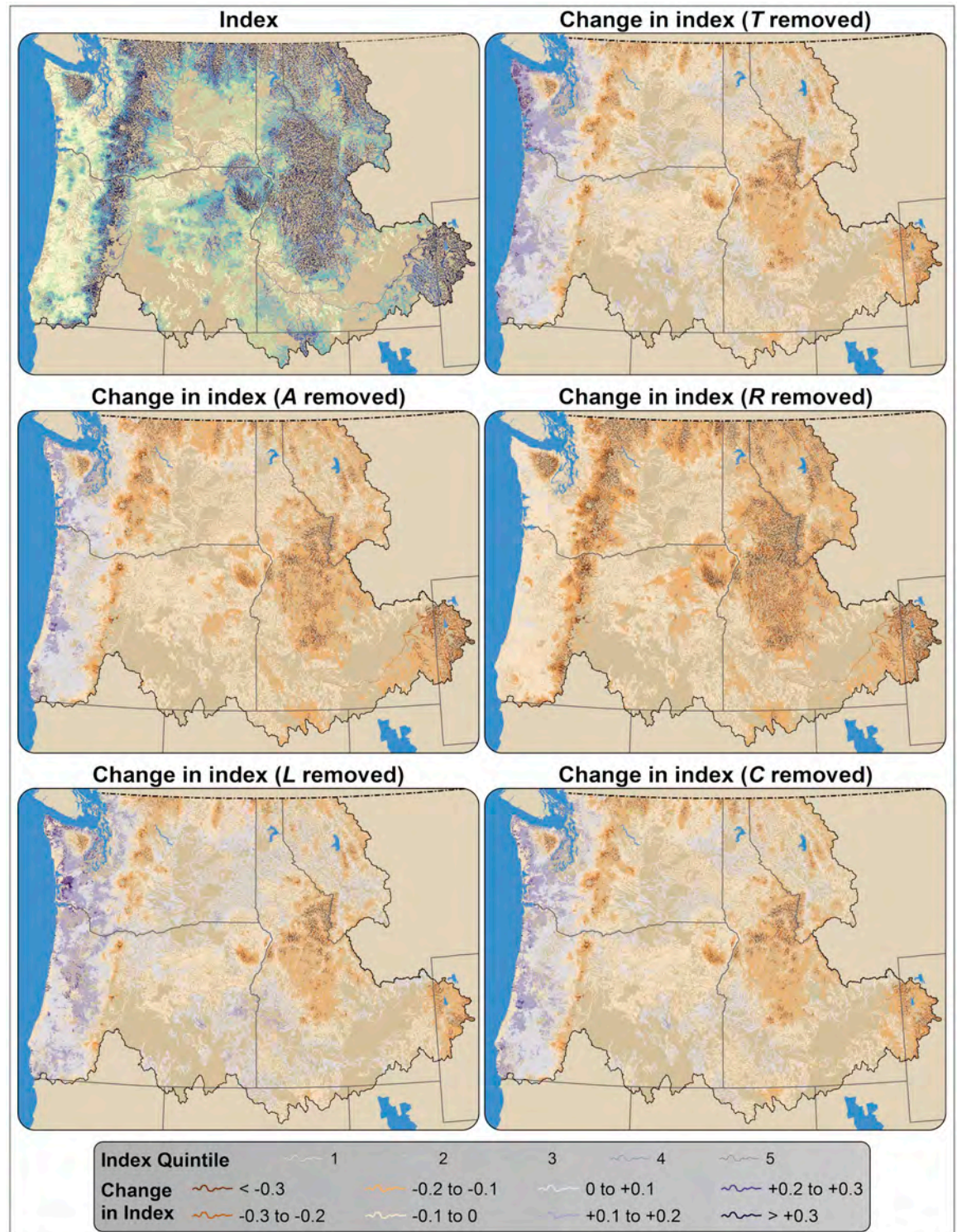
**Fig 6. Distribution of riparian climate-corridor index values.** Shown for all watershed-scale riparian corridors in the Pacific Northwest.

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We also found that relatively flat and highly modified ecoregions (e.g., the Columbia Plateau and Puget Lowlands ecoregions; Fig 4c and 4d) had the least protected high-scoring riparian climate-corridors among Pacific Northwest ecoregions (Fig 8). High-scoring riparian climate-corridors in these areas thus suggest immediate priorities for conservation action (e.g., protection or restoration), as they may provide some of the best adaptation opportunities in flat, highly modified landscapes that may limit species range movements and persistence in microclimatic refugia. We also found that a large number of otherwise high-quality potential riparian corridors along the coast received low index scores, because their interior headwaters have warmer mean annual temperatures than their streams' cooler, coastal outlets. These results emphasize that our index is designed to identify riparian climate-corridors expected to promote species range shifts from warmer to cooler areas, which may in some cases result in low scores for corridors that have high conservation value under static or current climates.

Index values for riparian climate-corridors along large rivers (e.g., the Columbia River) often had higher values than corridors within nearby lower-order streams (e.g., headwater streams). This is because higher-order streams frequently have tributaries at higher elevations; riparian climate-corridors associated with these higher-elevation tributaries tend to have relatively high index values, and the index values of riparian climate corridors along higher-order streams incorporate these upstream values. The high index values of riparian climate-corridors along higher order streams thus reflect their connectivity to high-scoring upstream corridors, and thus their capacity to promote range shifts and provide access to climatic refugia at a regional scale. Indeed, shorter riparian corridors, such as those that would be found along headwater streams, have been shown to be more effective at promoting species movements [51]. Thus, the trade-off of this multi-scale approach—designed to accommodate diverse

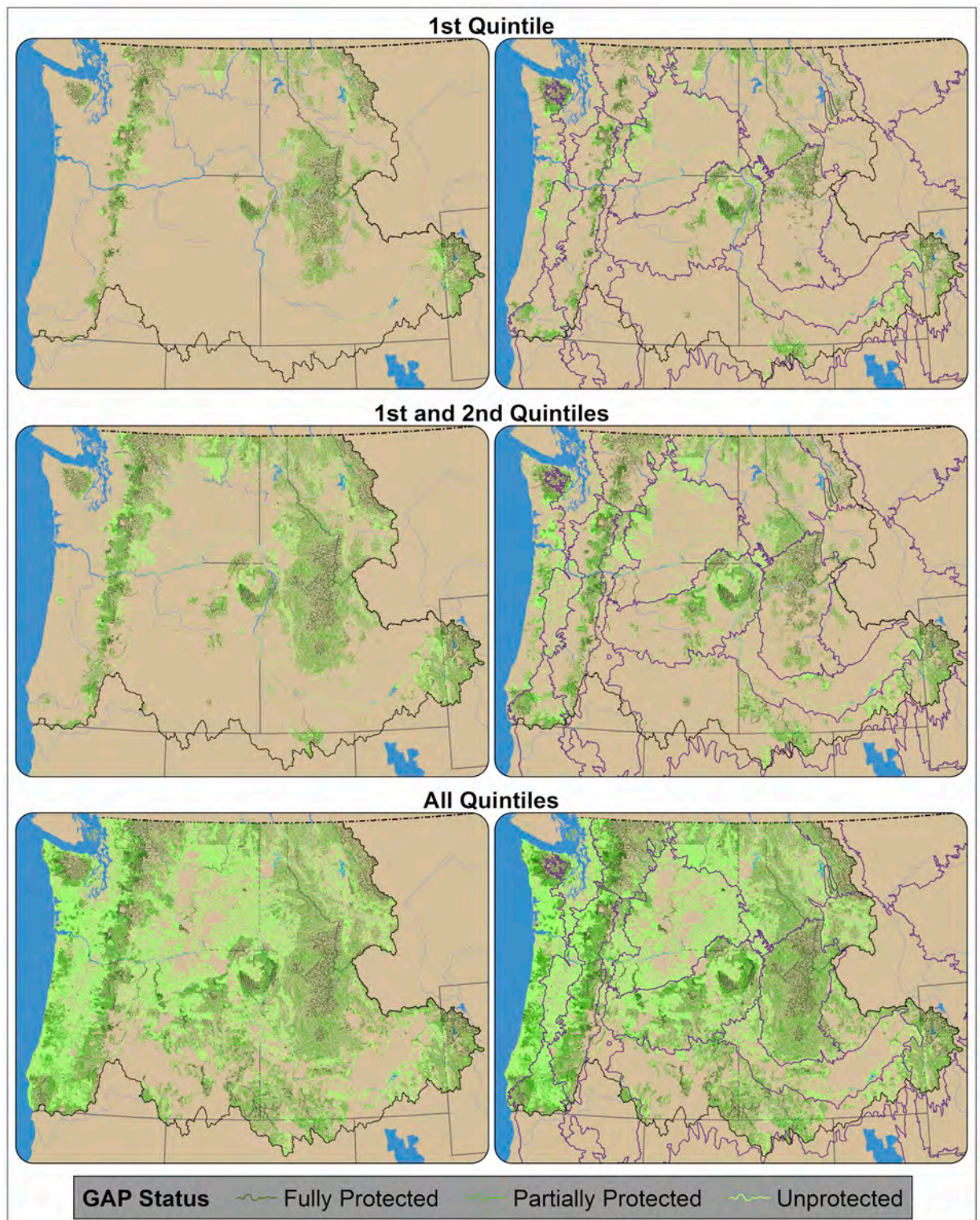




**Fig 7. Sensitivity of riparian climate-corridor index values to individual analysis variables.** Panels show the index with all variables included (top left), and the index with change in mean annual temperature (*T*) removed, with riparian area (*A*) removed, with potential relative radiation (*R*) removed, with landscape condition (*L*) removed, and with canopy cover (*C*) removed.

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**Fig 8. GAP status of riparian climate-corridors.** GAP status is shown for riparian corridors within the top quintile of riparian climate-corridor index values (top row), top two quintiles (middle row), and all quintiles (bottom row); by both the entire Pacific Northwest (left column) and within ecoregions (right column). GAP status is shown for fully protected (GAP status 1 and 2; forest green), partially protected (GAP status 3; kelly green), and unprotected (GAP status 4; lime green) riparian climate-corridors.

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species with needs for movement and refugia at a range of scales—is its potential to overlook riparian climate-corridors that may be valuable at a more local scale, but do not meaningfully contribute to broader-scale, regional adaptation. Identifying riparian climate-corridors with high index values within ecoregions (Fig 4c and 4d) or local watersheds (S6–S10 Figs) may help address needs for more local-scale prioritization.

We recommend considering several caveats when applying the riparian climate-corridor index. First, this approach only indirectly accounts for connectivity along riparian corridors; while index values will decrease with increasing human modification along a corridor, the effect of local but severe movement barriers (e.g., towns, cliffs) on index values could be muted if human modification is low elsewhere along the corridor, particularly at broader scales. The analysis could thus be improved by incorporating explicit connectivity measures that sufficiently penalize high-resistance, local barriers that could sever connectivity; a range of connectivity modeling approaches could be adapted for this purpose (e.g., [52]). The analysis could also be improved by further validating analysis inputs and assumptions, such as empirically measuring canopy cover and solar insolation across riparian areas and testing their influence on temperature, and, ultimately, range shifts and refugia. Future comparison of our index to other indices of riparian quality (e.g., [53]) would also aid in interpretation of results. Thus, we recommend using this analysis as a means of identifying priority riparian areas for additional evaluation (e.g., field validation, comparison with other data sets, integration with other conservation values) before making decisions regarding conservation action.

We also recognize the scaling challenges in mapping riparian vegetation and modeling potential riparian areas. Our analysis provides estimates of potential riparian climate-corridors at (>90 m) due to data resolution and computation limitations. Future work can apply our approach using high resolution data that have (or will likely) become available. An additional caveat is the risk of unintended negative consequences (e.g., spread of invasive species or disease) by protecting or restoring riparian climate corridors to promote species movements. Our analysis reduces this risk by prioritizing those riparian areas that are in good condition, and therefore expected to be less vulnerable to invasion. Further, previous research has shown that the benefits of corridors outweigh potential negative effects [54], including potential risks related to climate-induced range shifts [55]. Indeed, the synergistic threats of habitat loss, fragmentation and climate change present an urgent need to restore landscape features such as riparian corridors that have historically provided natural conduits for species movement.

Although riparian areas are expected to provide critical movement corridors and refugia under climate change [6–7,9], they are also among the most threatened habitats in many regions [56]. Our analysis offers a first step toward identifying, for large regions, those riparian areas most likely to promote species' ability to respond to climate change, as well as those that may be most vulnerable to climate change and in need of restoration measures. Such information may offer valuable guidance for future investments in riparian protection and restoration as part of climate adaptation efforts.

## Supporting information

**S1 Fig. Mean annual temperature ( $T$ ), based on the 30-year mean of mean annual temperatures from 1961–1990, using a 90 m digital elevation model and the ClimateWNA tool [34], which extracts and downscales PRISM [35] monthly data and calculates climate variables for specific locations based on latitude, longitude, and elevation.**

(TIFF)

**S2 Fig. Canopy cover (*C*), based on the percent tree canopy cover dataset from the National Land Cover Dataset [36].**

(TIFF)

**S3 Fig. Potential relative radiation (*R*), a unit-less measure of solar radiation that takes into account temporal changes in solar orientation as well as shading effects from neighboring topography [38], based on a 30 m digital elevation model from the National Elevation Dataset [36].**

(TIFF)

**S4 Fig. Landscape condition (*L*), provided by the Western Governors' Association's Crucial Habitat Assessment Tool (WGA 2013) as a measure of the degree to which potential riparian areas have been affected by human activities using the landscape condition model [39], where higher values correspond to lower landscape intactness.**

(TIFF)

**S5 Fig. Riparian area (*A*), based on the potential riparian area data layer from Theobald et al [32].**

(TIFF)

**S6 Fig. Riparian climate-corridor index values averaged across individual watersheds (6<sup>th</sup> field HUCs).**

(TIFF)

**S7 Fig. Riparian climate-corridor index values averaged across individual watersheds (5<sup>th</sup> field HUCs).**

(TIFF)

**S8 Fig. Riparian climate-corridor index values averaged across individual watersheds (4<sup>th</sup> field HUCs).**

(TIFF)

**S9 Fig. Riparian climate-corridor index values averaged across individual watersheds (3<sup>th</sup> field HUCs).**

(TIFF)

**S10 Fig. Riparian climate-corridor index values averaged across individual watersheds (2<sup>nd</sup> field HUCs).**

(TIFF)

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## Author Contributions

**Conceptualization:** Meade Krosby, David M. Theobald, Brad H. McRae.

**Data curation:** Robert Norheim.

**Formal analysis:** Meade Krosby, David M. Theobald, Robert Norheim.

**Funding acquisition:** Meade Krosby, David M. Theobald.



**Investigation:** Meade Krosby, David M. Theobald.

**Methodology:** Meade Krosby, David M. Theobald, Robert Norheim, Brad H. McRae.

**Project administration:** Meade Krosby.

**Supervision:** Meade Krosby, David M. Theobald.

**Visualization:** Robert Norheim.

**Writing – original draft:** Meade Krosby, David M. Theobald.

**Writing – review & editing:** Meade Krosby, David M. Theobald, Robert Norheim, Brad H. McRae.

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# Gene flow and pathogen transmission among bobcats (*Lynx rufus*) in a fragmented urban landscape

JUSTIN S. LEE,\* EMILY W. RUELL,† ERIN E. BOYDSTON,‡ LISA M. LYREN,‡  
ROBERT S. ALONSO,§ JENNIFER L. TROYER,¶ KEVIN R. CROOKS§ and SUE VANDEWOUDE\*

\*Department of Microbiology, Immunology, and Pathology, Colorado State University, 1619 Campus Delivery, Fort Collins, CO 80523-1619, USA, †Department of Biology, Colorado State University, 1878 Campus Delivery, Fort Collins, CO 80523-1878, USA, ‡U.S. Geological Survey, Western Ecological Research Center, 401 West Hillcrest Drive, Thousand Oaks, CA 91360, USA, §Department of Fish, Wildlife, and Conservation Biology, Colorado State University, 1474 Campus Delivery, Fort Collins, CO 80523-1474, USA, ¶SAIC-Frederick, Inc., 915 Tollhouse Avenue Suite 211, Frederick, MD 21701, USA

## Abstract

Urbanization can result in the fragmentation of once contiguous natural landscapes into a patchy habitat interspersed within a growing urban matrix. Animals living in fragmented landscapes often have reduced movement among habitat patches because of avoidance of intervening human development, which potentially leads to both reduced gene flow and pathogen transmission between patches. Mammalian carnivores with large home ranges, such as bobcats (*Lynx rufus*), may be particularly sensitive to habitat fragmentation. We performed genetic analyses on bobcats and their directly transmitted viral pathogen, feline immunodeficiency virus (FIV), to investigate the effects of urbanization on bobcat movement. We predicted that urban development, including major freeways, would limit bobcat movement and result in genetically structured host and pathogen populations. We analysed molecular markers from 106 bobcats and 19 FIV isolates from seropositive animals in urban southern California. Our findings indicate that reduced gene flow between two primary habitat patches has resulted in genetically distinct bobcat subpopulations separated by urban development including a major highway. However, the distribution of genetic diversity among FIV isolates determined through phylogenetic analyses indicates that pathogen genotypes are less spatially structured—exhibiting a more even distribution between habitat fragments. We conclude that the types of movement and contact sufficient for disease transmission occur with enough frequency to preclude structuring among the viral population, but that the bobcat population is structured owing to low levels of effective bobcat migration resulting in gene flow. We illustrate the utility in using multiple molecular markers that differentially detect movement and gene flow between subpopulations when assessing connectivity.

**Keywords:** carnivores, disease ecology, gene flow, habitat fragmentation, microsatellites, viral phylogenetics

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## Introduction

Habitat loss and degradation are the leading causes of species declines around the world (<http://www.iucnredlist.org/>). Urbanization, an extreme form of habitat degradation, results in immediate displacement of

wildlife from developed areas, followed by the increasing isolation of groups of animals confined to shrinking natural areas (McKinney 2002; McDonald *et al.* 2008). A common effect of urbanization is the fragmentation of once contiguous landscapes into smaller patches of non-contiguous habitat.

Maintaining functional connectivity, the extent to which organisms and genetic material move between

Correspondence: Justin S. Lee, Fax: (970) 491 0603; E-mail: jlee337@colostate.edu

habitat patches, can be essential for population persistence in fragmented landscapes (Crooks & Sanjayan 2006). Reduced functional connectivity between habitat patches can result in physically and genetically isolated subpopulations prone to inbreeding and to the loss of genetic diversity through genetic drift (Frankham 2006). However, measuring functional connectivity can be difficult, especially for cryptic solitary species such as large carnivores (Crooks 2002). One commonly used method of evaluating functional connectivity involves characterizing patterns of gene flow using molecular markers to evaluate the distribution of genetic diversity within and among groups of individuals (Frankham 2006; Balkenhol & Waits 2009; Ruell *et al.* in press). Populations with high connectivity should exhibit homogeneous distributions of genetic diversity. Populations with low connectivity will be genetically structured, exhibiting localized variations in genetic diversity as a consequence of reduced gene flow among isolated groups of individuals.

Microsatellites are neutral heritable molecular markers commonly used to evaluate genetic structure, and hence connectivity, among natural populations (Avice 2004; Hedrick 2005a). These polymorphic, codominant markers provide a powerful means for assessing gene flow. However, microsatellite markers only reflect individual movement within structured populations if a migrant is sampled or if a migrant successfully reproduces and at least one offspring is sampled. Transient movements between subpopulations, or migrants that do not reproduce, may not be detected by analysing microsatellites (Riley *et al.* 2006). Therefore, while powerful, host genetic markers may not accurately characterize connectivity when individual movements do not result in gene flow.

Because directly transmitted obligate pathogens are inextricably linked to their hosts, pathogens can serve as alternative or additional markers for studies of wild-life population dynamics (Nieberding & Olivieri 2007; Liu *et al.* 2008). Feline immunodeficiency virus (FIV), a retrovirus that naturally infects many felid species (Troyer *et al.* 2005; Vandewoude & Apetrei 2006), has many characteristics that render it potentially useful as a marker of population dynamics in wild cats. First, the mutation rate of FIV is significantly faster than that of host genetic markers (approximately  $\mu = 1\text{--}3\%$  every 10 years in mountain lions) (Biek *et al.* 2003). Also, infection with FIV is life-long because an obligatory step in viral replication involves the permanent insertion of a copy of the viral genome into the host's chromosomal DNA. Therefore, FIV genotypes have the capacity to serve as life-long molecular markers for each infected individual. Furthermore, the virus cannot be transmitted by insect vectors, nor is it stable in the envi-

ronment, and thus, transmission events are indicators of direct contact between individuals.

Finally, the strains of FIV, which infect domestic cats, are genetically distinct from the strains isolated from wild felids. The domestic cat strains have never been documented to infect nondomestic felids in the wild, and therefore, the genetic diversity of FIV among nondomestic felids is only influenced by the distribution, movement and contact rates among conspecifics across the landscape.

Indeed, previous studies have demonstrated that patterns of FIV relatedness closely reflect the geographical distribution of bobcats, mountain lions and African lions at various geographical scales (Biek *et al.* 2006; Franklin *et al.* 2007a; Antunes *et al.* 2008). Specifically, Franklin *et al.* (2007a) demonstrated that the FIV isolates infecting bobcats north and south of Los Angeles, CA are genetically distinct, having diverged since the isolation of the two host populations. Because of these characteristics, viral genetic analyses may provide novel and powerful techniques for assessing connectivity and population structure with improved resolution, supplementing that which is currently possible using host genetic markers.

Bobcats (*Lynx rufus*), with large home ranges and high resource requirements, are susceptible to the effects of habitat loss and fragmentation in urbanizing systems (Crooks 2002; Riley *et al.* 2003, 2006, 2010). We investigated patterns of genetic diversity among bobcats and FIV isolates from a fragmented landscape in southern California to evaluate how urbanization affects connectivity among bobcats in this region. We specifically evaluated the extent to which several large freeways, and the developed areas surrounding them, are barriers to gene flow and pathogen transmission between habitat patches. We predicted that decreases in connectivity would lead to significant genetic structure among both host and pathogen populations. We performed standard population genetics analyses using 16 unlinked microsatellite loci from 106 bobcats. We also constructed phylogenetic trees to assess patterns of relatedness among FIV isolates from 19 of these individuals infected by the virus.

Our findings, presented below, demonstrate that two spatially structured, genetically distinct bobcat subpopulations exist. However, the pathogen phylogeny revealed no association between FIV relatedness and bobcat population structure, suggesting movements, contacts and disease transmission between subpopulations continue despite very low levels of host gene flow. This finding was inconsistent with our hypothesis that decreased gene flow among bobcats would lead to similar genetic structure among the virus population. However, these results are consistent with other studies that have found major roads and urban development to

be more permeable to transient bobcat movements than to effective migration, allowing for the potential movement of pathogens in the absence of gene flow (Riley *et al.* 2006; Ruell *et al.* in press). We illustrate the utility in using multiple molecular markers, each with different determinants of movement throughout populations, to assess complex questions of connectivity.

## Methods

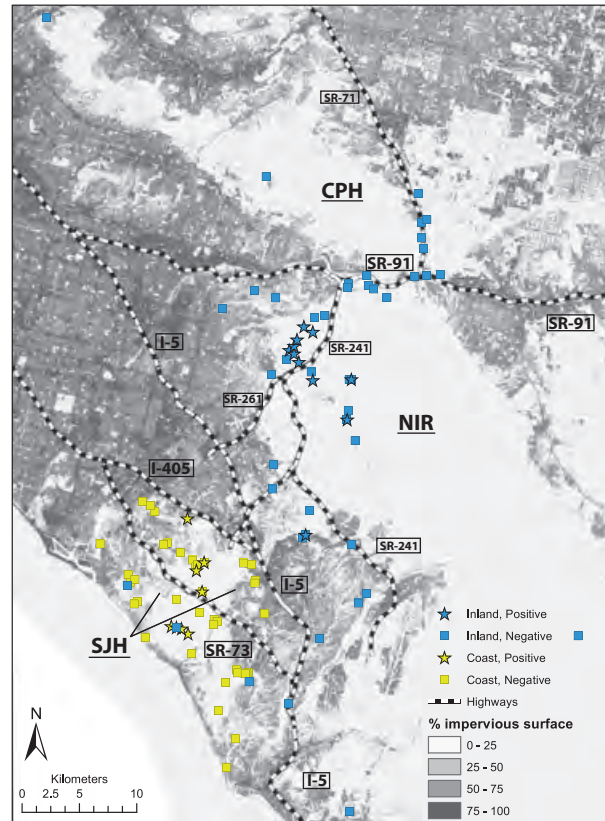
### *Location and field sampling*

This study was located south and west of Los Angeles, CA and included four habitat patches divided by three large freeways—Interstate-5 (I-5), the Riverside Freeway (SR-91) and the San Joaquin Hills Transportation Corridor (SR-73) (Fig. 1). I-5 through this region was constructed from 1944 to 1958 and has an average annual daily traffic volume (AADT) of ~262 000 cars per day (California DOT 2009). SR-91 was originally completed in 1971 and underwent a major expansion in 1995. The AADT of this freeway is ~264 000 cars per day (California DOT 2009). SR-73 was constructed in 1996 and has an AADT of ~73 000 cars per day (California DOT 2009). Aside from these roads and adjacent urban development, the only potential natural barrier to bobcat movement is the Santa Ana River, which flows about 100 m to the north of SR-91. No other natural barriers to gene flow (i.e. major mountain ranges) exist between these habitat patches, which are primarily characterized by chaparral, coastal scrub and grassland vegetative communities.

A total of 106 bobcats were included in this study. The majority of bobcats ( $n = 75$ ) were live-captured between December 2002 and March 2009 using wire cage traps baited with visual and odour attractants (Lyren *et al.* 2006, 2008a,b). Animals were anesthetized, and blood samples were collected. Animals were captured, sampled and released with permission of cooperating agencies after approval by all appropriate animal care and use committees. The remaining individuals ( $n = 31$ ) were opportunistically sampled postmortem; when possible, heart blood clots, thoracic fluid, ear punch and hair samples were collected from these bobcats. Blood and tissues were stored at USGS facilities in Irvine, CA, and aliquots were sent to Colorado State University for analysis as described below.

### *Putative subpopulation assignments*

Bobcats were assigned to one of four putative subpopulations based on the GPS coordinates of the capture or road kill location relative to freeways I-5, SR-91 and SR-73 (Fig. 1). These three freeways were the focus of our



**Fig. 1** Map of study locations southeast of Los Angeles, California. GPS capture locations of 105 bobcats indicated by squares [feline immunodeficiency virus (FIV) negative] or stars (FIV positive). Blue or yellow fill of each symbol represents the genetic assignment of an individual to an inland (east of I-5) or coastal (west of I-5) subpopulation, respectively (see Fig. 2). The a priori assignment of individuals to putative subpopulations (SJH-W: San Joaquin Hills West; SJH-E: San Joaquin Hills East; NIR: North Irvine Ranch; CPH: Chino Puente Hills) was based on the capture location of bobcats relative to the focal roads SR-73, I-5 and SR-91, which were investigated as potential barriers to gene flow. Degree of urban development (% impervious surface) is represented by grey shading.

investigation because they completely traverse the study area (i.e. animals cannot move between habitat fragments without crossing one of these freeways), and these roads represent a gradient of permeability to bobcat movements based on previous studies [see discussion and also Lyren *et al.* (2008a,b)]. The San Joaquin Hills west subpopulation [SJH-west ( $n = 29$ )] was located between the coast and SR-73, which merges with I-405 to the north and I-5 to the south. The San Joaquin Hills east subpopulation [SJH-east ( $n = 20$ )] included individuals sampled between SR-73 and I-5. The North Irvine Ranch [NIR ( $n = 44$ )] subpopulation comprised individuals captured east of I-5 and south of SR-91, whereas the Chino Puente Hills [CPH ( $n = 12$ )] subpopulation consisted of individuals captured east of

I-5 and north of SR-91. One individual did not have a recorded capture location, and thus, it was not included in analyses that required the above subpopulation assignments. The following population genetics analyses were, except where noted, performed using this a priori assignment of individuals to putative subpopulations and the multilocus microsatellite genotype data for each individual.

#### Genotyping microsatellites

Bobcat genomic DNA was extracted from whole blood, peripheral blood mononuclear cells (PBMCs) or tissue using QIAamp® DNeasy blood and tissue kit (Qiagen Inc., Valencia, CA, USA). Seventeen microsatellite loci (Table 1) were amplified using primer pairs for polymerase chain reaction (PCR) developed by Menotti-Raymond *et al.* (1999): FCA008, FCA023, FCA026, FCA031, FCA043, FCA045, FCA077, FCA090, FCA096, FCA132, FCA149, FCA559; Menotti-Raymond *et al.* (2005): FCA740, FCA742; and Faircloth *et al.* (2005): BCE5T, BCD8T, BCG8T. Primers BCE5T and BCG8T were modified to contain the M-13 sequence instead of the CAG sequence as published. We selected these primer pairs from the above publications based on the following criteria: longer repeat units, efficiency of amplification and maximal heterozygosity. The 5' end of the forward primer of each primer pair was modified with a 16-bp tail comprising the M-13 sequence

(5'-GTA AAA CGA CGG CCA G-3'). Reverse primers were not modified. All microsatellite PCR products were fluorescently labelled using a second forward primer consisting of the above M-13 sequence with 6-FAM on the 5' end.

PCR methodologies were adapted from Boutin-Ganache *et al.* (2001) and Riley *et al.* (2006). PCR reaction conditions included 94 °C for 3 min followed by 22 cycles of (94 °C for 30 seconds; 59 °C for 30 seconds; and 72 °C for 45 seconds), followed by 10 cycles of (94 °C for 30 seconds; 53 °C for 30 seconds; and 72 °C for 45 seconds), and a final cycle of 72 °C for 10 min. Randomly selected PCR products as well as the negative control for each reaction were visualized under UV light using gel electrophoresis with ethidium bromide in 2% agarose gel to confirm the presence of amplicons of appropriate length. Precise PCR product fragment lengths were determined using an ABI 3730xl DNA Analyzer and Peak Scanner 1.0 software (Applied Biosystems, Foster City, CA, USA). PCR and genotyping were repeated in ten per cent of randomly chosen bobcat samples for each microsatellite locus to confirm genotypes and prevent scoring errors. All duplicated genotypes were consistent with the primary analysis, demonstrating a high degree of assay reproducibility and reducing the likelihood of genotyping errors owing to false alleles or allelic dropout.

**Table 1** Characterization of 17 microsatellite loci in 106 bobcats

Locus	Size range	No. of alleles	Repeat	Chromosome	$H_O$	$H_E$	PIC	References
FCA008	140–156	8	di	A1	0.71	0.77	0.73	1
FCA023	144–158	6	di	B1	0.67	0.72	0.67	1
FCA026*	138–166	13	di	D3	0.79	0.83	0.81	1
FCA031	237–255	8	di	E3	0.78	0.80	0.77	1
FCA043†	131–139	5	di	C2	0.78	0.73	0.68	1
FCA045*	147–173	7	di	A1	0.63	0.83	0.81	1
FCA077†	130–140	6	di	C2	0.77	0.74	0.70	1
FCA090*	108–126	7	di	A1	0.41	0.52	0.48	1
FCA096	189–209	8	di	A2	0.80	0.77	0.75	1
FCA132*	182–194	7	di	D3	0.66	0.78	0.74	1
FCA149	133–149	9	di	B1	0.76	0.78	0.75	1
FCA559	115–135	6	tetra	B1	0.64	0.67	0.60	1
FCA740	333–353	6	tetra	C1	0.84	0.79	0.76	2
FCA742	104–134	7	tetra	D4	0.65	0.67	0.61	2
BCD8T	156–180	5	tetra	Unknown	0.21	0.21	0.20	3
BCE5T	256–280	7	tetra	Unknown	0.70	0.75	0.71	3
BCG8T	275–299	11	di	Unknown	0.73	0.78	0.74	3

$H_O$ , observed heterozygosity;  $H_E$ , expected heterozygosity; PIC, polymorphic information content.

\*Null alleles may exist in one subpopulation.

†FCA077 and FCA 043 were found to be in linkage disequilibrium; FCA043 was not used in population genetics analyses.

References: (1) Menotti-Raymond *et al.* (1999); (2) Menotti-Raymond *et al.* (2005); and (3) Faircloth *et al.* (2005).



### Validating and characterizing microsatellite data

Microsatellite data were screened for genotyping errors because of stuttering, null alleles and large allele dropout at all loci in MICROCHECKER 2.2.3 (Van Oosterhout *et al.* 2004). There was no evidence of errors because of stuttering or large allele dropout at any loci. The following three loci showed evidence of null alleles when testing across all individuals with no subpopulation information: FCA045, FCA090 and FCA132. The null alleles at these loci correspond to NIR (FCA045 and FCA090) and SJH-west (FCA132) when the same analysis was run with a priori subpopulation assignments.

Tests for linkage disequilibrium among loci were performed in GENEPOP 4.0 (Raymond & Rousset 1995; Rousset 2008). The results for linkage disequilibrium varied greatly between subpopulations with seven significant tests in SJH-west (120 total tests;  $\alpha = 0.009313$ ), four significant tests in SJH-east (120 total tests;  $\alpha = 0.009313$ ), two significant tests in NIR (136 total tests;  $\alpha = 0.009102$ ) and one significant test in CPH (104 total tests;  $\alpha = 0.009567$ ). Loci FCA077 and FCA043 were in linkage disequilibrium in all four putative subpopulations, and therefore, FCA043 was eliminated from further analyses.

Hardy-Weinberg equilibrium probabilities were calculated using GENEPOP 4.0 (Raymond & Rousset 1995; Rousset 2008). Three of four subpopulations significantly deviated from Hardy-Weinberg equilibrium at one unique locus: FCA023 in SJH-west (15 tests;  $\alpha = 0.015068$ ), FCA045 in NIR (16 tests;  $\alpha = 0.014790$ ) and BCE5T in CPH (16 tests;  $\alpha = 0.014790$ ). The remaining loci in each subpopulation did not deviate from HW equilibrium, and therefore, all subpopulations were assumed to be in HW equilibrium. Observed and expected heterozygosity and the polymorphic information content (PIC) for each locus were determined using the program CERVUS 3.0 (Table 1) (Kalinowski *et al.* 2007).

### Assessment of population structure

Population differentiation based on allele frequencies was calculated for each pair of putative subpopulations using GENEPOP 4.0 (96 tests;  $\alpha = 0.0097$ ) (Raymond & Rousset 1995; Rousset 2008). Allelic richness, estimated using rarefaction to avoid bias caused by differences in sample size (Leberg 2002), was calculated for each putative subpopulation using FSTAT 2.9.3.2 (Goudet 1995). Allelic richness results were confirmed to be normally distributed using a Ryan Joiner Test in Minitab Student Version 14.11.1 (Ryan Joiner test;  $P > 0.1$ ). Analysis of variance (ANOVA) was used to determine whether allelic richness differed significantly between subpopulations

( $\alpha = 0.05$ ). Estimates of subpopulation differentiation ( $D_{est}$ ) were calculated using the online program Software for Measurement of Genetic Diversity (Jost 2008; Crawford 2010).  $F_{ST}$  values were calculated in FSTAT (Goudet 1995). The use of  $F_{ST}$  values as measures of population differentiation has recently been criticized (Hedrick 2005b; Jost 2008). Therefore, we include them here as supplemental information only to allow a general comparison among similar, previously published studies (Table S1, Supporting information).

Bayesian clustering in program STRUCTURE 2.3.3 was used to infer the number of genetically distinct subpopulations ( $K$ ) and to assign each individual to the subpopulation with which they share the highest genetic similarity. Parameters were set to include 50 000 burn-in and 500 000 Markov Chain Monte Carlo iterations (Pritchard *et al.* 2000). Data were first analysed without a priori source population information for individuals. Independent allele frequencies among subpopulations and genetic admixture were included as parameters so as not to introduce an upward bias in the estimation of  $K$  (Pritchard *et al.* 2000). This analysis was repeated five times for each  $K$  to verify the consistency of likelihood values between runs.  $K$  was varied from  $K = 1$  to 5, representing a range of greater than expected  $K$  values to ensure our analysis included all ecologically plausible values of  $K$ .

This was followed by additional analyses with the data set divided into two groups: coastal animals (SJH-west and SJH-east) and inland animals (NIR and CPH) to more closely evaluate possible substructure within each of these two groups (Pritchard *et al.* 2010). The parameters of this model were the same as above, with each analysis repeated five times for each  $K$  from  $K = 1$  to 3 for each group. For all of the above analyses, posterior probability values were computed for each  $K$  according to Pritchard *et al.* (2010). Additionally,  $\Delta K$  values, which have been shown to accurately reflect the actual number of genetic clusters, were calculated according to Evanno *et al.* (2005).

Structure was also used to identify individuals that were captured in one subpopulation but genetically assigned to another and thus represent migrants. The parameters for this analysis were the same as described above except subpopulation assignments were included in the analysis with the migration prior set to 0.05. Individuals with a probability of assignment to their source population  $\leq 0.01$  were considered migrants. Individuals with ambiguous assignment probabilities were considered hybrids.

An individual pairwise relatedness test was performed after correction for null alleles using the program Maximum-likelihood (ML)-Relate (Kalinowski *et al.* 2006; Wagner *et al.* 2006; Carlsson 2008). The

average pairwise relatedness of each subpopulation was compared using a *t*-test.

#### Detection of FIV infection

All bobcats for which serum samples were available ( $n = 91$ ) were screened for antibodies to FIV by Western blot as previously described (Franklin *et al.* 2007b). Of these, 24 (26.4%) were scored as 'weak positive' or 'positive' for FIV antibodies. PCR was used to confirm FIV infection in these samples (two to four PCR attempts per seropositive individual) using DNA extracted from whole blood or PBMCs. We used a set of degenerate nested primers, which was previously shown to amplify a region of the *RT-pol* gene from a diverse set of FIV isolates (Troyer *et al.* 2005). All bobcats that were not screened by Western blot ( $n = 15$ ) were screened for FIV infection by the PCR method only. In total, 19 individual bobcat FIV isolates were amplified by PCR and included in the FIV genetic analyses.

#### FIV *pol* and *env* PCR amplification and sequencing

Two gene regions were analysed to evaluate viral phylogeny using both a highly conserved region (*RT-pol*, encoding the essential viral polymerase) and a region that is less evolutionarily constrained (*env*, encoding the surface envelope protein) (Pecon-Slattery *et al.* 2008). PCR amplification of a region of the *RT-pol* gene was performed using degenerate primers as previously described (Troyer *et al.* 2005). Primers to amplify a region of the *env* gene were designed by first performing an alignment of two previously published FIV sequences: PLV-14 [GeneBank (accession no. U03982)] isolated from a Florida panther (*Puma concolor coryi*) and PLV-1695 [GenBank (accession no. DQ192583)] isolated from a puma (*Puma concolor cougar*) in British Columbia. Degenerate nested primer pairs were designed from regions of homology including first-round primers mJLenvF1 (5'-GTG CAI GTC ATI AGA TGT AGA G-3') and mPLVenvR7 (5'-GGG GTG TCA TTA TAA IIA GTA AAA TT-3'), amplifying a fragment of ~700 bp, and second-round primers mPLVenvF8 (5'-GGG TGC ATT IGT IAA AGA ICC ATT TTT AG-3') and mPLVenvR6 (5'-GGT GCI TTG AAI GGA CAC ATT CC-3'), which amplified a 570-bp product. Underlined bases indicate 5' tail sequences added to the primers to lengthen primers and increase strength of primer binding to the template DNA.

Fifty microlitre PCR reaction mixtures contained 25  $\mu$ L iQSuperMix (Qiagen), 400 nM of each primer and 10  $\mu$ L DNA. DNA concentrations varied among samples resulting in a range of ~100–500 ng template per reac-

tion. PCR reaction conditions for both rounds included a hot start at 94 °C followed by 20 cycles of melting at 94 °C for 30 seconds, touchdown annealing temperatures ranging from 55 to 46 °C decreasing by 1 °C every 2 cycles for 30 seconds, extension at 72 °C for 30 seconds, followed by 25 cycles of melting at 94 °C for 30 seconds, annealing at 52 °C for 30 seconds and extension at 72 °C for 30 seconds with a final extension at 72 °C for 3 min. This protocol successfully amplified proviral *env* fragments from three FIV-positive bobcats.

The resulting sequences were aligned, and the regions of highest homology were used to develop the following nested primer pairs that successfully amplified *env* fragments from all remaining bobcats with amplified *pol* sequences ( $n = 16$ ). First-round primers were envfw201 (5'-TTT CTC ATG TTC CTT GAA TGG TAC-3') and envrv202 (5'-CAC ATT CCA CTT AAT TGG TAT TG-3'), resulting in approximately a 450-bp amplicon. Second-round primers were envfw202 (5'-TGG TAC ATT CTG GGT GTT TAA ATC-3') and envrv201 (5'-CTA TTT TGG TCA CTC TCT GAT GC-3'), resulting in approximately a 400-bp product. PCR reagents and reaction conditions were the same as above with the exception that touchdown annealing temperatures ranged from 58 to 49 °C and the annealing temperature for the last 25 cycles was 54 °C. PCR products were visualized under UV light using gel electrophoresis with ethidium bromide in 2% agarose gel to confirm the presence of product bands.

PCR products were purified using the QIAquick PCR Purification Kit (Qiagen Inc.) prior to sequencing. Forward and reverse sequences were aligned using BLAST (National Center for Biotechnological Information, Bethesda, MD, USA), and a single consensus FIV sequence was produced for each infected bobcat. All sequences were verified manually. All sequences are available in the NCBI GenBank under accession numbers JN383436–JN383465.

#### Genetic alignments and phylogenetic analyses

Sequences were trimmed at the 5' and 3' ends resulting in all sequences having the same length (*pol* = 427 bp, *env* = 347 bp). Trimmed consensus sequences for each gene fragment ( $n = 19$  *pol* & *env*) were converted to coding frame using an online DNA translator tool (Swiss Institute of Bioinformatics; <http://www.isb-sib.ch/>), prior to alignment in CLUSTAL X2 (Larkin *et al.* 2007). Alignments were input into jMODELTEST (Posada 2008) to estimate the best-fit model of nucleotide substitution, which was the TPM2uf model with among-site rate variation for both gene segments (Kimura 1981). The estimated model parameters used for *pol* were [Lset base = (0.4030 0.1312 0.1592) nst = 6 rmat = (7.3755



50.7381 7.3755 1.0000 50.7381) rates = gamma shape = 0.2280 ncat = 4 pinvar = 0]. The model parameters for *env* included [Lset base = (0.3707 0.1869 0.1840) nst = 6 rmat = (4.2249 11.3706 4.2249 1.0000 11.3706) rates = gamma shape = 0.2250 ncat = 4 pinvar = 0].

Maximum-likelihood phylogenetic analyses were conducted in Phylogenetic Analysis Using Parsimony (PAUP) (Sinauer Associates, Sunderland, MA, USA) (Swofford 2003). The corresponding *pol* and *env* gene regions from an FIV isolate sequenced from a Florida panther in 1994 were included to provide a root for each tree (Langley *et al.* 1994). ML trees were constructed using an NJ starting tree, followed by a heuristic search using the tree-bisection-reconnection branch-swapping algorithm. The *pol* and *env* trees were found to be congruent, and therefore, a single *pol-env* concatenated sequence was used to construct the final phylogenetic tree for analysis. Bootstrap analyses were performed with 100 iterations for all trees. Viral isolates were divided into four 'FIV Groups' based on clusters of related isolates arising from a basal node supported with an ML bootstrap value of 70 or greater.

We estimated the number of FIV migration events between coastal and inland bobcat subpopulations by calculating the *s* statistic for the observed ML phylogenetic tree in Mesquite 2.75 (Maddison & Maddison 2011). The *s* statistic reflects the minimum number of parsimony steps that explain the discord between subpopulations as monophyletic groups on the tree (Slatkin & Maddison 1989).

To estimate the timeline of past virus transmissions within and between subpopulations, the concatenated viral sequence data were analysed in the coalescent framework as implemented by the program BEAST 1.6.2 (Drummond & Rambaut 2007). The SDR06 substitution model was used with a relaxed uncorrelated lognormal molecular clock (Drummond *et al.* 2006). The tree model included a piece-wise linear Bayesian Skyline prior with five groups and a randomly generated starting tree (Drummond *et al.* 2005). An initial run of 10 000 000 Markov chain Monte Carlo (MCMC) iterations, sampled every 1000 runs, was performed to estimate model parameter values. The first 10% of logged values were discarded as burn-in. From this analysis, the following model parameter priors were changed from default settings: (i) the relative rate parameters were set to vary from 0 to 10; (ii) the Bayesian Skyline population size was set to vary from 0 to 500; and (iii) the mean rate for the uncorrelated relaxed molecular clock was set to vary from 0 to 10.

The final analysis included the above settings with 50 000 000 MCMC iterations sampled every 1000 runs. The first ten per cent of logged values were again dis-

carded as burn-in. The estimated values and associated effective sample size (ESS) for each model parameter were viewed in TRACER 1.5 (Rambaut & Drummond 2007). ESS values for all parameters were >500. The maximum clade credibility tree was produced in TREEANNOTATOR 1.6.2 (Rambaut & Drummond 2002). The resulting tree was viewed in FIGTREE 1.3.1 (Rambaut 2006), and the mean posterior probability heights with 95% highest posterior density (HPD) intervals were labelled on internal nodes.

## Results

### *Bobcat population structure*

*Distribution of alleles.* An analysis of population differentiation performed in GENEPOP indicated that the distribution of alleles among bobcats from the two coastal subpopulations, SJH-west and SJH-east, differed significantly ( $P = 0.0064$ ) at only the FCA008 microsatellite locus. Therefore, the coastal bobcats, regardless of whether they were captured east or west of SR-73, had a similar distribution of alleles at 15 of the 16 microsatellite loci examined. Similarly, the two inland subpopulations, NIR and CPH, significantly differed in allelic distribution at only FCA026 ( $P = 0.0025$ ) and FCA077 ( $P = 0.0048$ ). This finding demonstrates that bobcats captured north and south of SR-91 had a similar distribution of alleles at 14 of the 16 microsatellite loci we analysed. However, the distribution of alleles differed greatly between the coastal and inland subpopulations. SJH-west bobcats significantly differed from NIR and CPH bobcats at 13 and 10 microsatellite loci, respectively, and SJH-east bobcats differed from both NIR and CPH bobcats at 13 loci ( $P < 0.01$  all significant pairwise tests). These results indicate a high degree of genetic differentiation exists between bobcats separated by I-5 and its associated urban development.

*Genetic diversity.* No pairwise difference existed in allelic richness (Table S2, Supporting information) when comparing the two coastal subpopulations ( $F_{1,29} = 2.59$ ,  $P = 0.118$ ) or the two inland subpopulations ( $P = 0.982$ ,  $F_{1,30} = 0.00$ ). However, the coastal bobcats (combined SJH-W and SJH-E) had significantly lower allelic richness than the inland bobcats (combined NIR and CPH) ( $P < 0.001$ ,  $F_{1,62} = 12.62$ ). This further suggests that coastal and inland bobcats are genetically distinct and indicates that coastal bobcats have lower genetic diversity than inland bobcats. Interestingly, the BCD8T locus appears to have drifted to fixation in coastal bobcats as only one allele was sampled at this locus from all 49 coastal bobcats. Although the frequency of this allele was also high in NIR (0.82) and CPH (0.67), four and

five alleles, respectively, were present at this locus in these subpopulations.

*Departures from random mating.* The overall estimate of genetic differentiation among the four putative subpopulations,  $D_{est} = 0.11$ , indicates a moderate amount of genetic structure exists within this population. Pairwise  $D_{est}$  values were lowest when comparing the two coastal subpopulations ( $D_{est} = 0.008$ , SJH-west:SJH-east) or the two inland subpopulations ( $D_{est} = 0.014$ , NIR:CPH) and highest between the coastal and inland subpopulations ( $D_{est} = 0.11$ , SJH-west:NIR;  $D_{est} = 0.13$ , SJH-west:CPH;  $D_{est} = 0.14$ , SJH-east:NIR;  $D_{est} = 0.19$ , SJH-east:CPH). The estimated differentiation between the coastal bobcats (combined SJH-W and SJH-E) and the inland bobcats (combined NIR and CPH) was  $D_{est} = 0.14$ . Locus-specific  $D_{est}$  values are reported in Table S2 (Supporting information).

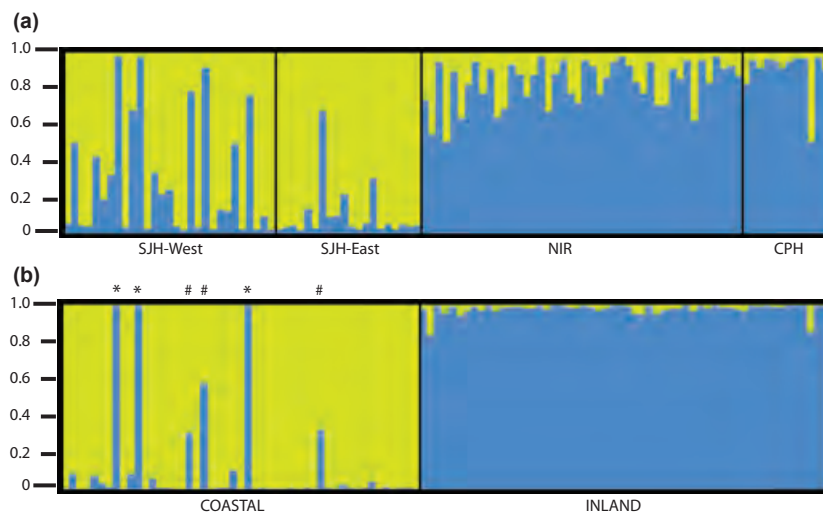
We found no evidence of inbreeding within the overall population ( $F_{IS} = 0.013$ ; 95% CI:  $-0.29$ – $0.065$ ), nor in any of the putative subpopulations [ $F_{IS} = (0.011, \text{SJH-W}; -0.045, \text{SJH-E}; 0.029, \text{NIR}; 0.034, \text{CPH})$ ].

*Individual assignment tests.* Bayesian clustering indicated the assumption of two genetically distinct subpopulations ( $K = 2$ ) best explained the variation in our microsatellite data (Fig. S1, Supporting information). This result was the same regardless of whether or not source population information was used as a prior in the anal-

ysis. All bobcats caught east of I-5 (NIR and CPH bobcats  $n = 56$ ) were assigned to one 'inland' subpopulation, while 46 of 49 bobcats caught west of I-5 (SJH-west and SJH-east bobcats) were assigned to a 'coastal' subpopulation (Fig. 2). Three individuals captured west of I-5 were genetically assigned to the inland subpopulation and thus represent possible migrants. However, no bobcats captured east of I-5 were genetically assigned to the coastal subpopulation. If any additional human development and/or freeways in this region (i.e. SR-91, SR-73, SR-241, SR-261) were causing genetic structure, a population model with  $K > 2$  should have had the highest support. Therefore, the I-5 corridor is the only human development in this region implicated as a cause of genetic structure among bobcats during our period of sample collection.

Three individuals were identified as first-generation migrants as they were captured in the coastal area but had assignment probabilities of 1.00 to the inland population when capture locations were included in the Structure analysis (denoted by \* in Fig. 2b). Three other bobcats captured in the coastal area had the genetic profile of hybrids with partial assignment to both subpopulations (denoted by # in Fig. 2b). No individuals sampled from the inland area were identified as migrants or hybrids from the coastal area.

*Relatedness of individuals.* The average relatedness of bobcats in the coastal population ( $R = 0.096$ ;  $SE = 0.0037$ )



**Fig. 2** Individual bobcat genetic assignments to each of two distinct subpopulations. Each vertical bar represents one individual. Values on the  $y$ -axis are the probability of assignment of each individual to one of the two genetic groups identified (Fig. S1). The shading of each bar corresponds to the probability of genetic assignment to either the coastal group (yellow) or the inland group (blue) of bobcats. (a) Results for simulation of  $K = 2$  without including a priori capture locations. The majority of individuals captured west of I-5 had strong assignment to one subpopulation (coastal—yellow), while all of the individuals captured east of I-5 had a high probability of assignment to a second subpopulation (inland—blue). (b) Three migrants (\*) and three hybrids (#) were identified in Structure using a priori assignments to coast or inland subpopulations based on capture locations. All gene flow was detected from the inland to the coastal subpopulation.

was significantly higher ( $t_{5634} = 7.23$ ;  $P < 0.001$ ) than in the inland population ( $R = 0.064$ ;  $SE = 0.0026$ ).

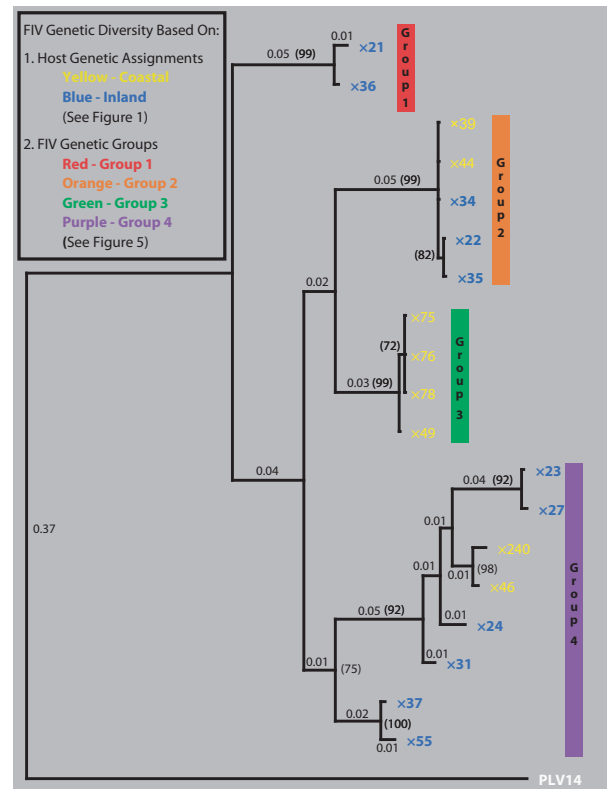
### FIV phylogenetic analyses

We amplified a 427-bp region of *pol* and 347-bp region of *env* by PCR from 19 bobcats (four in SJH-west, four in SJH-east and 11 in NIR) bobcats. These included 17 of the 24 (70.8%) bobcats putatively seropositive by Western blot, one bobcat that was negative by Western blot and one bobcat that was screened by PCR only. The inability to amplify FIV sequences from a subset of putatively seropositive bobcats is similar to the findings of previous studies (Troyer *et al.* 2005; Franklin *et al.* 2007b). This is probably the result of a difference in the sensitivity and specificity of these two assays and/or a relatively low FIV proviral load present in a subset of infected animals.

The demographic information for 18 of the 19 FIV-positive bobcats was known: 13 were adult males, one was a yearling male, two were adult females and two were yearling females. The age-specific prevalence of FIV was 14.2% (3/21) for yearlings and 23.8% (15/63) among adults.

The ML phylogenetic tree built from *pol-env* concatenated gene sequences (Fig. 3) shows no evidence of association between capture location (coastal vs. inland) and FIV relatedness (see also Fig. 4). The basal nodes have low bootstrap support, suggesting little overall genetic structuring within the virus population. The number of parsimony steps ( $s$  statistic) that best explains the discord of FIV relatedness between subpopulations indicates a minimum of three FIV transmission events have occurred between the coastal and inland subpopulations (Slatkin & Maddison 1989).

We estimated the past timeline of virus movement within and between bobcat subpopulations using a coalescent Bayesian model (Drummond *et al.* 2005; Drummond & Rambaut 2007). Figure 5 illustrates the maximum clade credibility tree with labels representing the estimated year of coalescence (mean posterior node ages) for each internal node. The age of the basal nodes is difficult to interpret because of large 95% HPD intervals (analogous to 95% confidence intervals). Therefore, it is impossible to reconstruct a precise timeline of ancestral divergence into the observed FIV groups. However, the more terminal nodes are insightful as they depict the estimated year of recent FIV coalescent events. FIV Group 4, the largest supported group of isolates, comprises six isolates from inland bobcats (x23, x24, x27, x31, x37 and x55) and two isolates from coastal bobcats (x240 and x46). The two coastal isolates in this group share a common ancestor with two of the

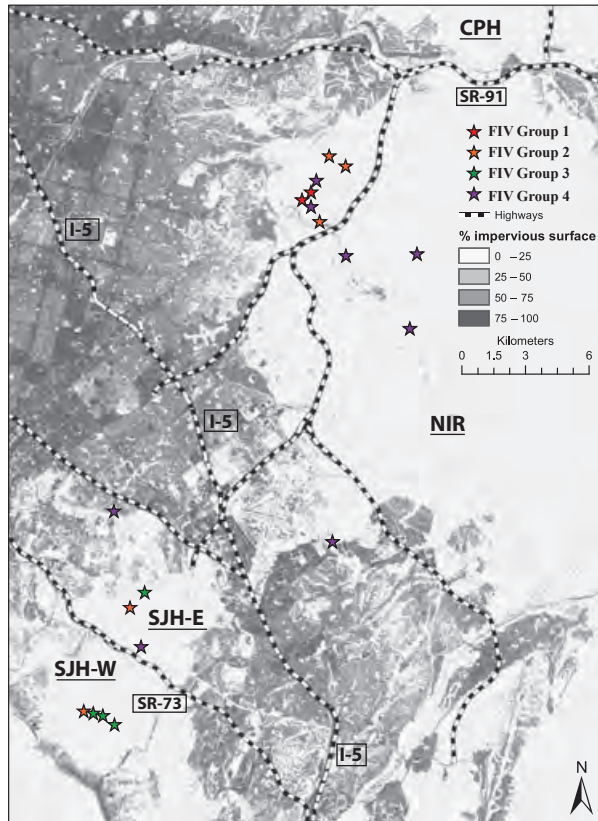


**Fig. 3** Maximum-likelihood phylogenetic tree of feline immunodeficiency virus (FIV) concatenated *pol-env* sequences from 19 infected bobcats. The tree was constructed using a single 774-bp sequence (427 bp from *pol*, 347 bp from *env*) of proviral DNA from each individual. All sequences are in coding frame. Bootstrap values  $>70$  are indicated in parentheses. Branch lengths  $\geq 0.01$  are also indicated. Individuals have been coloured to represent their genetic assignment based on the results of the *Structure* analysis (see Figs 1 and 2). Because no migrants were infected with FIV, the colour of an individual also represents whether an individual was captured west (yellow) or east (blue) of I-5. FIV isolates were assigned to groups based on the four most basal supported nodes to illustrate the distribution of FIV genetic diversity across the landscape (See Fig. 4). The tree is rooted with PLV-14, a viral sequence from the same FIV clade, which was sequenced from a Florida panther in 1994.

inland isolates (x23 and x27) in *c.* 1990 (Fig. 5; 95% HPD: 1967–2003). Similarly, FIV Group 2, with 99% bootstrap support, contains nearly identical sequences from three inland bobcats (x22, x34 and x35) and two coastal bobcats (x39 and x44), which share a common ancestor in approximately the year 2000 (Fig. 5; 95% HPD: 1995–2003).

Feline immunodeficiency virus Group 3 contains four closely related viral isolates (Fig. 3; x75, x76, x78 and x49) from related coastal bobcats ( $r > 0.25$ ). To our knowledge, this is the first evidence of FIV familial transmission among bobcats. Familial transmission of





**Fig. 4** Geographical distribution of feline immunodeficiency virus (FIV) genetic diversity among inland and coastal bobcats. Each star indicates the capture location of one FIV-positive bobcat. The stars are coloured corresponding to which of the four groups of related FIV isolates was sampled from each bobcat (See Fig. 3). FIV Groups 1 (red) and 3 (green) contain isolates sampled only from inland or coastal bobcats, respectively. FIV Groups 2 (orange) and 4 (purple), containing both inland and coastal bobcats, resulted from the movement of FIV across Interstate-5. Degree of urban development (% impervious surface) is represented by grey shading.

FIV has been previously documented in mountain lions (Poss *et al.* 2008).

## Discussion

### *Bobcat population structure*

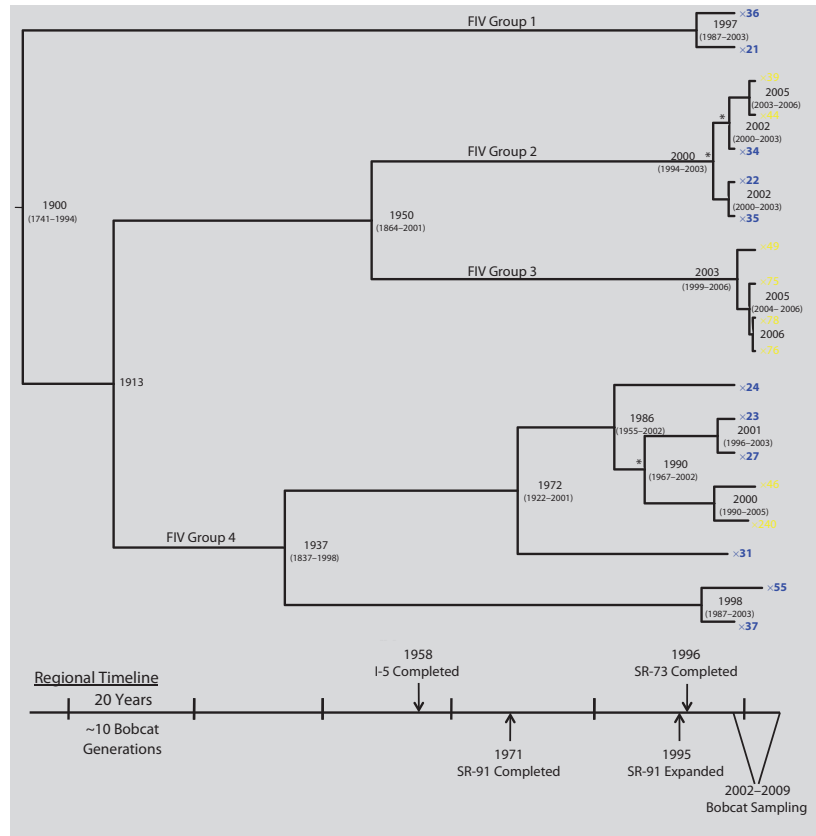
Understanding the degree of connectivity among populations in heterogeneous landscapes is an important goal of ecology, population genetics and conservation biology (Taylor *et al.* 1993; Crooks & Sanjayan 2006; Fischer & Lindenmayer 2007). We evaluated host and pathogen genetic markers to investigate connectivity among bobcats throughout a fragmented urban landscape in southern California. Our results indicate that two genetically distinct groups of bobcats existed in our

study area, defined as coastal and inland subpopulations, separated by urban development including Interstate-5 (Figs 1 and 3). This finding is in agreement with other analyses performed previously with a small subset of these bobcats and four of the 16 microsatellite loci utilized in this report (Ruell *et al.* in press).

Our results indicate that the coastal and inland bobcat subpopulations had a different distribution of alleles at most of the microsatellite loci examined and a low, unidirectional pattern of migration from the inland to the coastal area. We also observed reduced genetic diversity and increased relatedness among individuals in the coastal population. These findings suggest the observed genetic differentiation is because of decreased migration through the urban matrix between the inland and coastal habitat patches. We therefore conclude that urban development, including I-5, has been a physical barrier that has reduced bobcat movement and gene flow between isolated groups of individuals.

We did not detect substructure among bobcats separated by the two other freeways that we specifically evaluated, SR-91 and SR-73 and nor did we find evidence of genetic structure because of any other freeways (i.e. SR-241, SR-261) or human development in the region. The maintenance of gene flow across SR-91 and SR-73 is probably explained by the fact that these roadways are perforated by more functional wildlife underpasses and are bordered by more natural habitat than I-5. Therefore, the distance between habitat patches is shorter across SR-91 and SR-73 than across I-5, a factor that has been shown to be an important determinant in carnivore movement among habitat fragments in this region (Crooks 2002). It is possible that because SR-91 and SR-73 are newer roads, any isolation these may be causing has not yet resulted in detectable genetic structure.

Our findings, revealed by analyses of empirical genetic data, are supported by observations from remotely triggered cameras placed near underpasses of all three focal roadways. Cameras placed near the only potential wildlife corridor under I-5 that directly links SJH-E to NIR did not document any movement of bobcats between these habitat patches during 204 consecutive days of observation (Lyren *et al.* 2008a). Cameras, however, did not monitor another potential path across I-5 connecting NIR to SJH-W to the south; road kill carcasses and models of connectivity both suggest this path may be utilized by bobcats (Lyren *et al.* 2008a). In contrast to the lack of remote camera observations of bobcat movement across I-5, a similar duration of camera monitoring of potential wildlife corridors under SR-91 documented many successful movements between NIR and CPH (E. E. Boydston, unpublished data). Likewise, multiple bobcat movements between



**Fig. 5** The estimated timeline of viral coalescent events. Maximum clade credibility Bayesian phylogenetic tree of *pol-env* concatenated sequences constructed using dated tips. Internal node labels correspond to the highest mean posterior probability estimate [with 95% highest posterior density (HPD) interval] for the year of coalescence. The estimated dates on basal nodes lack precision; therefore, it is impossible to accurately reconstruct the timeline of ancestral diversification into the current four-group structure of feline immunodeficiency virus (FIV). Estimates of recent coalescent events are more precise and depict contemporary FIV transmission within and between bobcat subpopulations. \*Indicates common ancestor to contemporary isolates sequenced from both inland and coastal bobcat isolates. Viral movement across I-5 has probably occurred since the estimated date of these coalescent events, resulting in the presence of related viral strains sampled in both subpopulations (See Fig. 4).

SJH-W and SJH-E were also recorded during 358 days of camera observations near SR-73 (Lyren *et al.* 2008b).

Interstate-5 and the surrounding urban matrix have greatly increased in size over time since the original construction was completed in 1958. While it is difficult to know when I-5 became a 'barrier' to bobcat movement, Crooks (2002) estimated that the coastal San Joaquin Hills might have become effectively isolated from inland natural areas around 1980. Given the generation time of bobcats (*c.* 2 years) (Knick *et al.* 1985), between 12 (*c.* 1980) and 25 (*c.* 1958) generations have passed because the inland and coastal bobcat subpopulations became physically isolated.

#### *FIV phylogenetic analyses*

Directly transmitted pathogens are inextricably linked to their hosts, and therefore, the geographical distribu-

tion of pathogens reflects the movement and contacts of their hosts throughout the landscape. We analysed two gene sequences from FIV, a retroviral pathogen of bobcats, to evaluate whether the gene flow (transmission) of the virus revealed information about bobcat movement not discernable from traditional host genetic analyses. We hypothesized that urban development, which limits bobcat gene flow, would also limit viral transmission between bobcat subpopulations. Given that only one in five bobcats are infected with FIV, the expected virus migration rate is five times lower than the host migration rate. Thus, we expected each of the two bobcat subpopulations would be infected with a genetically distinct viral strain, divergent from one another owing to years of isolation, low viral migration rates and the high mutation rate of FIV.

This prediction is consistent with previous literature demonstrating that geographical or social barriers,

which prevent mixing between neighbouring host subpopulations, result in genetically structured retrovirus populations (Franklin *et al.* 2007a; Liu *et al.* 2008; see also Fig. S2, Supporting information—demonstrating clear divergence between FIVs isolated from bobcats north or south of Los Angeles). However, the phylogenetic trees constructed in this study from FIV gene segments demonstrated a pattern that differs from these previously published findings. The relatedness of FIV isolates is mixed among coastal and inland bobcat subpopulations, indicating that there is no association between FIV relatedness and the geographical/genetic structure of its host (Figs 3 and 4). While this finding differs from our prediction based on the ecology of FIV, it is consistent with previous studies of urban bobcats in southern California, which have found that individual movements (and thus opportunities for disease transmission) between fragmented habitat patches occur more frequently than predicted by observed levels of gene flow (Riley *et al.* 2006; Ruell *et al.* in press).

The topology of the ML phylogenetic tree (Fig. 3) illustrates that neither the coastal nor the inland bobcats are infected with a monophyletic cluster of viruses. Instead, we identified four groups of related FIV isolates but found no evidence to suggest these groups developed because of the population structure of bobcats. While two of the four groups contained only coastal or inland isolates (FIV Groups 1 and 3), these were the smallest groups sampled and the other two FIV groups did not follow this pattern. Instead, FIV Groups 2 and 4 contained closely related viruses arising from both bobcat subpopulations. The coastal isolates within each of these two groups shared recent common ancestry with inland viruses (Fig. 5), and thus, we conclude that FIV-infected bobcat migration events across I-5 are responsible for the observed mixing of isolates. Half of the viruses infecting coastal individuals (4/8) recently originated from, or were transmitted to, inland bobcats. The former is likely to have occurred in FIV Group 2 as suggested by the presence of multiple inland isolates basal to the two coastal isolates and evidence of a long Group 2 residence time within the inland subpopulation.

#### *Utilizing host and pathogen genetics*

The presence of related FIV strains on both sides of I-5 suggests that the intervening urban development is somewhat permeable to bobcat movement and disease transmission, despite the presence of distinct genetic structure among the host population. There may be several explanations for the discrepancy between the population structure of FIV and its host. One hypothesis is that a recent increase in bobcat migration across I-5 has

led to the observed mixing of viral genotypes, but not enough time has passed for this recent increase in migration to counteract previously established genetic structure among the bobcats. While possible, we consider this unlikely as human development along the I-5 corridor has increased over time, and no notable changes have been made in the area (e.g. underpasses, culverts) that would account for a recent increase in connectivity between the two subpopulations.

An alternative hypothesis is that FIV exchange between the two subpopulations is not necessarily linked to bobcat gene flow. Transient movements of individuals across a semi-permeable barrier such as I-5 may not result in the exchange of genetic material, but may involve sufficient contact between individuals to allow for disease transmission. Under this hypothesis, the contrasting patterns of population structure may reflect differences in the underlying ecology of the two molecular markers.

Microsatellite markers are useful for detecting host gene flow, the specific process involving animal movement which results in the exchange of genetic material from one group of individuals to another (Endler 1977). According to this definition, gene flow is dependent upon successful mating after migration. FIV transmission, however, can occur both vertically *and* horizontally, allowing FIV isolates to move between individuals and subpopulations in the absence of gene flow. For example, Biek *et al.* (2003) reported that for one population of mountain lions, horizontal transmission among adults resulted in the majority of new FIV infections and accounted for the observed increasing prevalence of FIV with age. Vertical transmission, resulting in a cohort of young individuals infected prior to adolescence, was equally important in explaining the dynamics of FIV in the population.

Given that bobcats and mountain lions share many life history characteristics, it is probably that similar FIV transmission dynamics occur in bobcats. Indeed, the relative prevalence of FIV in yearlings (14%) vs. adults (24%) in this study is similar to the age-prevalence relationship described in Biek *et al.* (2003). Young infected individuals may therefore play an important role in the maintenance and spread of FIV in this population. At adolescence, juvenile (usually male) bobcats often make transient movements during dispersal from their natal range while attempting to establish a new home range (Kitchings & Story 1984; Knick 1990; Hansen 2007). Young bobcats infected prior to dispersal therefore represent a potentially important mode of virus movement within and between subpopulations.

In fragmented landscapes such as southern California, where urban development and freeways act as boundaries limiting animal movement, bobcat home



ranges may shrink, and the amount of overlap between neighbouring home ranges may increase (Riley 2006; Riley *et al.* 2006). This pattern of 'home-range pile-up' has been described in other bobcat populations in California (Riley *et al.* 2006). This phenomenon decreases the probability that juveniles dispersing to a neighbouring subpopulation will successfully mate. Under these conditions, the actual rate of bobcat movements, contacts and opportunities for disease transmission between subpopulations would be higher than expected based on migration rates estimated from gene flow.

The low level of gene flow we detected across I-5 occurred in a unidirectional pattern from the inland area towards the coast. The coastal population, while reduced in overall genetic diversity, contains both migrants and hybrids from the inland population. This suggests that, while rare, inland bobcats can successfully migrate to and breed in the coastal population, while the reverse was not seen. However, inland FIV isolates do not form a monophyletic group; two of the three FIV groups infecting coastal bobcats also infect inland bobcats. There are two possible explanations to this pattern. One is that movement of FIV has occurred repeatedly one-way from the inland subpopulation to the coast, causing the diversity among coastal isolates to closely mirror that observed inland. This hypothesis is consistent with the one-way pattern of bobcat movement we detected from the microsatellite analysis.

The other possibility is that a coastal virus population diverged from inland viruses after the two groups were isolated by urban development and has since been transmitted back into the inland subpopulation multiple times via transient movements and contacts resulting in disease transmission but not gene flow. Tracking the movements of individual bobcats, evaluating FIV diversity in other neighbouring bobcat populations and utilizing spatially explicit phylogeographic analyses may help to distinguish between these alternatives.

In conclusion, our findings indicate that bobcats inhabiting this fragmented landscape in southern California are physically isolated and genetically structured. This pattern is consistent with decreased connectivity across urban development, resulting in low levels of migration and/or a low probability that migrants establish a home range and successfully mate. However, movements are apparently made, allowing for disease transmission between these habitat fragments. This conclusion carries with it conservation implications as populations with these characteristics are susceptible to decline as a result of a continued loss of genetic diversity from genetic drift and decreased individual fitness because of inbreeding depression (Frankham 2006). In addition, both subpopulations should be managed as a

unit when considering treatment and prevention interventions during future disease outbreaks. Habitat conservation and restoration as well as connectivity enhancements such as functional underpasses to better facilitate movement of bobcats under roadways may help safeguard their persistence in the face of substantial ongoing threats posed by humans in this region.

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The authors are interested in research involving ecology, conservation, and/or infectious diseases of carnivores. They share particular interest for topics relating to the effects of human activities on carnivores.

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### Data accessibility

DNA sequences—GenBank accession numbers JN383436–JN383465. Microsatellite data—DRYAD entry doi:10.5061/dryad.mmm317th7.

### Supporting information

Additional supporting information may be found in the online version of this article.

**Table S1**  $F_{ST}$  values calculated from 16 bobcat microsatellite loci.

**Table S2** Measures of genetic structure among bobcats calculated from 16 microsatellite loci.

**Fig. S1** Estimating the number of genetic subpopulations ( $K$ ) of bobcats.

**Fig. S2** Maximum-likelihood phylogenetic tree built from *pol* sequences using the same model parameters as those described to produce the Maximum-likelihood tree in Fig. 4 (see Methods).

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# Developing a correction factor to apply to animal–vehicle collision data for improved road mitigation measures

Tracy S. Lee<sup>id</sup> <sup>A,D</sup>, Kimberly Rondeau<sup>id</sup> <sup>B</sup>, Rob Schaufele<sup>A</sup>,  
Anthony P. Clevenger<sup>C</sup> and Danah Duke<sup>A</sup>

<sup>A</sup>Miistakis Institute, Mount Royal University, 4825 Mt Royal Gate SW, Calgary, Alberta T3E 6K6, Canada.

<sup>B</sup>University of Calgary, 2500 University Drive NW, Calgary, Alberta T2N 1N4, Canada.

<sup>C</sup>Western Transportation Institute, Montana State University, 2327 University Way, Bozeman, Montana 59715, United States.

<sup>D</sup>Corresponding author. Email: [tracy@rockies.ca](mailto:tracy@rockies.ca)

## Abstract

**Context.** Road mitigation to reduce animal–vehicle collisions (AVCs) is usually based on analysis of road survey animal carcass data. This is used to identify road sections with high AVC clusters. Large mammals that are struck and die away from a road are not recorded nor considered in these analyses, reducing our understanding of the number of AVCs and the cost–benefit of road mitigation measures.

**Aims.** Our aim was to develop a method to calculate a correction factor for large mammal carcass data reported through road survey. This will improve our understanding of the magnitude and cost of AVCs.

**Method.** Citizen scientists reported animal carcasses on walking surveys along transects parallel to the highway and reported observations using a smartphone application at three sites over a 5-year period. These data were compared with traditional road survey data.

**Key result.** We found that many large mammals involved in AVCs die away from the road and are, therefore, not reported in traditional road surveys. A correction factor of 2.8 for our region can be applied to road survey data to account for injury bias error in road survey carcass data.

**Conclusions.** For large mammals, AVCs based on road survey carcass data are underestimates. To improve information about AVCs where little is known, we recommend conducting similar research to identify a correction factor to conventionally collected road survey carcass data.

**Implications.** Identifying road mitigation sites by transportation agencies tends to focus on road sections with above-threshold AVC numbers and where cost–benefit analyses deem mitigation necessary. A correction factor improves AVC estimate accuracy, improving the identification of sites appropriate for mitigation, and, ultimately, benefitting people and wildlife by reducing risks of AVCs.

**Keywords:** animal vehicle collisions, citizen science, road ecology, road mitigation.

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## Introduction

Animal–vehicle collisions (AVCs), particularly those involving ungulates, are increasingly recognised as a significant concern for traffic safety, socioeconomics, animal welfare and wildlife management in the United States, Canada, Australia and Europe (Groot Bruinderink and Hazebroek 1996; Huijser *et al.* 2008; Ward *et al.* 2011; Ang *et al.* 2019). In the USA alone, it is estimated that 1 million deer (*Odocoileus* sp.)–vehicle collisions occur annually, with an associated cost of more than US\$1 billion in vehicle damages and 29 000 human injuries (Conover *et al.* 1995). Similar patterns and growing concerns about vehicle collisions with large animals are found in Canada and Europe (Langbein *et al.* 2011; Vanlaar *et al.* 2012; Morelle *et al.* 2013; Rosell *et al.* 2013).

In an effort to reduce the frequency of AVCs, transportation agencies around the world have implemented road mitigation measures such as wildlife under- and overpasses, fencing, animal detection systems, and variable message signs (Huijser *et al.* 2008; van der Ree *et al.* 2015). AVC records are often used to locate optimal sites for these measures. For example, AVC data have been used solely, or in conjunction with, wildlife movement data to plan the location of mitigation measures on roads (Lenhert and Bissonette 1998; Van Manen *et al.* 2012; Gagnon *et al.* 2019). AVC data are also analysed together with landscape and road variables to identify where high AVC rates might occur, so as to help inform the underlying mechanisms leading to future AVCs (Ramp *et al.* 2005; Litvaitis and Tash 2008; Ward *et al.* 2011; Clevenger *et al.* 2015). For both



purposes, it is imperative that transportation agencies collect sound data to ensure that analyses provide strong inferences to inform decision making (Snow *et al.* 2015).

This includes systematically collected AVC information to avoid potential observation bias (Huijser *et al.* 2007; Santos *et al.* 2018). Common factors related to how the survey is conducted can affect the reliability and accuracy of AVC data. These range from speed at which surveys are conducted, the number and consistency of observers, to time of day when surveys are conducted (Slater 2002; Santos *et al.* 2011).

Animal–vehicle collision data collection can also be strongly biased if observers fail to detect road-kills along the survey (Ascensão *et al.* 2019). These biases may occur due to (1) carcass removal, for example, by scavenging animals or people, (2) detectability, as small road-killed animals are less likely to be observed than are large animals and (3) injury; that is, animals are not immediately killed by the collision but are injured and die some distance, out of sight of the road (Winton *et al.* 2018).

For many years, there has been speculation regarding a systematic discrepancy between reported or recovered numbers of AVCs and the actual numbers killed on roadways (Huijser *et al.* 2007). It is important to know the real road-kill rate to identify and prioritise road sections for mitigation planning (Lee *et al.* 2006; Polak *et al.* 2014; Sáenz-de-Santa-María and Tellería 2015). AVCs can be a significant cost to society and thresholds in the number of AVCs are used to identify what roads and segments are cost effective (Conover *et al.* 1995; Huijser *et al.* 2009). Having a more accurate estimate of AVCs will aid transportation agencies in selecting road segments where motorist safety is at high risk and benefits of mitigation outweigh costs.

Unreported AVCs include those collisions where animals are hit by vehicles, are injured and move well away from the road to die. These animals may not be observed during road surveys by road maintenance clean-up crews. We designed the present study to better understand injury bias in AVC data by comparing the relationship between AVC survey data obtained by a standard method of road survey (reported animal carcasses on the road by road maintenance clean-up crews) and data obtained by walking surveys using citizen scientists (detecting animal carcasses off the road to quantify the number of unreported animal carcasses). This will enable us to develop a correction factor for related landscapes in North America that can be applied to road survey carcass reports to both obtain a more reliable estimate of AVCs and to better understand the true societal costs of AVCs. Although the correction factor calculated in the present study may not be applicable to other landscapes with different habitats and species assemblages, our study outlines field-based methods for determining a road-kill correction factor.

## Materials and methods

### *The Crowsnest Pass region*

The Highway 3 transportation corridor is located in the Crowsnest Pass, Alberta, in the southern Canadian Rocky Mountains. The corridor is in a low-elevation, east–west aligned mountain pass bisecting the predominately north–south aligned Canadian Rocky Mountains. The elevation of the region ranges from 1113 m at the valley bottom to 2804 m at the mountain peaks and is

characterised by a rapid ecological transition from the prairie to alpine ecological zones. The complement of large mammals for the region includes grizzly bear (*Ursus arctos*), black bear (*Ursus americanus*), lynx (*Lynx canadensis*), cougar (*Puma concolor*), wolf (*Canis lupus*), wolverine (*Gulo gulo*), elk (*Cervus elaphus*), mountain goat (*Oreamnos americanus*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), and Rocky Mountain bighorn sheep (*Ovis canadensis*).

In this region, Highway 3 is a 45 km long, two-lane paved road, supporting between 6000 and 9000 weighted average annual daily vehicle traffic. The highway connects six small settlements (ranging in size from 100 to 1500 people) and is a major trucking and commuter route between Alberta and British Columbia. Most of the region is managed for multiple values, including resource extraction, agriculture, human settlement, and tourism that includes both motorised and non-motorised recreation. The lower-elevation lands parallel to the highway are predominantly privately owned, with some government-owned crown land. The lower valley connects crown forest reserves and protected areas to the north and south. The Crowsnest Pass is recognised as a key wildlife linkage zone at a local and transboundary scale (Apps *et al.* 2007; Weaver 2013). Highway 3 bisects this critically important landscape for a variety of large mammal species (McKelvey *et al.* 2011; Proctor *et al.* 2012).

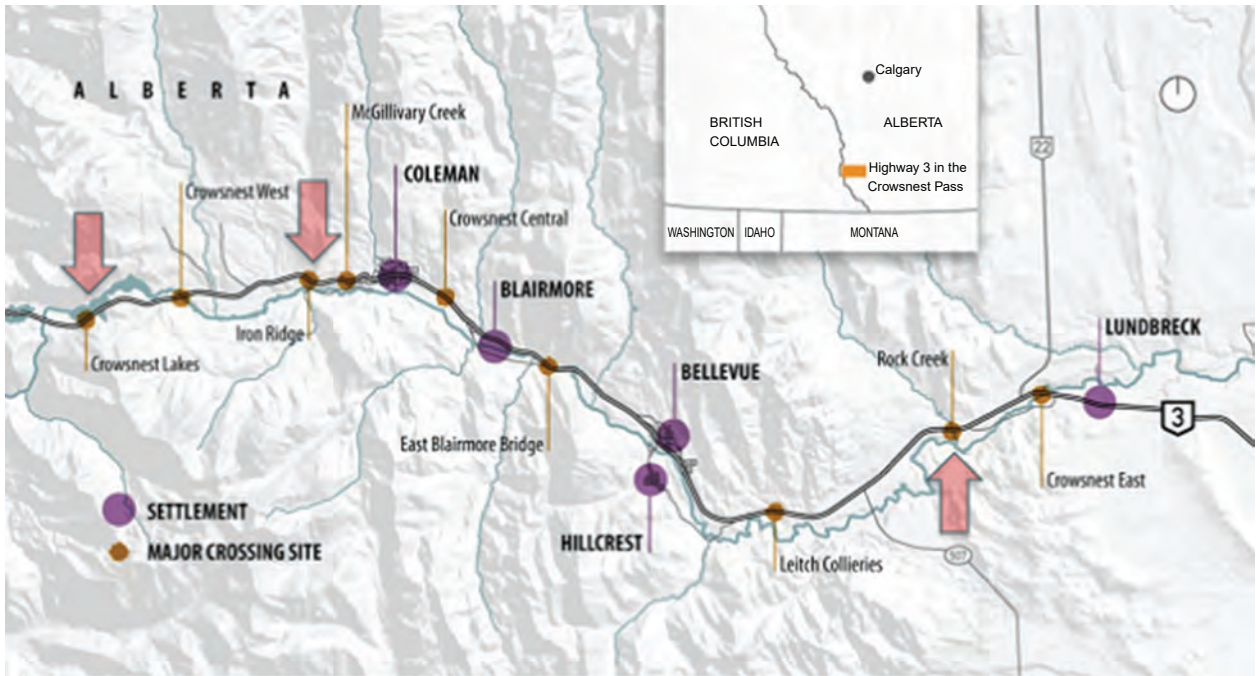
### *Site selection for road and walking surveys*

Animal–vehicle collisions are common along Highway 3 and involve a diversity of large-bodied mammals, with deer species being the most common. Road sections with a high number of AVCs (identified in Clevenger *et al.* 2010) and animal connectivity models were reviewed to identify nine mitigation emphasis sites (MES) where road mitigation measures would improve motorist and wildlife safety (Fig. 1; Apps 1997; Apps *et al.* 2007; Chetkiewicz 2008; Chetkiewicz and Boyce 2009; Clevenger *et al.* 2010). Two of the sites, Rock Creek and Emerald Lake MESs, have also been prioritised by Alberta Transportation for road mitigation. In addition to the two priority MESs, a third site, Iron Ridge, was selected as a control site where no road mitigation measures are being planned.

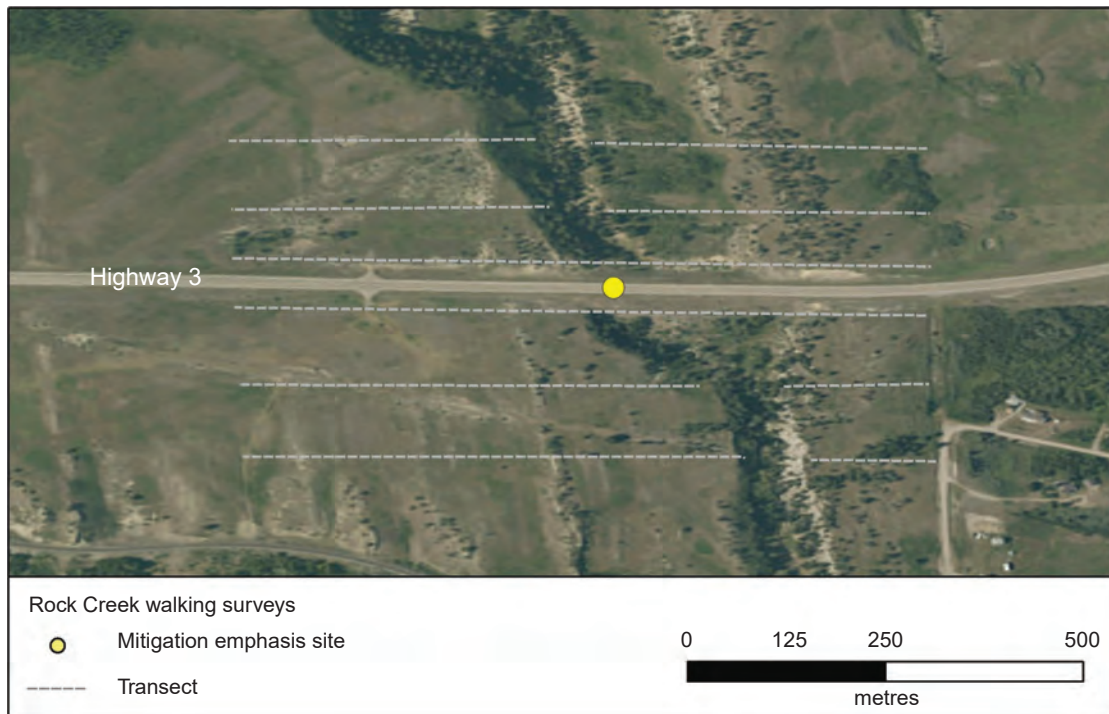
All three MESs occur in the montane natural subregion of Alberta, occurring in a lower-elevation valley consisting of moderately dry south- and west-facing slopes vegetated by open forests or grasslands. Open forests typically include lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), trembling aspen (*Populus tremuloides*) and white spruce (*Picea glauca*) as pure or mixed stands. Grasslands are also common on moderately dry south- and west-facing aspects and include mountain rough fescue (*Festuca campestris*), Idaho fescue (*Festuca idahoensis*) and Parry's oatgrass (*Danthonia parryi*; Alberta Sustainable Development 2008).

At each MES (Rock Creek, Iron Ridge, Emerald Lakes), we established three walking transects, parallel to, but off the road surface, 1000 m long. Each transect was separated by 50 m to the north and south of the highway, except where limited by terrain (see Fig. 2 for Rock Creek transects). For example, on the northern side of Iron Ridge, we established only two walking transects (1000 m) separated by 50 m intervals. A third transect





**Fig. 1.** Highway 3 study area in Alberta, Canada. The study included nine mitigation emphasis sites (MESs) collected by road crews from vehicles (orange dots) and three MESs with walking surveys (red arrows).



**Fig. 2.** Example of walking transects along Highway 3 (white dashed lines) at the Rock Creek mitigation emphasis site (MES) on northern side of Highway 3, Alberta, Canada. Three parallel transects each 1000 m long and separated by 50 m.

was not included on the northern side because of dense tree cover that was inhospitable for surveying. An observer reported animal carcasses up to 10 m on either side of the transect by

using a visual scan. Areas with complex topography and tree patches caused some variability in line of sight along transects, potentially leading to missed animal carcass detections.

The majority of transects were difficult to see from the road, owing to terrain complexity and vegetation. Species presence for all three MESs was similar, including white tailed deer, mule deer, moose, elk, black bear, grizzly bear, wolf, cougar and coyote. The Emerald Lake MES also included bighorn sheep.

#### *Animal-carcass road and walking surveys*

Animal carcass data were acquired from two sources, namely, by road maintenance clean-up crews during regularly driven road surveys and by citizen scientists walking designated surveys at the three MESs.

Road maintenance clean-up crews reported animal carcass data during routine road surveys every weekday morning and late afternoon. From 1997 to 2017, animal carcasses were recorded on paper forms and then transcribed into a GIS environment by using local landmarks and distance to measurements (m). Local landmarks are consistently used by surveyors and were, on average, 250 m apart. It is, therefore, estimated that accuracy of animal carcasses collected by road maintenance clean-up crews is within 250 m of a landmark. For 2018, animal carcass data were reported using the Alberta Wildlife Watch (AWW) smartphone application using GPS for location information (Alberta Transportation 2017). There were no duplicate records in road survey data because animal carcasses were removed by road maintenance clean-up crews during the survey. To compare with walking surveys, AVC data were clipped to the spatial distribution of each MES. All three MESs occur at a local landmark used by road surveyors and, therefore, observed road survey animal carcasses are assumed to be accurately associated with each MES.

Citizen scientists reported animal carcasses during walked surveys at all three MESs. Animal carcasses were recorded using a smart phone application by 20 citizen scientists that walked transects once a week for approximately 5 years (2014–2018 inclusive).

For each animal carcass, citizen scientists reported species, date, time, and whether the carcass was visible from the road. Some animal carcasses had deteriorated beyond recognition and were classified as unknown species. A local project coordinator trained citizen scientists on data collection protocols, safety guidelines and the use of the smartphone application. The coordinator assigned transects to paired volunteers.

#### *Understanding error*

We acknowledge possible sources of error associated with multiple people reporting observations. Risk of error may increase as a result of multiple observers being involved in walking surveys, which can lead to double counting animal carcasses or species identification errors. To address this, participant groups (made up of two people for safety) walked the same transects reducing the number of people surveying at each MES. For example, Rock Creek south was surveyed by two groups who participated on alternate weeks. A series of rules were used to reduce possibility of duplicate records, animal carcasses reported during walking surveys were compared by species, date range (within month), and data were plotted spatially to ensure independent records. Citizen scientists were encouraged to report a species as unknown when not confident in

the identification. In some cases, photos were taken to aid species verification.

#### *Data analysis*

To determine the trend in AVCs along Highway 3, animal carcass data reported by road maintenance clean-up crews between 1997 and 2018 were summarised per year and linear regression was used to determine AVC trend over time.

Citizen science data collection started in April 2014 and was completed in December 2018. Walking survey data were verified to remove duplicate records and data were removed for the Emerald Lake MES after September 2016 because road mitigation measures were implemented there (including fencing tied into an existing underpass and jump-outs). In addition, from April through June 2014, animal carcass data reported as bones were excluded from the walking surveys to account for older animal carcasses that were likely to have occurred before the initiation of the project.

Through discussion with local biologists, we determined that walking surveys should occur at a minimum of once a week to ensure detection of carcasses before deterioration. However, surveys were missed sporadically during periods of heavy snow that prevented citizen scientists from parking safely in designated areas, or during periods of extremely high fire hazard, such as in the autumn of 2017 and winter of 2018. To account for differences in sampling effort among sites, walking surveys were standardised by multiplying the number of carcasses found per actual surveys walked with the expected number of surveys walked.

Previous research has indicated that driving surveys for large mammal detection should occur at a minimum of every 2 days (Santos *et al.* 2011). In our study, road maintenance crews surveyed the highway twice daily during weekdays, meeting the minimum survey requirements. In addition, because each method was designed for adequate carcass detection under the conditions, we did not standardise for sampling effort between survey types.

To calculate an injury-bias correction factor, animal carcasses reported by the road maintenance crews and walking surveys were both summed for each MES. The summed total was then divided by road survey data to determine the correction factor to apply to road survey datasets.

#### *Cost–benefit assessment*

We calculated the total cost of AVCs per 1 km road section with and without the correction factor for a 45 km section of Highway 3, by using a published cost–benefit model (Huijser *et al.* 2009). The model estimated the cost of an AVC for large-bodied ungulates such as a deer (US\$6617), an elk (US\$17 483), and a moose (US\$30 760) in 2007 US\$ values (Huijser *et al.* 2009). We compared this to the cost per kilometre of investing in road mitigation measures (i.e. underpass, jump-outs with fencing estimated to be US\$32 457 annually discounted at 7%) to reduce AVCs (Huijser *et al.* 2009). The authors calculated a 7% discount rate that was amortised into equivalent annual terms to account for the asymmetry between cost and benefit elements over time (Huijser *et al.* 2009).

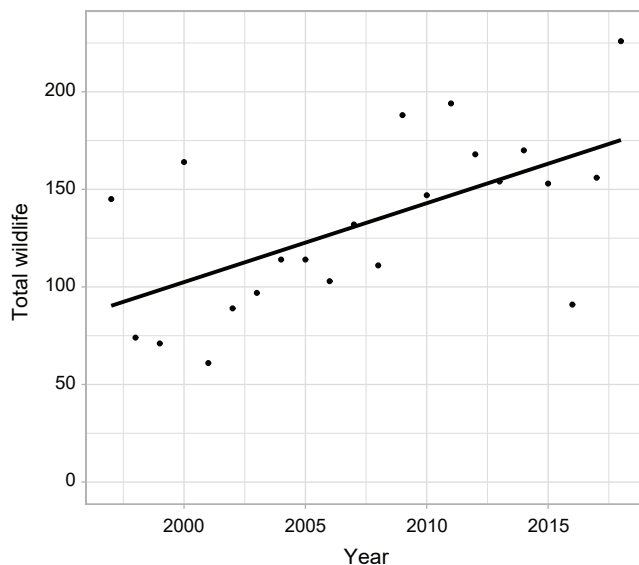
To determine the cost of AVCs per 1 km road section per year, we used the number of animal carcasses reported during road surveys and calculated the average AVC for each species on the basis of a 5-year time-period (2014–2018). We included all large-bodied ungulates, namely, white tailed deer, mule deer, elk, moose and bighorn sheep. For each 1 km road section, we multiplied the cost of collisions of the specific species as provided by Huijser *et al.* (2009) to that species average number of AVCs and then summed among species to determine the total annual cost of AVCs. We applied the average cost of a collision of a deer to bighorn sheep as a conservative estimate of societal costs from collisions with bighorn sheep, because this species was not included in the study of Huijser *et al.* (2009). All other large-bodied species, such as carnivores recorded in AVCs, were not included in the model because collision costs for carnivore species are not currently available. Collision cost estimates are conservative because AVCs involving carnivore species are not included. So as to determine the difference in collision costs before and after applying the correction factor, we adjusted each species total per 1 km by multiplying the AVCs for each species by the correction factor, and then multiplying by the species estimated collision cost.

The resulting collision cost per 1 km was graphed to highlight the difference with and without the correction factor, and we then compared collision costs to the cost threshold for investing in an underpass, jump-outs and fencing, so as to document any change in the number of 1 km road sections where road mitigation is cost-effective.

## Results

### AVC trends and correction factor

Over the past 20 years, road maintenance clean-up crews have reported 2385 animal carcasses along Highway 3 resulting from AVCs. We found a significant increasing trend in annual AVCs in



**Fig. 3.** Total number of animal–vehicle collisions from 1997 to 2018 along Highway 3, Alberta, Canada, from Lundbreck, Alberta to the Alberta–British Columbia provincial border.

our study area from 1997 to 2018 ( $r^2 = 0.36$ ,  $P = 0.003$ ; Fig. 3). The species reported in the AVC data included white tailed deer, mule deer, elk, moose, bighorn sheep, black bear and grizzly bear.

The number of animal carcasses detected per year at each MES from road and walking surveys are shown in Tables 1–3. Animal carcasses recorded at MES during walking surveys include deer species, elk, cougar and bighorn sheep. Deer species were most common at Rock Creek and Iron Ridge, whereas bighorn sheep were most common at Emerald Lake. To account for the difference in walking survey sampling effort, we calculated the number of carcasses per MES standardised to walking survey effort (Table 4).

We determined a correction factor applied to road-surveyed carcass data for large mammals of  $2.8 \pm 0.74$  (Table 4), so as to account for injury bias in traditional road survey datasets. There was variability among the MESs, with a correction factor of 2.4 at Rock Creek, 3.5 at Iron Ridge and 2.1 at Emerald Lake.

### Cost–benefit of road mitigation with a correction factor

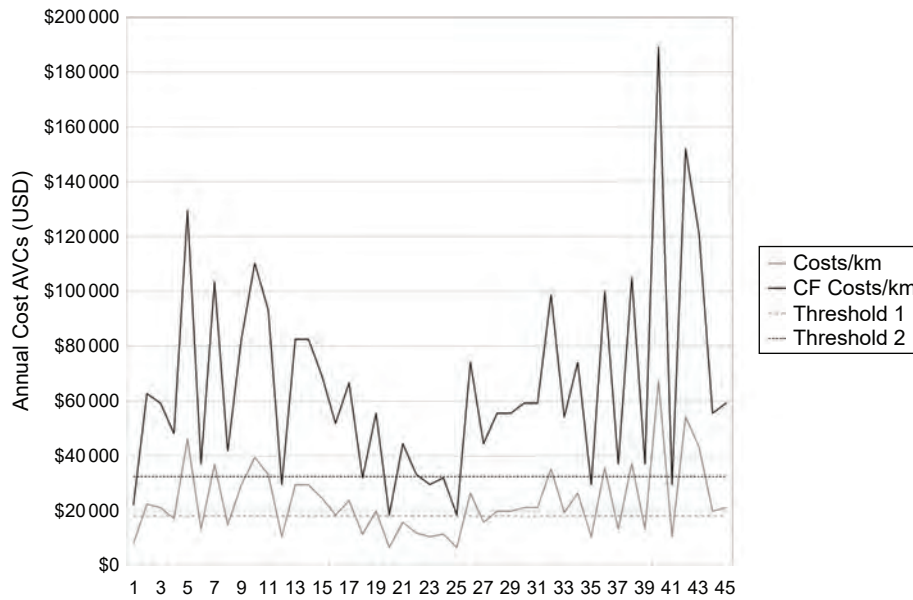
The total annual cost of AVCs for the 45 km stretch of Highway 3 from the Alberta–British Columbia border to Lundbreck, Alberta, is US\$1 045 417. With the calculated correction factor of 2.8, the annual cost increases to US\$2 927 168. To better understand the implications for cost–benefit of road mitigation, we compared the total cost of collisions per 1 km with and without the correction factor applied (Table 5). Without the correction factor, 10 km of road (representing 22% of the study area) exceeded the cost–benefit threshold for underpass, jump-outs and fencing on the basis of US\$32 457 annual cost (7% discounted rate) associated with the mitigation (Fig. 4). With the correction factor applied, 36 km of road (representing 80% of the study area) exceeded the cost–benefit threshold for mitigation of an underpass, jump-outs and fencing.

In addition, the correction factor increased the number of neighbouring road sections where road mitigation would be cost-effective. Without the correction factor, two road mitigation neighbourhoods (defined as a grouping of adjacent road sections where road mitigation is cost-effective) were identified. With the correction factor, six road mitigation neighbourhoods were identified, ranging from 4 to 10 km long (Table 5, represented in dark grey).

## Discussion

The Canadian road network supports continually increasing traffic volumes. Traffic on Canada’s National Highway System grew by 18% from 2005 to 2018, increasing the risk of AVCs (Transport Canada 2018). Along Highway 3 in Alberta, our results show a statistically significant increase in the number of AVCs over 20 years. Increasing AVCs are a concern to both motorist safety and maintaining healthy wildlife populations in this important landscape (Clevenger *et al.* 2010; Weaver 2013). In rural Alberta, 50% of collisions are due to AVCs, costing the province an estimated C\$280 million per year (Alberta Transportation 2017). Concern for motorist safety and the high cost of AVCs create strong socioeconomic incentives for transportation agencies to implement road mitigation strategies. Decision-making associated with road mitigation measures tends to be driven by identifying road sections with AVC clusters and where cost–benefit





**Fig. 4.** Annual costs of animal–vehicle collisions per road section (1 km) along Highway 3, Alberta, Canada (dark grey) and with correction factor applied (black). Threshold 1 represents the costs of wildlife underpass, fencing and jump-outs based on 3% discounted rate. Threshold 2 represents the costs of wildlife underpass, fencing and jump-outs based on a 7% discounted rate. The 1-km road sections run along the x-axis from Road section 1 (Alberta–British Columbia provincial border) to Road section 45 (Lundbreck, Alberta, Canada).

**Table 1.** Number of animal carcasses recorded during road surveys and walking surveys at the Emerald Lake mitigation emphasis site, Alberta, Canada

BHS, bighorn sheep; D, deer; UK, unknown species; TRS, total road survey; WS, total walking survey

Year	Road survey				Walking survey				Total
	BHS	D	UK	TRS	BHS	D	UK	TWS	
2014	2	0	0	2	1	0	0	1	3
2015	1	2	0	3	0	4	0	4	7
2016	1	0	0	1	1	0	0	1	2
2017	2	1	0	3	0	0	0	0	3
2018	2	1	0	3	0	0	1	1	4
Total	8	4	0	12	2	4	1	7	19

**Table 2.** Number of animal carcasses recorded during road surveys and walking surveys at Iron Ridge mitigation emphasis site, Alberta, Canada

E, elk; D, deer; UK, unknown species; TRS, total road survey; WS, total walking survey

Year	Road survey				Walking survey				Total
	E	D	UK	TRS	E	D	UK	TWS	
2014	0	0	0	0	0	0	4	4	4
2015	0	2	0	2	1	0	3	4	6
2016	0	2	0	2	0	1	0	1	3
2017	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	1	0	1	1
Total	0	4	0	4	1	2	7	10	14

**Table 3.** Number of animal carcasses recorded during road surveys and walking surveys at Rock Creek mitigation emphasis site, Alberta, Canada

C, cougar; D, deer; UK, unknown species; TRS, total road survey; WS, total walking survey

Year	Road survey				Walking survey				Total
	C	D	UK	TRS	C	D	UK	TWS	
2014	0	2	0	2	0	2	1	3	5
2015	0	5	0	5	0	4	0	4	9
2016	0	8	0	8	1	3	2	6	14
2017	0	9	0	9	0	12	0	12	21
2018	0	4	0	4	0	12	1	13	17
Total	0	28	0	28	1	33	4	38	66

assessments justify road mitigation measures. Providing a more accurate assessment of the number of AVCs equips transportation agencies to implement effective road mitigation.

Our study demonstrated that AVCs involving large mammals are underestimated; more animal carcasses were reported during walking surveys off the road than were reported during road surveys. These animal carcasses represent error sources in traditional AVC datasets generated by road surveys, because of injury bias. In our region of the Rocky Mountains, we suggest that a correction factor of 2.8 can be applied to road survey datasets to account for undetected road-kills. Factors affecting sources of error are not likely to be consistent across sites, habitat types and/or species guilds and should, therefore, be assessed by region and species assemblage (Slater 2002). Our correction factor will not be appropriate for smaller species that

**Table 4.** Total number of animal carcasses for road surveys (RS) and walking surveys (WS; standardised WS carcass data to expected number of surveys) at each mitigation emphasis site to calculate the correction factor (CF)

MES	WS sample expected	WS carcass	WS sample actual	WS carcass standardised	RS carcass	CF
Emerald Lake	122	6	110	6.7	6	2.1
Iron Ridge	260	10	228	11.4	4	3.9
Rock Creek	259	38	250	39.4	28	2.4
Average CF						2.8

are harder to detect and whose carcasses persist for shorter periods of time, for example, small mammals, amphibians and reptiles (Santos *et al.* 2011; Degregorio *et al.* 2011; Santos *et al.* 2016). We recommend that in regions with different habitat types and species guilds, similar studies be conducted to determine a correction factor for AVC data collection and cost–benefit analyses.

Although our correction factor is specific for our landscape, our general result that traditional roadside AVC counts are underestimates applies to other landscapes and species assemblages. Improving methods should improve existing systems to account for animal carcasses observed off the road right of way. Alternatively, in areas where animal carcass visibility from the road surface is limited, the survey methodology presented here could improve estimate accuracy.

We found some variability among the MESs in our study area, ranging from a correction factor of 2.1 to 3.5. This highlights the importance of including multiple study sites in correction factor assessments. All three sites offer limited visibility to the surrounding landscape from the road surface, occur in similar vegetation communities and have similar traffic volumes and speed limits. The variability could be partially attributed to differences in species diversity at each MES; although all three sites reported deer AVCs, bighorn sheep occur only at the Emerald Lake MES and elk occur most commonly at Iron Ridge MES. Although there is some species diversity among the MESs, our study was not able to assess species responses to AVC injury bias because of the low numbers of large mammal species (other than deer) reported during the study at all three sites.

Our analysis was dependent on detecting animal carcasses through systematic monitoring by using two different survey types, namely, walking and driving. Possible detection errors include carcass persistence rate (how long carcasses remain visible), overlooked carcasses, removal by predators and/or difference in survey protocols (Santos *et al.* 2011, 2016). In the present study, the two survey methodologies (road vs walking surveys) differed in temporal resolution; road surveys were undertaken twice daily, whereas walking surveys occurred at ~7-day intervals on the basis of assumed differences in carcass detection probabilities. Carcass detection while driving at 110 km h<sup>-1</sup> along a highway was estimated to be lower than at walking speed; thus, walking surveys were less frequent.

Carcass persistence is dependent on body size and habitat type or vegetative cover. A study by Santos *et al.* (2011) suggested a 2-day interval between surveys on the basis of large-mammal carcass persistence on road rights-of-way. Our road surveys took place twice daily and, therefore, occurred

more frequently than recommended, which further improves our confidence that carcasses on the road were accounted for. A week between walking surveys was deemed a minimum survey period appropriate on the basis of expert knowledge and deterioration rates that would enable species identification. However, many of the large carcasses reported by citizen scientists were no longer identifiable and were, therefore, recorded as an unknown species. In addition, the expected number of walking surveys did not occur because of inclement conditions such as wildfires and snow events. To address the concern that walking surveys occurred less frequently than recommended, we normalised walking survey data to the expected number of surveys across the three MESs.

In addition, predators occur at all three sites, including cougar, coyote, wolf, black bear and grizzly bear. All will scavenge road-killed animal carcasses. It is possible that the presence of predators may have resulted in an underestimate of animal carcasses during walking surveys. Our method is not able to account for this error, nor cases where injured animals had moved further from the roadway than our walking survey was designed to detect. Given these limitations, and the small area covered during walking surveys, we believe our correction factor is a conservative estimate of injury bias caused by AVCs.

Our results demonstrated how an injury-bias correction factor can affect cost–benefit models for road mitigation. Once the correction factor was applied, cost–benefit analysis suggested that 21 additional kilometres of road in our study area would qualify for road mitigation, including underpasses, jump-puts and fencing. Such road mitigation measures have proven to be effective in reducing AVCs, improving both motorist safety and animal survival, while enabling animal movement across roads (Huijser *et al.* 2008; Rytwinski *et al.* 2016).

In addition, the correction factor identified six road mitigation neighbourhoods, ranging in length from 4 to 10 km. A road mitigation neighbourhood represents longer stretches of highway where it is cost-effective to mitigate, and including longer road sections enables a more comprehensive road mitigation system to be designed. For example, long sections justify a series of crossing structures linked by fencing, further reducing the risk to motorists and wildlife and offering more opportunities for animal movement across the highway. A larger series of mitigations has cost efficiencies compared with single or multiple, isolated interventions. Without application of the correction factor, road mitigation measures along Highway 3 would remain focussed on few, isolated structures with wing fencing and have less overall impact on motorist and wildlife safety.



**Table 5. Average annual cost (US\$) of animal–vehicle collisions (AVCs) per 1 km road section (based on a 5-year average 2014–2018) with a correction factor (CF) of 2.8 being applied**

Road sections above the cost threshold are in light grey cells and road mitigation neighbourhoods are in dark grey cells

Road section	Costs km <sup>-1</sup>					Costs km <sup>-1</sup> with CF				
	Deer	Elk	Moose	Bighorn sheep	Total	Deer	Elk	Moose	Bighorn sheep	CF total
1	\$6617	\$0	\$0	\$1323	\$7940	\$18 528	\$0	\$0	\$3706	\$22 233
2	\$9264	\$6993	\$6152	\$0	\$22 409	\$25 939	\$19 581	\$17 226	\$0	\$62 745
3	\$18 528	\$0	\$0	\$2647	\$21 174	\$51 877	\$0	\$0	\$7411	\$59 288
4	\$6617	\$0	\$0	\$10 587	\$17 204	\$18 528	\$0	\$0	\$29 644	\$48 172
5	\$25 145	\$6993	\$6152	\$7940	\$46 230	\$70 405	\$19 581	\$17 226	\$22 233	\$129 445
6	\$11 911	\$0	\$0	\$1323	\$13 234	\$33 350	\$0	\$0	\$3706	\$37 055
7	\$22 498	\$6993	\$6152	\$1323	\$36 966	\$62 994	\$19 581	\$17 226	\$3706	\$103 506
8	\$7940	\$6993	\$0	\$0	\$14 934	\$22 233	\$19 581	\$0	\$0	\$41 814
9	\$11 911	\$17 483	\$0	\$0	\$29 394	\$33 350	\$48 952	\$0	\$0	\$82 302
10	\$7940	\$31 469	\$0	\$0	\$39 410	\$22 233	\$88 114	\$0	\$0	\$110 347
11	\$5294	\$27 973	\$0	\$0	\$33 266	\$14 822	\$78 324	\$0	\$0	\$93 146
12	\$10 587	\$0	\$0	\$0	\$10 587	\$29 644	\$0	\$0	\$0	\$29 644
13	\$22 498	\$6993	\$0	\$0	\$29 491	\$62 994	\$19 581	\$0	\$0	\$82 575
14	\$22 498	\$6993	\$0	\$0	\$29 491	\$62 994	\$19 581	\$0	\$0	\$82 575
15	\$21 174	\$3497	\$0	\$0	\$24 671	\$59 288	\$9790	\$0	\$0	\$69 079
16	\$18 528	\$0	\$0	\$0	\$18 528	\$51 877	\$0	\$0	\$0	\$51 877
17	\$23 821	\$0	\$0	\$0	\$23 821	\$66 699	\$0	\$0	\$0	\$66 699
18	\$7940	\$3497	\$0	\$0	\$11 437	\$22 233	\$9790	\$0	\$0	\$32 024
19	\$19 851	\$0	\$0	\$0	\$19 851	\$55 583	\$0	\$0	\$0	\$55 583
20	\$6617	\$0	\$0	\$0	\$6617	\$18 528	\$0	\$0	\$0	\$18 528
21	\$15 881	\$0	\$0	\$0	\$15 881	\$44 466	\$0	\$0	\$0	\$44 466
22	\$11 911	\$0	\$0	\$0	\$11 911	\$33 350	\$0	\$0	\$0	\$33 350
23	\$10 587	\$0	\$0	\$0	\$10 587	\$29 644	\$0	\$0	\$0	\$29 644
24	\$5294	\$0	\$6152	\$0	\$11 446	\$14 822	\$0	\$17 226	\$0	\$32 048
25	\$6617	\$0	\$0	\$0	\$6617	\$18 528	\$0	\$0	\$0	\$18 528
26	\$26 468	\$0	\$0	\$0	\$26 468	\$74 110	\$0	\$0	\$0	\$74 110
27	\$15 881	\$0	\$0	\$0	\$15 881	\$44 466	\$0	\$0	\$0	\$44 466
28	\$19 851	\$0	\$0	\$0	\$19 851	\$55 583	\$0	\$0	\$0	\$55 583
29	\$19 851	\$0	\$0	\$0	\$19 851	\$55 583	\$0	\$0	\$0	\$55 583
30	\$21 174	\$0	\$0	\$0	\$21 174	\$59 288	\$0	\$0	\$0	\$59 288
31	\$21 174	\$0	\$0	\$0	\$21 174	\$59 288	\$0	\$0	\$0	\$59 288
32	\$29 115	\$0	\$6152	\$0	\$35 267	\$81 521	\$0	\$17 226	\$0	\$98 747
33	\$15 881	\$3497	\$0	\$0	\$19 377	\$44 466	\$9790	\$0	\$0	\$54 257
34	\$26 468	\$0	\$0	\$0	\$26 468	\$74 110	\$0	\$0	\$0	\$74 110
35	\$10 587	\$0	\$0	\$0	\$10 587	\$29 644	\$0	\$0	\$0	\$29 644
36	\$35 732	\$0	\$0	\$0	\$35 732	\$100 049	\$0	\$0	\$0	\$100 049
37	\$13 234	\$0	\$0	\$0	\$13 234	\$37 055	\$0	\$0	\$0	\$37 055
38	\$25 145	\$0	\$12 304	\$0	\$37 449	\$70 405	\$0	\$34 451	\$0	\$104 856
39	\$13 234	\$0	\$0	\$0	\$13 234	\$37 055	\$0	\$0	\$0	\$37 055
40	\$67 493	\$0	\$0	\$0	\$67 493	\$188 982	\$0	\$0	\$0	\$188 982
41	\$10 587	\$0	\$0	\$0	\$10 587	\$29 644	\$0	\$0	\$0	\$29 644
42	\$54 259	\$0	\$0	\$0	\$54 259	\$151 926	\$0	\$0	\$0	\$151 926
43	\$37 055	\$0	\$6152	\$0	\$43 207	\$103 755	\$0	\$17 226	\$0	\$120 980
44	\$19 851	\$0	\$0	\$0	\$19 851	\$55 583	\$0	\$0	\$0	\$55 583
45	\$21 174	\$0	\$0	\$0	\$21 174	\$59 288	\$0	\$0	\$0	\$59 288
Total					\$1 045 417					\$2 927 168

## Conflicts of interest

The authors declare no conflicts of interest.

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Lima, Lorin L.  
Salmon, Terrell P.

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# Assessing Some Potential Environmental Impacts from Agricultural Anticoagulant Uses

Lorin L. Lima and Terrell P. Salmon

University of California Cooperative Extension - San Diego County, San Diego, California

**ABSTRACT:** This study was designed to give us a better understanding of the relationship between agricultural anticoagulant rodenticide uses and related occurrence of these materials in raptor tissues. The project utilized data from raptor carcasses collected, both in urban San Diego County and in largely agricultural Fresno, Kern, and Madera Counties, as part of the public health surveillance programs of the County Veterinarian(s) and/or Departments of Environmental Health. Most raptors contained detectible levels of second-generation anticoagulants, which are registered only for commensal rodent control in and around structures; very few contained first-generation anticoagulants, which are the only anticoagulants registered for use in agricultural production in California. This suggests that secondary hazards to raptors and other wildlife from anticoagulants stems primarily from retail sale of commensal rodent baits, particularly in residential areas, and not from anticoagulant rodenticide uses in agricultural regions.

**KEY WORDS:** agriculture, anticoagulants, California, nontarget hazard, potential environmental impact, raptor exposure, rodent control, rodenticides, secondary hazard, urban wildlife

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## INTRODUCTION

Anticoagulant rodenticides are the most common baits used in agricultural and domestic areas to manage rodent pests (Litovitz et al. 1998, Maroni et al. 2000). They are generally classified as first- or second-generation anticoagulants based on their toxicity relative to the amount of bait a rodent must eat. The first-generation anticoagulants such as chlorophacinone, diphacinone, and warfarin usually require multiple feedings over several days to be lethal. The second-generation anticoagulants, such as bromadiolone, brodifacoum, and difethialone, are more persistent in animal tissues and in many situations can be lethal from only one feeding. In California, only first-generation anticoagulants are registered for agricultural uses. Almost 1 million pounds of formulated chlorophacinone and diphacinone baits are sold annually by California Agricultural Commissioners (CDPR 2007, CDPR 2009) to control agricultural ground squirrels, voles, and some other rodent pests. Additional first-generation anticoagulant bait is sold by commercial outlets for agricultural protection and some commensal use, but use data are not readily available. A much larger quantity of second-generation anticoagulants is sold to homeowners, structural pest control operators, and others for control of commensal rodents (Norway and roof rats, *Rattus norvegicus* and *R. rattus*, and house mice, *Mus musculus*) in and around structures (CDPR 2007). All of these uses have the potential of creating primary and secondary poisoning risks to pets, domestic animals, and wildlife including birds of prey.

Various predators and scavengers in California have tested positive for second-generation anticoagulants, while a much lower number of first-generation exposures have been detected (Redig and Arent 2008). However, without information on anticoagulant use patterns in the areas where these animals were collected, we cannot paint a complete picture of the exposure risks and impacts of anticoagulant use in agricultural production areas. Yet,

in the absence of such data, persons concerned about pesticide residues in wildlife often assume that anticoagulant rodenticides used in agriculture cause widespread risk to non-target wildlife, particularly predators and scavengers of rodents.

## OBJECTIVES

This study was undertaken to help understand the extent of raptor exposure to anticoagulants, particularly in relation to anticoagulant uses for protecting agriculture. Data were utilized from raptors that were collected as part of the public health surveillance programs of the County Veterinarian(s) and/or Departments of Environmental Health, as well as by submission from other organizations such as California Fish and Game and the United States Department of Agriculture – Wildlife Services. None of the raptors analyzed were initially suspected of having anticoagulant exposure or poisoning.

The ultimate goal was to determine possible raptor exposure to first- and second-generation anticoagulants by evaluating the relationship between the use of these materials in agricultural versus urban settings and the presence/absence of residues in raptor tissues collected from each region.

A second objective was to determine if wild rodents captured as part of a county Hantavirus surveillance program would show any signs of exposure to anticoagulants. While anticoagulant residues have been found in many carnivores, few reported data exist demonstrating the occurrence of residues in rodents found in areas where anticoagulant materials are used. The data that are available originates from rodents targeted by specific baiting programs. It is likely that some of these rodents survive baiting by consuming a sub-lethal dose. In turn, these survivors could have some anticoagulant residue remaining in their tissues, providing a possible exposure route for raptors and carnivores.



## METHODS

San Diego County has a robust public health surveillance program that includes testing of raptors and other birds found dead throughout the County. This provided a large number of raptors for potential analysis. Since San Diego County is fairly urban, we wanted to compare data from these birds with birds from more rural and agricultural counties. The top 5 agricultural counties with the highest quantity of total agricultural pesticide use in California in 2007 were Fresno, Kern, Tulare, San Joaquin, and Madera (Brooks 2008). Of these, Fresno, Kern, and Tulare Counties were selected because we have worked on extensive ground squirrel problems in these areas for the past 30 years. We sought to compare anticoagulant residue data from raptors collected in these counties to those from the more urban San Diego County, where we assume most rodenticides applied are used by homeowners for the control of commensal rodents.

### Anticoagulant Use

In order to better understand the information gathered, we estimated how much anticoagulant was used in each county. Table 1 provides the total amount of active ingredient of each of the 7 anticoagulants sold by all entities in counties comprising our study sites, in 2007. We assume that materials purchased would be used in the county of purchase within a 1-year period.

For example, 2.92 lbs of diphacinone (as active ingredient) reported for San Diego County would, when formulated at 0.005% a.i. in rodent baits, represents a total of 58,400 lbs of ready-to-use bait.

**Table 1. Pounds of anticoagulants (active ingredient) use for each included county as reported by rodenticide manufacturers or through the required applicator pesticide use reports (CDPR 2007).**

Active Ingredient (lbs)	San Diego County	Fresno County	Kern County	Tulare County
Chlorophacinone	0.0795	0.3927	0.8932	0.3235
Diphacinone	3.2941	1.8605	2.3378	3.523
Warfarin	0.1056	0.0903	0.0376	0.0024
Brodifacoum	0.0998	0.0647	0.045	0.0269
Bromadiolone	3.1664	0.8124	0.296	0.1553
Difethialone	0.2825	0.0378	0.0197	0.0159

### Raptor Tissue Collection

San Diego County has a robust public health surveillance program to detect the presence of West Nile virus in wild birds, and dead birds are routinely submitted to the County Veterinarian for testing. We partnered with the County Veterinarian to have the liver tissue removed and sent to UC Davis to test for the presence of anticoagulants. The Central Valley does not have a systematic raptor collection program. The birds that are submitted are generally obtained as a result of chance collection by members of the general public. Liver tissues from this region were provided by the Pesticide Investigations Unit of the California Department of Fish

and Game. Our project did not capture or handle raptors, nor did it cause any birds to be captured.

### Residue Analysis

Corresponding liver tissue samples from each animal were frozen and shipped to the California Animal Health & Food Safety Laboratory System at the University of California, Davis for anticoagulant residue analysis. If detected, the quantity in parts per million (ppm) was determined. When possible, the location where each bird specimen was found was entered into a GIS layer.

## RESULTS

Of 176 raptors available to us, 80 had no information on the specific site of collection, so we did not subject these to residue analysis. The remaining 96 were necropsied and liver tissues were sent for testing. Of these, 53 came from San Diego County and 43 from the three Central Valley counties.

The tested group consisted of 10 common raptor species: American kestrel, *Falco sparverius* (4); barn owl, *Tyto alba* (21); burrowing owl, *Athene cunicularia* (1); Cooper's hawk, *Accipiter cooperii* (12); great horned owl, *Bubo virginianus* (7); northern harrier, *Circus cyaneus* (1); red-tailed hawk, *Buteo jamaicensis* (22); red-shoulder hawk, *B. lineatus* (15); sharp shinned hawk, *A. striatus* (9); and Swainson's hawk, *B. swainsoni* (1).

Of the 53 birds tested from San Diego County, 92% ( $n = 49$ ) had anticoagulant detections. Some birds had multiple anticoagulant detections but all were of second-generation materials. Thirty-four of the 43 birds (69%) tested from the Central Valley counties also had anticoagulant detections. Detections included residues at levels above the limit of detection and residues in trace amounts (Tables 2, 3).

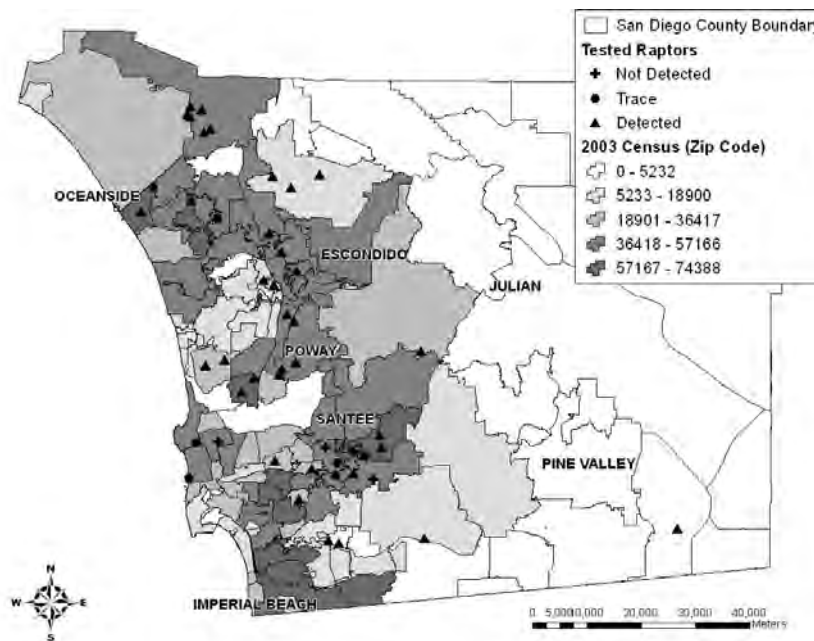
**Table 2. The reportable limit in parts per million for each anticoagulant included in this study.**

	Anticoagulant	Reportable Limit (ppm)
<b>First-Generation</b>	Chlorophacinone	0.25
	Coumachlor	0.05
	Diphacinone	0.25
	Warfarin	0.05
<b>Second-Generation</b>	Brodifacoum	0.01
	Bromadiolone	0.05
	Difethialone	0.25

For birds collected in San Diego Co., we plotted the pickup location (Figure 1). We define "rural birds" as those recovered within zip codes containing low human populations ( $\geq 36,417$  individuals), and "urban birds" were those occurring in highly populated zip codes ( $\leq 36,418$  individuals). Most birds came from "urban" areas, likely because more people were present and freshly dead birds were more likely to be seen and submitted. We see a trend of birds with detectable levels of anticoagulants occurring in the most highly populated areas, although this could be from a greater detection

**Table 3. Number of detections by chemical and location.**

		San Diego County		Central Valley	
		Detectable Level	Trace Amount	Detectable Level	Trace Amount
<b>First-Generation</b>	Chlorophacinone	0	0	0	2
	Coumachlor	0	0	0	0
	Diphacinone	0	0	0	0
	Warfarin	0	0	0	0
<b>Second-Generation</b>	Brodifacoum	44	5	5	1
	Bromadiolone	12	10	23	8
	Difethialone	5	3	0	0



**Figure 1. Locations of tested raptor carcasses within San Diego County in reference to human population.**

probability. No birds from San Diego Co., either “urban” or “rural”, contained any first-generation anticoagulants.

Of the 43 raptors submitted from the Central Valley, there were 34 individuals with anticoagulant residues. Only 2 birds contained residues of a first-generation anticoagulant (chlorophacinone), and in both cases it was present only in trace amounts. The other residues found were all second-generation anticoagulants.

**DISCUSSION**

Figure 2 shows the results of raptor collection site in relation to human population and agricultural commodity areas. It appears that raptors with detectable second-generation anticoagulants were more common in areas with higher population densities, although this could be the result of increased detection probability. This finding would make sense, because exposure to second generation anticoagulants is likely originating from commensal rodent pest control programs in and around buildings.

Due to the nature of the sample carcass collection in the Central Valley, we did not have specific collection location information for most of the birds. In these cases, the location was coded as the county where the bird was

collected. When evaluating the potential anticoagulant exposure of raptors in the selected Central Valley counties (see Figure 3), it appears that agricultural areas are much more dominant than urban areas. Because of the heavy agricultural production in these counties, we would expect more detection of first-generation anticoagulants in raptors collected in these counties if exposure simply relates to amount of material used. However, this is not supported by the data collected in this study. This finding could be from exposure rates but also could result for the shorter half-life of first generation anticoagulants in poisoned rodents.

**RODENTS**

**Methods**

As part of the Hantavirus surveillance program, San Diego County’s Department of Environmental Services set trap lines to capture wild rodents. The lines were set along fence lines radiating from urban areas into adjacent non-developed environments. A total of 131 rodent carcasses were obtained over several months, and all pickup locations were entered into a GIS layer. Due to limited resources, only 26 were selected for analysis to cover a variety of habitats. Necropsies were performed

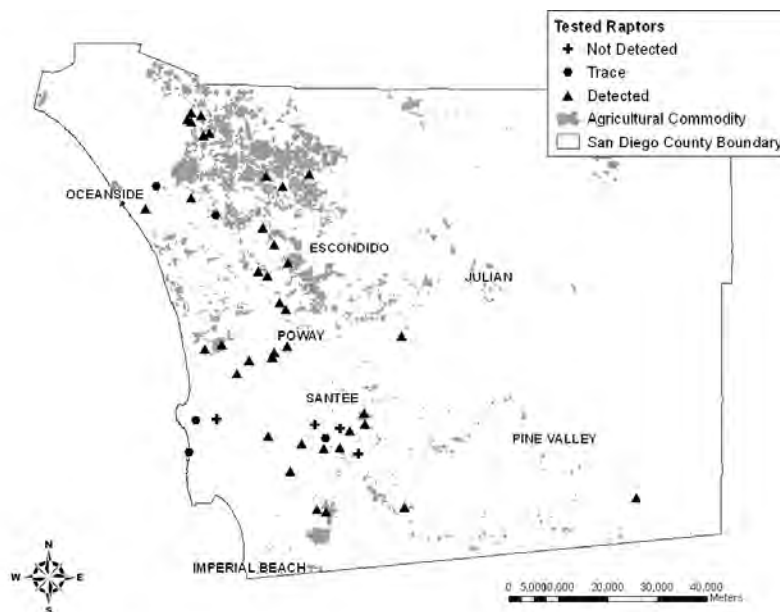


Figure 2. Locations of raptor carcasses in relation to human population and agricultural commodities of San Diego County.

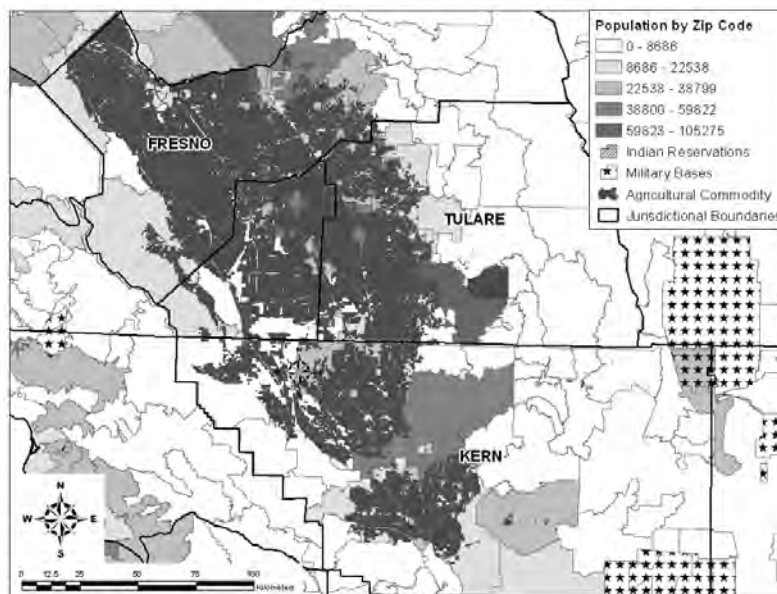


Figure 3. Human population and agricultural commodities in the Central Valley.

and liver samples were sent to the UC Davis laboratory for testing.

The tested specimens included: deer mouse, *Peromyscus maniculatus* (5); Baja mouse, *P. raterculus* (3); California mouse, *P. californicus* (6); and cactus mouse, *P. eremicus* (12).

Of the liver tissues submitted, 5 had trace detections of anticoagulants, only 1 of which was a first-generation anticoagulant. Unfortunately, we were unable to process a large enough sample of carcasses to show any real trends, but we were able to determine that measurable amounts of anticoagulants were present in “free-ranging” small rodents. Presumably, these rodents were exposed

to anticoagulants from a rodent control program, although none of these species are target animals of the second-generation anticoagulants. Since all of the detections were in trace amounts, the data should only be used to guide future research.

## CONCLUSION

With over a million pounds of anticoagulant baits sold annually in California for all target species, these are the most common rodenticides used in agricultural and domestic areas, and this creates potential primary and secondary risks to pets, domestic animals, and wildlife, including birds of prey. Anticoagulant exposure appears

to be relatively common, with the predominant anticoagulants detected in this study being the second-generation materials. In this study, 1 in every 1.17 raptors tested containing detectible levels of second-generation anticoagulants. Only 1 in 48 tested positive for first-generation materials. This difference could be from the higher persistence of second-generation materials in exposed animal tissue. Raptors with second-generation anticoagulants in their tissues were more commonly found in urban areas where commensal rodent control is presumably more common; however, this could be the result of more people to detect carcasses in the urban areas. In addition, it could be that the higher number of second-generation detections is from the greater half-life of these materials in carcasses of exposed animals, or because the detection levels for second-generation materials are generally much lower than for first-generation anticoagulants. Raptors were not commonly found in agricultural areas, but those that were tested did not usually contain any first-generation anticoagulant in their tissue.

While second-generation anticoagulant residues were found in many raptors we tested, there was no information available to us on the impact of these residues on the birds. No birds tested displayed symptoms of anticoagulant poisoning, so these levels were not indicative of anticoagulant poisoning. However, these residues could have had sublethal impacts on the birds or contributed to mortality from other causes. Clearly, more study is needed, particularly on the impacts of specific residue levels on raptors and other non-target wildlife.

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Review

# Estimation of Bird-Vehicle Collision Mortality on U.S. Roads

SCOTT R. LOSS,<sup>1,2</sup> *Migratory Bird Center, Smithsonian Conservation Biology Institute, National Zoological Park, P.O. Box 37012, MRC 5503, Washington, DC 20013, USA*

TOM WILL, *U.S. Fish and Wildlife Service, Division of Migratory Birds, Midwest Regional Office, 5600 American Boulevard West, Suite 990, Bloomington, MN 55437-1458, USA*

PETER P. MARRA, *Migratory Bird Center, Smithsonian Conservation Biology Institute, National Zoological Park, P.O. Box 37012, MRC 5503, Washington, DC 20013, USA*

**ABSTRACT** Roads have numerous direct and indirect ecological impacts on wildlife. Vehicle collisions are a top impact of roads on birds, with tens of millions of birds thought to be killed each year in the United States. However, currently available mortality estimates are extrapolated from a single study. We reviewed the literature and used 20 mortality rates extracted from 13 studies to systematically quantify data-driven estimates of annual U.S. mortality from bird-vehicle collisions. We generated 4 separate estimates along with uncertainty using different subsets of data deemed to be rigorous enough to contribute relatively little bias to estimates. All of our estimates of vehicle mortality are higher than previous U.S. figures. When averaging across model iterations, we estimated that between 89 and 340 million birds die annually from vehicle collisions on U.S. roads. Sensitivity analyses indicated that uncertainty about survey-related biases (scavenger removal and searcher detection of carcasses) contributes the greatest amount of uncertainty to our mortality estimates. Future studies should account for these biases to provide more accurate local estimates of mortality rates and to inform more precise national mortality estimates. We found relatively little information available to quantify regional, seasonal, and taxonomic patterns of vehicle collision risk, and substantial uncertainty remains about whether collisions contribute to large-scale impacts on bird populations. Nonetheless, the large magnitude of bird mortality caused by vehicle collisions combined with evidence that collisions can contribute to local population declines for some species highlights the need for implementation of conservation and management actions to reduce this mortality. Published 2014. This article is a U.S. Government work and is in the public domain in the USA.

**KEY WORDS** anthropogenic mortality, automobiles, birds, detection probability, roadkill, roads, scavenger removal, systematic review, United States, vehicles.

The global proliferation of road networks has led to a multitude of ecological impacts that affect biological diversity. In the United States, the greater than 6.5 million kilometers of roads (U.S. Department of Transportation 2012) ecologically affect at least 22% of the nation's land area (Forman 2000), causing loss and fragmentation of habitat; pollution with chemicals, light, and noise; alteration of animal movement and behavior; and direct mortality of wildlife from vehicle collisions (Forman and Alexander 1998, Trombulak and Frissell 2000, Forman et al. 2003, Coffin 2007). For birds, vehicle collisions are one of the greatest threats posed by roads (Kociolek et al. 2011), with as many as 80 million birds thought to be killed annually in the United States (Erickson et al. 2005) and roughly 13 million birds

estimated to be killed annually in Canada (Bishop and Brogan 2013). Moreover, roadkills have the potential to constitute the vast majority of total mortality for some bird species—most notably, barn owls (*Tyto alba*) (Moore and Mangel 1996, Newton et al. 1997). Roadkill mortality can also result in the creation of population sinks (Mumme et al. 2000, Boves and Belthoff 2012, Grilo et al. 2012) and may be an additive source of mortality that contributes to population declines (Bujoczek et al. 2011).

A large body of literature has identified numerous factors that influence bird-vehicle collision rates. Mortality rates have been found to increase with increasing traffic speed and volume (Case 1978) and rates are generally highest during spring and summer. Mortality rates are also greater for juvenile birds, in areas with favorable bird habitat in close proximity to the road, and where bird populations are abundant (Loos and Kerlinger 1993, reviewed by Erritzoe et al. 2003, Gunson et al. 2010, Boves and Belthoff 2012). In some cases, mortality rates have been found to increase with increasing width of the road corridor (Oxley et al. 1974) or to be greater along road segments that are elevated above the surrounding land (Baudvin 1997, Lodé 2000). Often, 2 or

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<sup>1</sup>E-mail: scott.loss@okstate.edu

<sup>2</sup>Present address: Department of Natural Resource Ecology and Management, Oklahoma State University, 008C Agricultural Hall, Stillwater, OK 74078, USA

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more of the above factors are strongly correlated—i.e., wider roads usually have a higher traffic volume than narrow roads—making it difficult to dis-entangle the relative impact of each factor. Furthermore, exceptions to the above relationships occur and are illustrative of how mortality rate correlates are often region-, taxa-, and habitat-specific. For example, several studies have found no link between traffic volume and mortality rates (Massemin et al. 1998, Lodé 2000, Coelho et al. 2008, Kambourova-Ivanova et al. 2012).

Current estimates of annual U.S. bird mortality from vehicle collisions—ranging from 60 to 80 million—are highly speculative, based on extrapolation of mortality rates from a single British study (Hodson and Snow 1965) to the entire U.S. road network (Banks 1979, Erickson et al. 2005). Comprehensive meta-analyses of studies that quantify bird populations have concluded that roads are consistently associated with reductions in bird abundance (Fahrig and Rytwinski 2009, Benitez-Lopez et al. 2010), but no clear evidence exists that vehicle collision mortality is a significant driver of these road-related declines. In addition, no such comprehensive analyses have been completed to assess bird-vehicle collision mortality in the United States. When compared to speculative or extrapolative estimates based on small samples of data, such systematic and quantitative reviews provide a more rigorous approach to estimating mortality, an improved understanding of the sources of uncertainty associated with estimates (Loss et al. 2012, 2013a, 2014; Machtans et al. 2013), and a more valid evidence base on which to prioritize policy and management strategies and to identify major research needs (Calvert et al. 2013, Machtans and Thogmartin 2014).

We reviewed the North American and European bird-vehicle collision literature and defined inclusion criteria to screen and remove studies likely to bias our estimates substantially. Based on data extracted from the remaining studies, we 1) systematically quantified the magnitude of bird mortality (along with uncertainty) caused by collisions with vehicles on U.S. roads by combining probability distributions of mortality rates, the length of U.S. roads, and biases associated with surveys for dead birds; 2) used sensitivity analyses to quantitatively investigate factors contributing to estimate uncertainty and to identify major research needs; and 3) summarized the available species-specific data on bird-vehicle collisions in the United States.

## METHODS

### Literature Search and Inclusion Criteria

We used Google Scholar and the Web of Science database to search for publications about bird-vehicle collisions on roads. The search terms we used were “bird-vehicle collision,” “bird-vehicle roadkill,” the previous terms with “bird” replaced by “avian” and “vehicle” replaced by “automobile,” “car,” and “truck.” We checked reference lists to locate additional sources, and we also referenced an annotated bibliography that included approximately 670 sources covering the impacts of roads on wildlife (Nietvelt 2002). For 5 North American studies (Nero and Copland 1981,

Decker 1987, Smith et al. 1994, Sutton 1996, Potvin and Bishop 2010), we were unable to access full-text articles and instead extracted the data as summarized in a review of bird-vehicle collisions in Canada (Bishop and Brogan 2013). Because of the large quantity of international studies—many that are published in languages other than English or inaccessible online or through North American libraries—we could not exhaustively review this literature. However, our review of the North American literature was comprehensive, and we likely located all studies that included a systematic sampling component. We may have overlooked some North American publications containing descriptions of incidentally found roadkill victims; however, these studies would have been excluded from analyses based on our inclusion criteria described below.

We defined several criteria for studies to be included in our estimation models. We designed inclusion criteria to remove studies that were not useful for generating mortality rate estimates or that were likely to substantially bias estimates. We excluded studies prior to in-depth review if they included no original data; were conducted in a region other than the United States, Canada, or Europe; or were published in a language other than English. In addition, because we sought to generate mortality estimates that were relevant to relatively modern road types and traffic patterns, we arbitrarily selected 1970 as the earliest date for which publications could be included in analyses (see also Bishop and Brogan 2013). Following in-depth review of the remaining 53 studies, we also excluded studies that 1) were retrospective, based on assessment of opportunistically collected data sets or recoveries of banded or radio-tagged birds, 2) focused on particular bird species or groups without sampling or presenting data for all species and groups, 3) included an experimental component without presenting control and treatment data separately, 4) were prospective but also included incidentally collected data without presenting it separately, 5) did not provide information about the proportion of the year covered by sampling, 6) did not present the length of road corridor sampled or a per kilometer mortality rate, 7) were based on a single survey or a series of surveys that covered less than 1 month, and 8) did not separately report fatalities from vehicle collisions and other collision sources (e.g., roadside fences). After implementing the above inclusion criteria, 16 of the 53 reviewed studies remained (9 U.S. and 7 European studies; Table 1; see Table S1 for excluded studies).

For the summary of species representation of mortality, we included data from U.S. studies meeting criteria 1–4 and 7–8 above. We considered criteria 5 and 6 unnecessary for producing unbiased species summaries. We used 7 of the 9 U.S. studies meeting inclusion criteria for the mortality estimate for the species analysis. The 2 excluded studies did not provide data at the species level (Oxley et al. 1974, Gerow et al. 2010).

### Data Extraction

From most studies meeting the above inclusion criteria, we extracted a single mortality rate. However, for studies that

**Table 1.** Meta-data and mortality rates for studies meeting inclusion criteria for 1) estimation of annual bird-vehicle collision mortality on U.S. roads and/or 2) species mortality summary.

Location	Sampling coverage	Used?		Road type	Mortality per km <sup>c</sup>	Study
		Total <sup>a</sup>	Species <sup>b</sup>			
United States						
Southern Idaho	Yr-round	Yes	Yes	4-lane paved	2.01	Boves and Belthoff (2012)
Bow River Valley, AB	Apr–Nov	Yes	Yes	2-lane paved	0.38	Clevenger et al. (2003)—Bow Valley Parkway
Bow River Valley, AB	Apr–Nov	Yes	Yes	4-lane paved	0.37	Clevenger et al. (2003)—Trans-Canada Highway
Tippecanoe County, IN	Yr-round	Yes	Yes	2-lane paved	6.54	Glista et al. (2008)—South River Road
Tippecanoe County, IN	Yr-round	Yes	Yes	2-lane paved	5.69	Glista et al. (2008)—State Road 26
Tippecanoe County, IN	Yr-round	Yes	Yes	2-lane paved	4.85	Glista et al. (2008)—U.S. Highway 231
Central California	25 May–26 Nov	Yes	Yes	4-lane paved	1.20	Moore and Mangel (1996)
Athens County, Ohio	Yr-round	Yes	Yes	4-lane paved	6.56	Seibert and Conover (1991)
Southern Ontario/Quebec	31 May–23 Sep	Yes	No	Unpaved	0.23	Oxley et al. (1974)—Gravel unpaved road 1
Southern Ontario/Quebec	31 May–23 Sep	Yes	No	Unpaved	2.11	Oxley et al. (1974)—Gravel unpaved road 2
Southern Ontario/Quebec	31 May–23 Sep	Yes	No	2-lane paved	2.96	Oxley et al. (1974)—2-lane paved highway
Southern Ontario/Quebec	31 May–23 Sep	Yes	No	4-lane paved	3.22	Oxley et al. (1974)—4-lane paved highway
Long Point, ON	Apr–Oct	No <sup>d</sup>	Yes	2-lane paved	91.43	Ashley and Robinson (1996)
Tippecanoe County, IN	Yr-round	No <sup>d</sup>	Yes	2-lane paved	24.44	Glista et al. (2008)—Lindberg Road
Alachua County, FL	Yr-round	No <sup>d</sup>	Yes	4-lane paved	43.44	Smith and Dodd (2003)
Saguaro Nat. Park, AZ	Yr-round	No <sup>e</sup>	No	?	NA	Gerow et al. (2010)—Rincon Mountain
Saguaro Nat. Park, AZ	Yr-round	No <sup>e</sup>	No	?	NA	Gerow et al. (2010)—Tucson Mountain
Europe						
Northeast France	Yr-round	Yes	No	2-lane paved	1.54	Baudvin (1996)
Northeast Poland	Yr-round	Yes	No	2-lane paved	11.55	Gryz and Krauze (2008)
Galanta, Slovakia	Yr-round	Yes	No	?	17.09	Hell et al. (2005)
Belovo, Bulgaria	Mar–Oct	Yes	No	?	3.00	Kambourova-Ivanova et al. (2012)—1st-class road
Belovo, Bulgaria	Mar–Oct	Yes	No	?	8.09	Kambourova-Ivanova et al. (2012)—Trakia highway
Western France	Apr–Nov	Yes	No	?	8.80	Lodé (2000)
Wroclaw, Poland	Mid-Mar–Oct	Yes	No	?	5.89	Orlowski (2005)
Spain and France	Yr-round	Yes	No	?	0.65	Pons (2000)

<sup>a</sup> Whether we used the mortality rate to estimate bird-vehicle collision mortality on U.S. roads.

<sup>b</sup> Whether we used the source to calculate average proportional representation for individual species (excluded U.S. studies focused on particular bird group(s) without including all species; we excluded all international studies).

<sup>c</sup> We calculated mortality rates using raw data (i.e., we did not directly extract reported rates from studies because calculation approaches varied among studies and were not always calculated transparently). We first divided the total number of fatalities reported for a road segment by the length of road corridor covered by that segment. For rates representing >1 year of sampling, we then divided by the number of years sampled; we applied a partial-year sampling correction in the mortality estimation model (see Methods section in main text for details).

<sup>d</sup> Study meets inclusion criteria but was removed from calculation of mortality rate probability distribution because mortality rate is a statistical outlier among studies meeting criteria.

<sup>e</sup> Study meets inclusion criteria but was removed from calculation of mortality rate probability distribution because mortality rate is adjusted for biases associated with carcass surveys (detection probability and scavenger removal); these biases were separately accounted for in our mortality estimation model.

sampled along more than 1 road type (e.g., paved and unpaved roads and/or roads with different numbers of lanes) or used different sampling methods (e.g., different sampling intervals or survey types) for different portions of the study area, we extracted separate mortality rates. This resulted in extraction of 25 mortality rates (17 U.S. and 8 European rates; Table 1) from the 16 included studies. We calculated all rates as the number of dead birds found per kilometer of road corridor sampled. This approach is different than that of

some studies that calculate mortality rates using the total length of lanes sampled (e.g., for a 2-lane road, lane-length is twice the length of the road corridor). Some studies did not provide enough information to clarify how they calculated mortality rates. Therefore, rather than directly extracting the reported rates, we recalculated rates based on the number of fatalities reported for a road segment divided by the length of road corridor covered by that segment. Because we recalculated rates using this raw data, the mortality rate we

calculated was sometimes different than that presented in the original study.

We then used one of several approaches to convert multi-year mortality rates to annual rates. For multi-year studies that sampled across the entire calendar year in every year of the study, we divided mortality rates by the number of years to generate the annual rate (Table 1). We also took this approach for multi-year studies that only sampled a portion of each year; we accounted for partial-year sampling coverage separately (see following subsection). For 4 studies that sampled at least 1 entire calendar year as well as an additional partial year (Seibert and Conover 1991, Baudvin 1997, Hell et al. 2005, Glista et al. 2008), we treated the partial year as a full year when calculating the annual rate. This approach led to conservative rate estimates because mortality was spread across a longer time period than it actually occurred in.

We excluded 3 mortality rates from the above data set for being statistical outliers and 2 for being adjusted for various sampling biases that we accounted for separately in the mortality estimation model (see Supplementary Methods, available online at [www.onlinelibrary.wiley.com](http://www.onlinelibrary.wiley.com)). The final data set used for estimation of mortality therefore included 20 mortality rates (12 U.S. and 8 international rates) extracted from 13 studies (6 U.S. and 7 European studies; Table 1).

### Quantification of Annual Bird Mortality

To increase the comparability of mortality estimates from different studies, mortality rates should ideally be standardized to account for varying proportions of the year being covered by sampling (Loss et al. 2012). Potential standardization approaches include 1) using mortality rates from year-round studies to proportionally correct partial-year studies (Longcore et al. 2012, Loss et al. 2013a), 2) including a correction factor in the mortality estimation model that accounts for partial-year sampling (Loss et al. 2014), or 3) using only full-year mortality rates to generate mortality estimates. We were unable to implement the first approach because year-round vehicle collision studies either do not present data separately for different portions of the year or only provide seasonal data for single bird species or taxa other than birds. Because the second and third approaches were both possible, we repeated mortality estimation using each approach. We expected the estimate generated using approach 2 would represent a maximum value because this approach assumed that mortality rates observed during the sampled portion of the year—typically the peak periods of vehicle collision mortality in spring, summer, and/or autumn—also applied to the un-sampled portion of the year (see Supplementary Methods).

Our approach for estimating mortality was to combine a mortality rate probability distribution with a probability distribution for the length of U.S. roads susceptible to that range of mortality rates. We defined the maximum susceptible road length to be the entire U.S. road network and the minimum susceptible length to be only the length of roads in rural areas (see Supplementary Methods). This approach assumes that mortality rates in urban areas are

likely lower than in rural areas, but does not entirely discount mortality in urban areas. We also incorporated correction factors to account for sampling coverage of less than the entire calendar year (for estimates that included partial-year mortality rates) and for biases associated with carcass surveys (all estimates), including removal of carcasses by scavengers and imperfect detection of carcasses by surveyors (Loss et al. 2013a, 2014). Because a preliminary analysis found little support for differences in mortality rates between 2-lane, 4-lane, and gravel roads, and because the sample of mortality rates was too small to generate separate probability distributions for different road types, we applied the same range of mortality rates across all U.S. road types. This simplified approach contributes uncertainty to our mortality estimate; however, we did not have enough available data to allow separate mortality estimates for different road types. In addition to repeating mortality estimation with and without inclusion of partial-year studies, we also estimated mortality with and without inclusion of European mortality rates. Thus, we generated 4 separate estimates of annual mortality using different subsets of data: U.S. year-round mortality rates, U.S. year-round and partial-year rates, U.S. and Europe year-round rates, and U.S. and Europe year-round and partial-year rates.

For the estimates based only on year-round mortality rates, we used the model:

$$\text{Mortality}_{\text{year-round studies}} = R \times K_{\text{year-round studies}} \times B \quad (1)$$

where  $R$  is the length of U.S. roads susceptible to the range of mortality rates in the mortality rate probability distribution ( $K$ ),  $K$  is the range of collision mortality rates per km of road corridor, and  $B$  is a bias correction factor to account for removal of carcasses by scavengers prior to surveys and imperfect detection of carcasses remaining at the time of surveys.

For the estimates based on year-round and partial-year rates, we used the model:

$$\begin{aligned} \text{Mortality}_{\text{year-round and partial-year}} \\ = R \times K_{\text{year-round and partial-year}} \times Y \times B \end{aligned} \quad (2)$$

where  $Y$  is a correction factor that accounts for the average proportion of the calendar year not covered by sampling in the studies used to develop the mortality rate distribution (Loss et al. 2014). The partial-year sampling correction factor was a fixed value; however, we defined all other parameters as uniform probability distributions (specific distributions shown in Table 2; rationale for distributions in Supplementary Methods). For all estimates, we used the `runif` function in Program R (R Version 3.0.1., <<http://www.r-project.org/>>. Accessed 14 Apr 2014) to draw random values from each probability distribution, and we calculated mortality using the above formulas. We repeated this calculation 10,000 times for each of the 4 estimation approaches to generate ranges of uncertainty for mortality estimates.

### Sensitivity Analyses

We used sensitivity analyses to quantitatively investigate the factors contributing to uncertainty in our mortality estimates.

**Table 2.** Probability distributions used for estimation of annual bird-vehicle collision mortality on U.S. roads.

Parameter	Distribution type	Distribution parameters	Source
Total length of road corridors in the United States <sup>a</sup>	Uniform	Min. = 3.76 M; max. = 4.33 M	U.S. Department of Transportation (2012)
Mortality rates (per km)			
U.S. studies (yr-round) <sup>b</sup>	Uniform	Min. = 3.48; max. = 6.78	95% CI across 5 rates meeting inclusion criteria
U.S. studies (all) <sup>c</sup>	Uniform	Min. = 2.78; max. = 6.73	95% CI across 12 rates meeting inclusion criteria
U.S. + Europe studies (yr-round) <sup>b</sup>	Uniform	Min. = 2.85; max. = 9.70	95% CI across 9 rates meeting inclusion criteria
U.S. + Europe studies (all) <sup>c</sup>	Uniform	Min. = 4.24, max. = 8.58	95% CI across 20 rates meeting inclusion criteria
Partial-yr sampling correction			
U.S. studies (all) <sup>c</sup>	NA <sup>d</sup>	Estimate = 1.49	1/average proportion of yr covered by mortality rates
U.S. + Europe studies (all) <sup>c</sup>	NA <sup>d</sup>	Estimate = 1.37	1/average proportion of yr covered by mortality rates
Bias correction factor	Uniform	Min. = 3.26; max. = 11.46	Bruun-Schmidt (1994), Gerow et al. (2010), Santos et al. (2011), Boves and Belthoff (2012), Texeira et al. (2013)

<sup>a</sup> Includes length in millions (M) of kilometers of all public roads in all states excluding Alaska and Hawaii.

<sup>b</sup> Estimate is based only on mortality rates from studies with year-round sampling coverage.

<sup>c</sup> Estimate is based on mortality rates from all studies meeting inclusion criteria.

<sup>d</sup> Parameter is a point estimate, not a probability distribution.

We defined univariate regression models with the 10,000 replicated mortality estimates as the dependent variable and randomly drawn values of model parameters as the independent variable. We repeated this analysis 4 times, once for each of the 4 mortality estimate models. We used the adjusted  $R^2$  values for each independent variable (averaged across the 4 sensitivity analysis iterations) to interpret the percentage of estimate uncertainty attributable to each model parameter (Blancher 2013, Loss et al. 2013a).

### Vehicle Collision Mortality by Species

In addition to estimating total annual mortality for all U.S. birds, we also calculated the average proportional representation of each bird species (Longcore et al. 2013, Loss et al. 2013a). We used this calculation rather than estimating species-specific mortality because the data from studies meeting inclusion criteria only represented 100 bird species. This value is likely much lower than the actual number of species killed along U.S. roadways each year. Estimates of species-specific mortality would therefore be biased high for observed species and biased low for species killed but not reported in the literature. Therefore, we would be unable to draw unbiased conclusions about species-specific collision risk. Nonetheless, to provide a rough summary of the findings to date, we estimated average proportional representation of species by 1) calculating the proportion of each study's total count represented by each species (i.e., multiple proportions calculated for each species, 1 from each study), and 2) averaging each species' individual-study proportions across all studies. For averaging, we only included zero-values of proportions (i.e., species was not found in study) when a species could have been found, as determined by overlap of breeding, migration, and/or wintering ranges with study sites (Sibley 2000).

## RESULTS

We found considerable variation (41.8%) among median mortality estimates produced using the 4 models (Table 3). The model using only year-round mortality rates from the United States produced the lowest annual estimate (median = 145.7 million; 95% CI = 61.9–274.6 million), and the model including both year-round and partial-year mortality rates and rates from both the United States and Europe produced the highest estimate and the estimate with the greatest range of uncertainty (median = 250.5 million; 95% CI = 103.8–476.8 million). Averaging across all 4 models (i.e., averaging the 4 estimates produced in each model iteration and then averaging these values across 10,000 iterations) resulted in a median annual mortality estimate of 199.6 million birds (95% CI = 88.7–339.8 million). Regardless of the model used, sensitivity analyses indicated that the bias correction factor for scavenger removal and searcher detection contributed the greatest uncertainty to estimates (average variance explained = 63.2%), followed by the mortality rate (32.5%) and the road corridor length over which the mortality rate applies (1.3%).

Among the species documented in studies meeting inclusion criteria, the barn owl had the highest average proportional representation across studies, averaging 32.4% of total counts (all species proportions in Table S2). Four other species, including 3 in the Corvidae family, had average proportional representation of at least 5%: common raven (*Corvus corax*; 6.3%), gray jay (*Perisoreus canadensis*; 6.0%), black-billed magpie (*Pica hudsonia*; 5.0%), and European starling (*Sturnus vulgaris*; 5.0%). Several species were found in 3 or fewer studies, and these species' proportions were more likely to be biased by abnormally high or low counts documented in single studies. Given the small sample of

**Table 3.** Estimates of annual bird-vehicle collision mortality on U.S. roads.

Mortality data used	Total mortality (millions)		Mortality per km	
	Median	95% CI	Median	95% CI
United States	145.7 <sup>a</sup>	61.9–274.6 <sup>a</sup>	36.0 <sup>a</sup>	15.3–68.0 <sup>a</sup>
	197.1 <sup>b</sup>	78.2–397.9 <sup>b</sup>	48.8 <sup>b</sup>	19.4–98.5 <sup>b</sup>
United States + Europe	171.0 <sup>a</sup>	59.6–381.5 <sup>a</sup>	42.3 <sup>a</sup>	14.8–94.4 <sup>a</sup>
	250.5 <sup>b</sup>	103.8–476.8 <sup>b</sup>	62.0 <sup>b</sup>	25.7–118.0 <sup>b</sup>
Average across models	199.6	88.7–339.8	49.4	22.0–84.1

<sup>a</sup> Estimate based only on mortality data from studies with year-round sampling coverage.

<sup>b</sup> Estimate based on data from all studies meeting inclusion criteria.

studies included in the species summaries (7 studies including 3,246 total fatality records), caution should be used when interpreting these results.

## DISCUSSION

### Annual Bird-Vehicle Collision Mortality on U.S. Roads

All of our estimates of annual bird-vehicle collision mortality exceed the previous estimates of between 60 and 80 million birds, which were produced by extrapolating the results of 1 British study (Hodson and Snow 1965) across the entire U.S. road network (Banks 1979, Erickson et al. 2005). We improved upon these earlier estimates by systematically incorporating 20 mortality rates from 13 studies that used a prospective sampling design and reported results for all potentially killed bird species. Even when considering the lowest estimate range (between 62 and 275 million birds), our results suggest that bird-vehicle collisions outrank many other sources of direct anthropogenic mortality. Among threats with estimates that are data-driven and systematically derived, only predation by free-ranging domestic cats (Loss et al. 2013<sup>a</sup>) and collisions with buildings and their windows (Loss et al. 2014) are estimated to cause greater annual bird mortality in the United States. Estimates of total numbers of birds killed by anthropogenic threats are useful for prioritizing conservation and management efforts. However, increased attention should also be given to documenting which species and regions are most vulnerable to vehicle collisions and other mortality sources (Longcore et al. 2013; Loss et al. 2013<sup>b</sup>, 2014).

As expected, estimates that incorporated both year-round and partial-year mortality rates were higher than those that used only year-round rates. This likely occurred because the partial-year correction factor was calculated under the assumption that mortality rates were constant across all seasons. Among the studies we used, sampling periods typically covered spring, summer, and/or autumn, seasons characterized by relatively high mortality rates for most species (Loos and Kerlinger 1993, Smith and Dodd 2003, Orłowski 2005, Gryz and Krauze 2008). Extrapolating mortality rates from these peak seasons to un-sampled seasons that are generally characterized by lower mortality rates may have inflated our estimates. Estimates from models including partial-year rates should therefore be viewed as maximum values. Additional year-round studies that present results separately by month and/or season are needed to

clarify intra-annual variation in vehicle collision mortality rates.

Estimates that included European mortality rates were higher than those that used only U.S. rates. This may have occurred due to the inclusion of 2 European rates that were not statistical outliers but were higher than all U.S. rates meeting inclusion criteria (11.6 and 17.0 birds/km/yr; Hell et al. 2005, Gryz and Krauze 2008). Although exceptionally high annual mortality rates of up to 91 birds/km (Ashley and Robinson 1996) have been documented locally in the United States, such rates likely do not apply across most roads. Roadkill fatalities are often clustered in hotspots (e.g., Gunson et al. 2010), and these areas are often the focus of mortality studies. This tendency to focus on areas already known to experience bird mortality may have contributed positive bias to individual estimates of mortality rates and to our national mortality estimates. Nonetheless, we sought to minimize this source of bias by removing mortality rates that were identified as statistical outliers.

We were unable to assess regional variation in bird-vehicle collision mortality rates and to produce regional mortality estimates. Only 6 U.S. studies met our inclusion criteria; this sample was insufficient to allow for quantification of regional variation. Filling this data gap will require rigorous and prospective studies across a broad cross-section of the United States within numerous ecosystems, states, and regions. Individual studies that randomly sample roadkill mortality across a large spatial scale (e.g., entire states or regions) will also provide increased understanding of regional variation.

### Research Needs and Estimate Limitations

The relatively small sample of data meeting inclusion criteria resulted in substantial uncertainty in our mortality estimates. When assessing specific uncertainty contributions of individual model components, sensitivity analyses indicate that the model parameter contributing the greatest uncertainty to our estimates is the bias correction factor, which accounts for both scavenger removal and imperfect detection of carcasses. Further research on these biases may decrease the uncertainty associated with this correction factor and allow for increased precision of future mortality estimates. However, the magnitude of these biases depends on a suite of factors, including the local scavenger community, habitat type, traffic volume, and weather conditions (Santos et al. 2011, Boves and Belthoff 2012, Guinard et al. 2012, Texeira et al. 2013). Development of a



narrow distribution of bias correction factors that apply across a national scale may therefore not be possible. An alternative approach is for future studies to estimate scavenger removal and searcher detection rates to calculate adjusted mortality rate estimates. A large sample of locally adjusted mortality rates would obviate the need for post hoc correction factors (Loss et al. 2013*b*). Recent studies outline considerations for scavenger removal and detection trials (Santos et al. 2011, Teixeira et al. 2013). Of particular promise are approaches that allow for estimation of both biases using a single experimental trial incorporated into standard fatality monitoring (Smallwood 2013) or using only the dead birds found during fatality monitoring, thus removing the need for separate experimental trials (Etterson 2013).

Mortality rate probability distributions also contributed substantial uncertainty to our estimates. The relatively small sample of studies meeting inclusion criteria along with the inherently variable nature of collision rates likely contributed to this uncertainty. To increase the number of mortality rates that can be used to estimate national mortality, future studies should seek to meet the level of rigor captured by our inclusion criteria. In particular, more studies are needed that sample and present data for all bird species. When summarizing average proportional representation of collision mortality, we found that a few species (particularly barn owls and several corvids) comprise a relatively large percentage of all fatalities that have been identified to species. However, sample sizes of usable studies and available data were small, and results of the species summary were likely biased by high detection probabilities for large species and by geographical biases in sampling. Taking a more species-inclusive approach to studying bird-vehicle collisions will improve understanding of species- and taxa-specific vulnerabilities to vehicle collisions. Because of the above limitations, species proportions should not be used to draw conclusions about national-scale vulnerabilities of bird species to vehicle collisions. Nonetheless, they provide a descriptive summary of the bird species that have been documented as roadkill victims along U.S. roads.

In addition to estimate bias caused by scavenger removal and imperfect detection of carcasses, an unknown number of birds that collide with vehicles fly out of detection range (i.e., crippling bias; Slater 2002, Teixeira et al. 2013) or are destroyed or carried away by vehicles (Stewart 1973, Mumme et al. 2000). Because these biases have never been formally quantified in the context of vehicle collisions, substantial uncertainty remains about to what degree they contribute to under-estimation of roadkill mortality rates. Future research of these bias sources is necessary for fully understanding the magnitude of bird mortality caused by vehicle collisions.

Numerous biotic and abiotic factors influence bird collision mortality rates along roads. These correlates collectively result in bird fatalities being clustered along particular road segments (Clevenger et al. 2003, Smith and Dodd 2003, Glista et al. 2008, Gunson et al. 2010). Further research is needed to clarify the combination of factors that lead to carcass clustering (e.g., habitat, characteristics of the road

and its cleared corridor, and community composition and population abundance of birds) and to assess how these correlates vary seasonally and regionally. When possible, studies should employ sampling designs that allow for separation of often-confounded mortality correlates (e.g., road width, traffic volume, and traffic speed).

The negative bias contributed to mortality rate estimates by scavenger removal is amplified with increasing time intervals between surveys. This occurs because—with all other factors held constant—more collisions occur between surveys, and a greater proportion of carcasses are removed by scavengers. Because carcass removal adjustment factors are less accurate across long search intervals (Smallwood 2013) and because carcass removal rates appear to be especially high along roadways (Bruun-Schmidt 1994, Antworth et al. 2005, Santos et al. 2011, Teixeira et al. 2013), optimal search intervals for documenting roadkill mortality are very short (e.g., sampling on alternate days for large birds and daily for small birds; Santos et al. 2011). Because the search intervals in the studies we used were between 2 and 15 days, mortality rates in individual studies could have been substantially under-estimated. This under-estimation could have contributed negative bias to our mortality estimates.

In addition to using long search intervals for carcass surveys, the studies we used conducted surveys using various transportation methods, including foot, bicycle, and automobile. Because of the relatively high speed at which sampling is conducted, automobile surveys usually detect only a small fraction of carcasses (Slater 2002, Gerow et al. 2010, Guinard et al. 2012, Teixeira et al. 2013). In the sample of mortality rates extracted from studies meeting our inclusion criteria, the majority of rates (15 of 20) were based on automobile surveys, and estimated mortality rates for automobile surveys averaged 2.3 times lower than for other survey types. Therefore, the use of automobile surveys may have contributed additional under-estimation bias to our mortality estimates. The use of automobile surveys may have also influenced our species summary, with surveys likely over-representing large-bodied species (e.g., raptors and corvids) that are relatively easy to detect from a fast-moving automobile.

## MANAGEMENT IMPLICATIONS

The large magnitude of mortality caused by vehicle collisions combined with the potential for impacts at the population level highlights the need for conservation and management attention to mitigate this threat. Mitigation efforts may be most relevant at areas known to experience exceptionally high rates of collision mortality (e.g., clear examples include the studies that were identified as statistical outliers for our mortality estimate). Following identification of mortality hotspots, potential options to reduce bird collision mortality along roads include (see also Boves and Belthoff 2012, Bishop and Brogan 2013) placing flight deflectors along roadsides to force birds to fly above vehicle height (Bard et al. 2001, Ramsden 2003, Gomes et al. 2009), locally reducing speed limits and erecting signage to alert drivers, reducing or removing the amount of favorable bird habitat

along roadsides, and using visual or auditory deterrents. All of these approaches have rarely been implemented and remain largely untested. Research is therefore needed to determine which combinations of the above approaches are most effective at reducing mortality and to clarify how responses vary by bird species, region, habitat, season, and road type. Identification and implementation of effective conservation measures is especially crucial given the increasing length of U.S. roadways, increasing traffic volume, and an increasing number of direct and indirect anthropogenic threats to bird populations.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web-site.

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# Anticoagulant Rodenticide Exposure in an Urban Population of the San Joaquin Kit Fox

Stella C. McMillin, Robert C. Hosea, and Brian F. Finlayson

Pesticide Investigations Unit, California Department of Fish and Game, Rancho Cordova, California

Brian L. Cypher

Endangered Species Recovery Program, California State University–Stanislaus, Bakersfield, California

Abdou Mekebri

Water Pollution Control Laboratory, California Department of Fish and Game, Rancho Cordova, California

**Abstract:** Concerned that San Joaquin kit foxes from urban areas may be exposed to commensal anticoagulants, the California Department of Fish and Game, Pesticide Investigations Unit, in conjunction with the Endangered Species Recovery Program's Urban Kit Fox Project, began monitoring San Joaquin kit foxes from the Bakersfield, CA population. Necropsies were performed and liver tissue samples collected from kit fox carcasses. Livers from archived kit foxes dating back to 1977 were also analyzed. A non-urban population of San Joaquin kit foxes from Lokern was used as a control. Other predators in the area, including coyotes and red foxes, were also analyzed for comparison. Between 1999 and 2007, tissue samples from 45 animals have been analyzed for residues of anticoagulant rodenticides. Anticoagulant compounds identified included brodifacoum, bromadiolone, pival, and chlorophacinone. Twenty-six of the 30 San Joaquin kit foxes from Bakersfield contained at least one anticoagulant, and the most commonly detected anticoagulant was brodifacoum. None of the 12 Lokern San Joaquin kit foxes contained anticoagulants. Other predators followed the same pattern: both red foxes from Bakersfield contained anticoagulant residues, but the coyote taken from Lokern did not.

**Key Words:** anticoagulants, brodifacoum, bromadiolone, chlorophacinone, diphacinone, kit fox, pival, rodenticide, *Vulpes macrotis*

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## INTRODUCTION

Monitoring by the California Department of Fish and Game (DFG) Pesticide Investigations Unit has shown that a number of predatory avian and mammalian species that inhabit the urban landscape have been exposed to anticoagulant rodenticides, presumably as a result of secondary exposure (Hosea 2000). Species that had residues of anticoagulants were coyote *Canis latrans*, gray fox *Urocyon cinereoargenteus*, San Joaquin kit fox *Vulpes macrotis mutica*, raccoon *Procyon lotor*, fox squirrel *Sciurus niger*, bobcat *Lynx rufus*, red fox *Vulpes vulpes*, mountain lion *Felis concolor*, Heermann's kangaroo rat *Dipodomys heermanni*, golden eagle *Aquila chrysaetos*, great horned owl *Bubo virginianus*, barn owl *Tyto alba*, red-shouldered hawk *Buteo lineatus*, red-tailed hawk *Buteo jamaicensis*, Cooper's hawk *Accipiter cooperii*, turkey vulture *Cathartes aura*, and wild turkey *Meleagris gallopavo*. The most frequently detected anticoagulant was brodifacoum. Anticoagulant rodenticides vary in terms of persistence in tissues, and brodifacoum, difethialone, and bromadiolone (second-generation anticoagulants) are the most persistent. In addition, as the second-generation anticoagulants may require several days to cause mortality, there is opportunity for rodents to ingest several doses and be available for predation while carrying high concentrations of anticoagulants.

A population of San Joaquin kit foxes *V. m. mutica* inhabits part of the City of Bakersfield in Kern County, California. This subspecies is currently federally listed as endangered and by the State of California as threatened. The proximity of this predator population to the urban environment puts kit foxes at elevated risk for secondary

exposure to rodenticides used by homeowners and businesses. This urban population contributes to conservation and recovery efforts by contributing to the genetic diversity of the subspecies and serving as a source population for reintroduction efforts.

## METHODS

San Joaquin kit fox carcasses were recovered by the Endangered Species Recovery Program (ESRP; California State University–Stanislaus) in an ongoing monitoring effort dating back to 1977. Approximately 10-20 carcasses were recovered per year from both urban (Bakersfield) and non-urban (Lokern) areas. The Lokern Natural Area is 40,000 acres of high-quality habitat located approximately 30 miles west of Bakersfield. The land is managed by a number of owners, including the California Department of Fish and Game and the Bureau of Land Management. The management objective is to maintain a functioning desert ecosystem for a number of sensitive species, including Kern mallow *Eremalche kernensis*, giant kangaroo rat *Dipodomys ingens*, Tipton kangaroo rat *Dipodomys nitratooides nitratooides*, San Joaquin antelope squirrel *Ammospermophilus nelsoni*, blunt-nosed leopard lizard *Gambelia sila*, and San Joaquin kit fox. Thirty San Joaquin kit fox liver samples from Bakersfield and 12 Lokern liver samples were analyzed. Two liver samples from red foxes recovered from Bakersfield, and one from a coyote recovered from Lokern, were also analyzed.

Liver tissue was homogenized by the DFG Pesticide Investigations Unit in Rancho Cordova, CA, and analyzed by DFG Water Pollution Control Laboratory in Rancho Cordova, CA, using high performance liquid chromatog-



**Table 1. Anticoagulant residues in San Joaquin kit fox livers collected in Lokern (in ng/g fresh weight). ND = not detected.**

Individual	Brodifacoum	Bromadiolone	Chlorophacinone	Diphacinone	Warfarin	Pival
1	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND
6	ND	ND	ND	ND	ND	ND
7	ND	ND	ND	ND	ND	ND
8	ND	ND	ND	ND	ND	ND
9	ND	ND	ND	ND	ND	ND
10	ND	ND	ND	ND	ND	ND
11	ND <sup>1</sup>	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
12	ND <sup>1</sup>	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
Detection limit	0.2	0.2	2	2	1	2

<sup>1</sup>Detection limit = 7 ng/g, fresh weight.<sup>2</sup>Detection limit = 50 ng/g, fresh weight**Table 2. Anticoagulant residues in San Joaquin kit fox livers collected in Bakersfield (in ng/g fresh weight). ND = not detected.**

Individual	Brodifacoum	Bromadiolone	Chlorophacinone	Diphacinone	Warfarin	Pival
1	ND	13.3	ND	ND	ND	ND
2	0.678	ND	ND	ND	ND	ND
3	0.466	2.18	ND	ND	ND	ND
4	0.2	ND	ND	ND	ND	ND
5	0.2	1.17	ND	ND	ND	ND
6	1703	770	246	ND	ND	ND
7	ND	ND	ND	ND	ND	ND
8	66.4	3123	ND	ND	ND	ND
9	9855	131	ND	ND	ND	ND
10	5662	786	ND	ND	ND	ND
11	1248	902	ND	ND	ND	ND
12	4138	304	ND	ND	ND	ND
13	2818	79.2	ND	ND	ND	ND
14	2642	2477	ND	ND	ND	ND
15	8648	148	ND	ND	ND	ND
16	132	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
17	161	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
18	ND <sup>1</sup>	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
19	191	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	6.93
20	122	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
21	706	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
22	381	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
23	19	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
24	ND <sup>1</sup>	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
25	296	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
26	9	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
27	91	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
28	373	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
29	130	140	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
30	11,000	ND <sup>1</sup>	ND <sup>2</sup>	ND <sup>2</sup>	ND <sup>1</sup>	ND <sup>2</sup>
Detection limit	0.2	0.2	2	2	1	2

<sup>1</sup>Detection limit = 7 ng/g, fresh weight.<sup>2</sup>Detection limit = 50 ng/g, fresh weight

**Table 3. Anticoagulant residues in other predator livers collected in Bakersfield and Lokern (in ng/g fresh weight).**

Species	Location	Brodifacoum	Bromadiolone	Chlorophacinone	Diphacinone	Warfarin	Pival
Red fox	Bakersfield	3667	67.9	ND	ND	ND	ND
Red fox	Bakersfield	838	974	ND	ND	ND	ND
Coyote	Lokern	ND	ND	ND	ND	ND	ND
Detection limit		0.2	0.2	2	2	1	2

raphy with mass spectrometry analysis. Anticoagulants analyzed were brodifacoum, bromadiolone, chlorophacinone, diphacinone, pival, and warfarin. Detection limits varied among anticoagulants with generally lower detection levels in the later analyses as laboratory methods were refined (Table 1).

## RESULTS

San Joaquin kit fox livers taken from Lokern contained no residues of anticoagulants (Table 1). Of the 30 livers tested from Bakersfield, 26 (87%) contained residues of brodifacoum, 13 (43%) contained residues of bromadiolone, one contained a residue of chlorophacinone, and one contained a residue of pival (Table 2). Anticoagulant residues, expressed as fresh weight, were as high as 11,000 ng/g for brodifacoum (mean of 1,960 ng/g for all samples with detections), 3,123 for bromadiolone (mean of 661 ng/g for all samples with detections), 246 ng/g for chlorophacinone, and 6.93 ng/g for pival. Livers of two red foxes *V. vulpes* from Bakersfield were also analyzed and both contained both brodifacoum and bromadiolone (Table 3). A coyote liver from Lokern contained no anticoagulant residues (Table 3).

## DISCUSSION

Results from this study confirmed that San Joaquin kit foxes are exposed to anticoagulants in urban environments. Eighty-seven percent of San Joaquin kit foxes in Bakersfield had been exposed to anticoagulant rodenticides, compared to none taken at the control site. The most commonly detected rodenticides, brodifacoum and bromadiolone, are registered for use only against commensal rodents. This suggests that commensal rodents are likely the source of secondary exposure for San Joaquin kit foxes. Further study on the predation habits of San Joaquin kit foxes would be helpful to determine route of exposure.

There was a single detection of pival, a first-generation anticoagulant rodenticide. The detection was in a fox that died in 2002, when all registrations for pival had been inactive for a decade or more. This product is less persistent in animal tissues than the second-generation anticoagulants, making secondary poisoning less likely. It is possible that this exposure was due to a improper disposal of an old product.

It has been noted that the lower detection limits for second-generation anticoagulant rodenticides than for the first-generation products could partially explain the greater number of detections of the newer products. However, the data in this study do not support this, as the majority of detections of the second-generation products were well above the higher detection limits used for the older products. A total of 22 out of 26 detections for brodifacoum and 12 out of 13 detections for bromadiolone were above

2 ng/g (the detection limit for first-generation anticoagulants).

The U.S. Environmental Protection Agency issued a risk mitigation decision for 9 rodenticides in May 2008. This decision will prohibit the sale of second-generation anticoagulants to homeowners, beginning in 2011. There will be a need to continue sampling to determine the effectiveness of the regulation change in reducing exposure of San Joaquin kit foxes and other predators. This is particularly true, as it is not known whether misuse or proper use of these products has resulted in secondary exposure. It will also be important to monitor first-generation anticoagulant rodenticides, as the regulations will likely result in a more frequent use of the older products by homeowners.

The consequences of anticoagulant exposure to predators are not fully known. It is likely that impairment of normal clotting factors makes animals more susceptible to excessive bleeding from minor injuries. Several studies also indicate that sub-lethal concentrations of second-generation anticoagulants may cause mortality to embryos (Laas et al. 1985, Godfrey and Lyman 1980, Munday and Thompson 2003). Population impacts that jeopardize recovery efforts of San Joaquin kit foxes may occur as a result of widespread anticoagulant exposure.

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Using Circuit Theory to Model Connectivity in Ecology, Evolution, and Conservation

Author(s): Brad H. McRae, Brett G. Dickson, Timothy H. Keitt and Viral B. Shah

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# CONCEPTS & SYNTHESIS

EMPHASIZING NEW IDEAS TO STIMULATE RESEARCH IN ECOLOGY

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## USING CIRCUIT THEORY TO MODEL CONNECTIVITY IN ECOLOGY, EVOLUTION, AND CONSERVATION

BRAD H. MCRAE,<sup>1,5</sup> BRETT G. DICKSON,<sup>2</sup> TIMOTHY H. KEITT,<sup>3</sup> AND VIRAL B. SHAH<sup>4</sup>

<sup>1</sup>National Center for Ecological Analysis and Synthesis, Santa Barbara, California 93101 USA

<sup>2</sup>Center for Environmental Sciences and Education, Northern Arizona University, Flagstaff, Arizona 86011 USA

<sup>3</sup>Section of Integrative Biology, University of Texas at Austin, Austin, Texas 78712 USA

<sup>4</sup>Department of Computer Science, University of California, Santa Barbara, California 93106 USA

**Abstract.** Connectivity among populations and habitats is important for a wide range of ecological processes. Understanding, preserving, and restoring connectivity in complex landscapes requires connectivity models and metrics that are reliable, efficient, and process based. We introduce a new class of ecological connectivity models based in electrical circuit theory. Although they have been applied in other disciplines, circuit-theoretic connectivity models are new to ecology. They offer distinct advantages over common analytic connectivity models, including a theoretical basis in random walk theory and an ability to evaluate contributions of multiple dispersal pathways. Resistance, current, and voltage calculated across graphs or raster grids can be related to ecological processes (such as individual movement and gene flow) that occur across large population networks or landscapes. Efficient algorithms can quickly solve networks with millions of nodes, or landscapes with millions of raster cells. Here we review basic circuit theory, discuss relationships between circuit and random walk theories, and describe applications in ecology, evolution, and conservation. We provide examples of how circuit models can be used to predict movement patterns and fates of random walkers in complex landscapes and to identify important habitat patches and movement corridors for conservation planning.

**Key words:** circuit theory; dispersal; effective distance; gene flow; graph theory; habitat fragmentation; isolation; landscape connectivity; metapopulation theory; reserve design.

CONCEPTS & SYNTHESIS

### INTRODUCTION

Connectivity among habitats and populations is considered a critical factor determining a wide range of ecological phenomena, including gene flow, metapopulation dynamics, demographic rescue, seed dispersal, infectious disease spread, range expansion, exotic invasion, population persistence, and maintenance of biodiversity (Kareiva and Wennergren 1995, Ricketts 2001, Moilanen and Nieminen 2002, Calabrese and Fagan 2004, Moilanen et al. 2005, Crooks and Sanjayan 2006, Damschen et al. 2006, Fagan and Calabrese 2006). Preserving and restoring connectivity has become a major conservation priority, and conservation organi-

zations are investing considerable resources to achieve these goals (Beier et al. 2006, Kareiva 2006).

Understanding broad-scale ecological processes that depend on connectivity, and making effective conservation planning decisions to conserve them, requires quantifying how connectivity is affected by landscape features. Thus, there is a need for efficient and reliable tools that relate landscape composition and pattern to connectivity for ecological processes. Many ways of predicting connectivity using landscape data have been developed (reviewed by Tischendorf and Fahrig 2000*a, b*, Moilanen and Nieminen 2002, Calabrese and Fagan 2004, Fagan and Calabrese 2006). Common approaches include the derivation of landscape pattern indices (e.g., Schumaker 1996), individual-based movement simulations (e.g., Schumaker 1998, Hargrove et al. 2005), and analytic measures of network connectivity, such as graph theory and least-cost path models (Keitt et al. 1997, Urban and Keitt 2001, Adriaensen et al. 2003, Minor and Urban 2007). The latter have gained increasing attention in recent years and are widely

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<sup>5</sup>Present address: The Nature Conservancy, 1917 1st Avenue, Seattle, Washington 98101 USA.  
E-mail: McRae@nceas.ucsb.edu

applied in connectivity modeling and in conservation planning.

We propose that connectivity models from electrical circuit theory can make a useful addition to the approaches available to ecologists and conservation planners. Circuit theory has been applied to connectivity analyses in chemical, neural, economic, and social networks, and has recently been used to model gene flow in heterogeneous landscapes (McRae 2006, McRae and Beier 2007). The same properties that make circuit theory useful in these fields hold promise for ecology and conservation as well. Because connectivity increases with multiple pathways in circuit networks, distance metrics based on electrical connectivity are applicable to processes that respond positively to increasing connections and redundancy. Additionally, previous work has shown that current, voltage, and resistance in electrical circuits all have precise relationships with random walks (Doyle and Snell 1984, Chandra et al. 1997). These relationships mean that circuit theory can be related to movement ecology via random-walk theory, providing concrete ecological interpretations of circuit-theoretic parameters and predictions. Finally, because algorithms to implement circuit models are well developed, they can be applied to large networks and raster grids.

Here we present several ways in which circuit theory can be used to model connectivity in ecology and conservation. We describe ecological applications of previously developed theory relating resistance, current, and voltage in electronic circuits to random walks on analogous graphs (Doyle and Snell 1984, Klein and Randic 1993, Chandra et al. 1997). This theory can be applied to predict movement patterns and probabilities of successful dispersal or mortality of random walkers moving across complex landscapes, to generate measures of connectivity or isolation of habitat patches, populations, or protected areas, and to identify important connective elements (e.g., corridors) for conservation planning. Our approach does not require new ways of representing landscape data; rather, it takes advantage of graph-theoretic data structures, which are already familiar to many ecologists, and can be applied in traditional graph-theoretic or raster GIS frameworks. Coupled with applications of circuit theory to predict equilibrium patterns of gene flow (McRae 2006, McRae and Beier 2007), these new applications comprise a modeling framework that integrates spatial aspects of ecology, evolution, and conservation.

BASIC CONCEPTS

Graph data structures and terminology

Connectivity models from circuit theory are applied to *graphs* (Harary 1969), so we will use the terminology of graph theory here (see Urban and Keitt 2001 for a review). Briefly, graphs are networks comprised of sets of *nodes* (connection points which represent, e.g., habitat patches, populations, or cells in a raster landscape) connected by *edges* (Fig. 1). Edges reflect functional

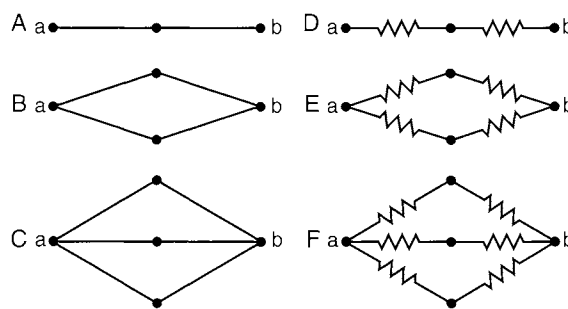


FIG. 1. Three graphs at left (A, B, C), with edge weights of 1. Traditional shortest path or geodesic distance,  $d$ , between nodes a and b is identical ( $d = 2$ ) all three cases. At right (D, E, F), edges have been replaced with unit resistors to create analogous circuits. Effective resistance,  $\hat{R}$ , measured between nodes a and b decreases from top to bottom ( $\hat{R} = 2, 1,$  and  $2/3$ , respectively), reflecting additional contributions from multiple pathways (figure modified from Klein and Randic [1993]).

connections, such as dispersal, between nodes. The *weight* of each edge typically corresponds to the strength of the connection (e.g., the ease of movement or number of dispersers exchanged) between the nodes it connects.

Circuit theory

In this paper, circuits are defined as networks of nodes connected by *resistors* (electrical components that conduct current) and are used to represent and analyze graphs (Fig. 1). The basic concepts of resistance, conductance, current, and voltage all apply, and their definitions and ecological interpretations are summarized in Table 1. Recall Ohm's law, which states that when a voltage  $V$  is applied across a resistor, the amount of current  $I$  that flows through the resistor depends on (1) the voltage applied and (2) the resistance  $R$ , such that  $I = V/R$ . The lower the resistance (or the higher the conductance,  $G$ , which is simply the reciprocal of resistance), the greater the current flow per unit voltage. Similarly, when a voltage is applied across two nodes in a resistive circuit (e.g., between nodes a and b in the circuits shown in Fig. 1), the total amount of current that flows across the circuit is determined by (1) the voltage applied and (2) the configuration and the resistances of the resistors the circuit contains. The *effective resistance* ( $\hat{R}$ ) between the nodes is the resistance of a single resistor that would conduct the same amount of current per unit voltage applied between the nodes as would the circuit itself, i.e.,  $\hat{R} = V/I$ .

In simple circuits, such as those shown in Fig. 1, effective resistance can be calculated using some basic rules. First, two resistors connected in series may be replaced by a single resistor with a resistance is that the sum of the two resistances. Thus, the effective resistance in the top circuit in Fig. 1D would be  $\hat{R} = R_1 + R_2 = 2$  ohms. Conversely, connecting resistors in parallel decreases their effective resistance, such that they may be replaced by a single resistor whose conductance is

TABLE 1. Electrical terms and their ecological interpretations.

Electrical term (symbol, unit)	Ecological interpretation
Resistance ( $R$ , ohm), the opposition that a resistor offers to the flow of electrical current.	Opposition of a habitat type to movement of organisms, similar to ecological concepts of landscape resistance or friction. Graph edges or grid cells allowing less movement are assigned higher resistance.
Conductance ( $G$ , siemens), inverse of resistance and a measure of a resistor's ability to carry electrical current.	Analogous to habitat permeability. In random-walk applications, it is directly related to the likelihood of a walker choosing to move through a cell or along a graph edge relative to others available to it. In population genetic applications (see McRae 2006), it is a measure of migrants exchanged between neighboring populations.
Effective resistance ( $\hat{R}$ , ohm), the resistance to current flow between two nodes separated by a network of resistors.	Also known as the <i>resistance distance</i> , a measure of isolation between pairs of nodes on a graph or cells on a raster grid. Similar to ecological concept of effective distance, but it incorporates multiple pathways (Fig. 1D–F). It scales linearly with equilibrium genetic differentiation in population genetic applications.
Effective conductance ( $\hat{G}$ , siemens), inverse of effective resistance, a measure of a network's ability to carry current between two nodes.	A measure of connectivity between pairs of nodes on a graph or cells on a raster grid. It increases with additional available pathways and scales linearly with effective migration in population genetic applications.
Current ( $I$ , ampere), flow of charge through a node or resistor in a circuit.	Current through nodes or resistors can be used to predict expected net movement probabilities for random walkers moving through corresponding graph nodes or edges (Fig. 2).
Voltage ( $V$ , volt), the potential difference in electrical charge between two nodes in an electrical circuit. Related to current and resistance by $V = IR$ .	Voltages can be used to predict the probability that random walkers leaving any point on a graph will reach a given destination (representing, e.g., successful dispersal) before another (representing, e.g., mortality; Fig. 3).

given by the sum of the conductances of the two resistors, that is,  $\hat{G} = G_1 + G_2$ . (In terms of resistance, these quantities are given by:  $\hat{R} = R_1 R_2 / [R_1 + R_2]$ .) Applying these equations to the circuits shown in Fig. 1, the effective resistance declines from the top to the bottom circuit.

Applying circuit theory to graphs involves preserving the same graph structure with interconnected nodes, but replacing graph edges with resistors, as in Fig. 1. The conductance of each resistor is typically a function of the corresponding edge weight or probability of movement between the pair of nodes it connects. The resistance of a resistor is the reciprocal of its conductance and can be thought of as representing isolation or movement cost between nodes.

#### INTERPRETATION OF RESISTANCE, CURRENT, AND VOLTAGE

##### *Resistance and conductance*

The simplest connectivity measure from circuit theory is the *resistance distance* (Klein and Randić 1993), a distance metric defined as the effective resistance between a pair of nodes when all graph edges are replaced by analogous resistors (as in Fig. 1D–F). A convenient property of the resistance distance is that it incorporates multiple pathways connecting nodes, with resistance distances measured between node pairs decreasing as more connections are added. Hence, the resistance distance does not reflect the distance traveled or movement cost accrued by a single individual. Rather, it incorporates both the minimum movement distance or cost and the availability of alternative pathways. As additional links are added, individuals do not necessarily travel shorter paths, but have more pathways available to them. For example, in the three

graphs in Fig. 1A–C, the minimum distance required to travel from node a to b (called geodesic distance in graph theory) is the same. However, the resistance distance decreases as more connections are added, reflecting increased flow capacities and levels of redundancy. In short, the resistance distance is small when two nodes are connected by many paths with low resistance (high conductance) edges and large when there are few paths with high resistance. Resistance distances can be calculated across irregular networks or with continuous landscape data, which are typically represented as discretized lattices or grids. On continuous surfaces, the resistance distance increases linearly with Euclidean distance in homogeneous one-dimensional habitats and with its log transformation in two-dimensional habitats, a property important for modeling gene flow (McRae 2006).

Resistance distances can also be related to random-walk times between nodes. For the theory and examples that follow, we assume that conductances are chosen so that the probability of moving from a node along any given edge is equal to the conductance assigned to the edge divided by the sum of the conductances of all edges connected to the node. For an organism moving through a habitat network (the main focus of this paper), this would correspond to a scenario where the individual chooses to move along an edge in proportion to the edge's conductance, a surrogate for habitat quality or (inverse) perceived risk, relative to the quality of all other choices of direction; this choice is then repeated at each subsequent step. For genes moving across a network of populations over many generations, this would correspond to a scenario where edge conductances correspond to per-generation migration rates (McRae 2006).



Chandra et al. (1997) showed that, when resistors are parameterized in this way, the resistance distance between a pair of nodes is precisely related to the *commute time* between the nodes, i.e., the expected time for a random walker to move from one node to the other and back again. The commute time between any pair of nodes  $u$  and  $v$  can be calculated using the following formula:

$$\text{Commute time} = \hat{R}_{uv} \sum_{x=1}^n \sum_{y=1}^n (1/R_{xy}) \quad (1)$$

where  $R_{xy}$  is the resistance of the resistor connecting nodes  $x$  and  $y$  and  $n$  is the number of nodes in the network. Note that Eq. 1 accommodates resistors connecting a node to itself, which would reflect a nonzero probability of staying at the node for any time step. Chandra et al. (1997) also provided formulas to calculate a commute *cost*, if there is a cost imposed for each step that is independent of the resistance (and thus independent of the behavior of a random walker). An interesting result of Eq. 1 is that if the goal is to minimize commute times between a pair of nodes, there is a penalty for adding connections which is offset by the degree to which the new connections help to lower effective resistance between the two nodes. Within a fixed network, commute times between different pairs of nodes will be directly proportional to the effective resistances measured between them. Another potentially useful way to apply resistance calculations across graphs is to compute upper and lower bounds for the *cover time*, or the expected number of steps of a random walk visiting all nodes in the graph (Chandra et al. 1997).

*“Functional” or “effective” distance.*—Used as an ecological distance metric, the resistance distance provides a conceptual complement to commonly used least-cost distances in two important ways. First, it integrates all possible pathways into distance calculations, whereas least-cost distances are measured along a single optimal pathway. Second, it offers a measure of isolation assuming a random walk, whereas least-cost distances presumably reflect the route of choice if a disperser has complete knowledge of the landscape it is traversing.

The resistance distance also provides a quantitative complement to least-cost distances. If only a single pathway between two nodes is available (e.g., in Fig. 1A or in any graph that is a tree), the resistance distance will equal the least-cost distance. On the other hand, when two identical and independent pathways connect a pair of nodes in parallel, the resistance distance will be half the least-cost distance. This suggests an interpretation of the resistance distance as an indicator of redundancy in connections relative to the least-cost distance:

$$\text{Redundancy} = (\text{least-cost distance})/(\hat{R}).$$

Thus, the two measures can be compared directly, their

ratio providing a rough measure of parallel pathways available to dispersers.

The relationship between resistance distances and commute times is one way to link circuit and ecological theories and is the basis of using resistance distances to predict patterns of gene flow and genetic structuring in heterogeneous landscapes (McRae 2006). Calculating commute times directly may provide valuable additional information because commute times take into account how efficiently a given landscape configuration will channel dispersal between source and destination nodes. Additional pathways that primarily result in increased wandering behavior rather than directed movement may reduce resistance distances but will increase commute times. Low commute times and low resistance distances between pairs of nodes indicate that dispersers will be efficiently directed between them.

### Current

Currents in circuits can also be interpreted in terms of random walks on corresponding graphs. Consider again a graph in which the probability that a random walker will move from a node along any graph edge is proportional to its conductance. Doyle and Snell (1984) showed that when 1 A (ampere) of current is injected into one node (node a in Fig. 2A) and a second node (node e) is tied to ground, the current  $i_{xy}$  flowing through the resistor connecting any pair of nodes  $x$  and  $y$  is equivalent to the expected net number of times that a random walker, starting at a and walking until it reaches e, will move along that branch. Because we are tallying net passages through the branch, movements from  $x$  to  $y$  are counted as positive, whereas movements from  $y$  back to  $x$  are counted as negative.

*Corridor identification and dispersal predictions.*—By predicting net movement probabilities along branches or through nodes, current density can be used to identify landscape corridors or “pinch points,” i.e., features through which dispersers have a high likelihood (or necessity) of passing. High current through a node or branch indicates that removing or converting it will have a high impact on connectivity. In Fig. 2, all the current passes through node b; removing that node (or the link between nodes a and b) would completely disconnect nodes a and e, whereas removing node c, through which only half the current passes, would reduce redundancy but would still leave nodes a and e connected via the lower branch. In graph terminology, node b is a *cutnode*, and the resistor connected nodes a and b is a *cutlink*.

### Voltage

Doyle and Snell (1984) also showed that voltage can be related to random walk probabilities. Consider a graph in which a voltage source set to 1 V is connected to one node (or to a set of nodes), and another node (or set of nodes) is connected to ground (Fig. 3). The voltage measured at any remaining node on the graph will equal the probability that a random walker, starting at that

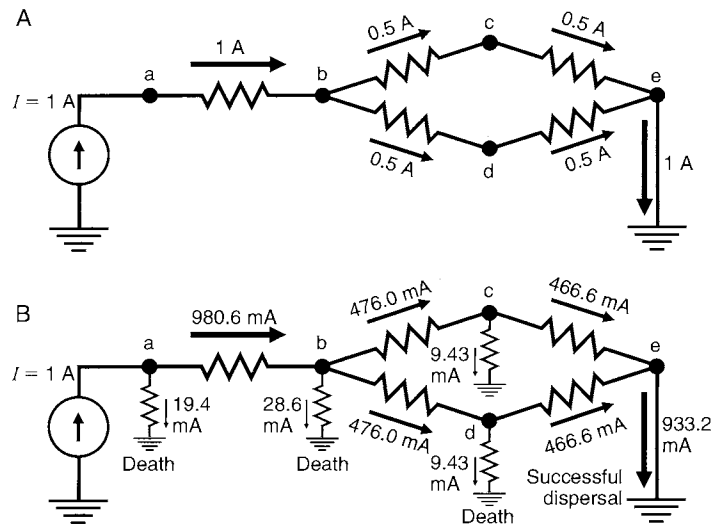


FIG. 2. (A) A simple circuit, with a 1-A (ampere) current source ( $I$ ) placed at node a, and with node e tied to ground. Branch currents that would be observed with unit resistors are shown and reflect the net number of times that a random walker, starting at node a, is expected to pass along each branch before reaching node e. All random walkers must pass across the first branch, but half would be expected to take the upper pathway, and half the lower. Resistances connecting nodes were set to 1 ohm for this simple example; the methods we describe here can accommodate heterogeneous resistances with values from 0 to infinity. (B) The same circuit as in (A), but with ground resistors added to reflect a 1% probability of mortality as the random walker passes through each node. To achieve this, resistances to ground for nodes a–d were set to 99, 33, 49.5, and 49.5 ohms, respectively. Currents show the expected number of net movements along each branch, as well as the expected number of deaths at each node. For example, the proportion of dispersers leaving node a expected to successfully reach node e is 0.9332 (933.2 mA equivalent). Deaths at each node exceed 1% because nodes are visited multiple times by random walkers, with the highest numbers of deaths observed in nodes with the highest numbers of visits. Only one possible dispersal destination was included here, but the method can accommodate as many dispersal destinations as desired. Although we tied the destination node directly to ground, resistors could be added between destination nodes and ground, with their conductances set to reflect a finite probability that a walker would settle rather than continue walking once reaching a node.

node, will reach any of the nodes set to 1 V before reaching any node connected to ground. The most obvious application of this property is to predict the probability of successful dispersal via a random walk from any node on a graph. Suitable destination patches for dispersal can be set to 1 V, whereas mortality can be represented by resistors connected to ground, with their conductances reflecting probabilities of mortality (Fig. 3).

#### APPLYING CIRCUIT ANALYSES TO RASTER GRIDS

Predicting connectivity using circuit theory requires translating spatial data sets into a graph structure, but that doesn't mean that primary landscape data must be in a patch-based or network-style format. In fact, we envision most landscape applications operating on raster data, with a graph extracted from these data as is done for least-cost path analyses (Adriaensen et al. 2003). Since well-developed computer algorithms allow millions of cells to be processed, large raster landscapes can be accommodated.

Analyzing a raster grid involves first assigning resistances to different habitat types in the grid. Fig. 4 shows a simple example with three different habitat types: assigned unit, infinite, and zero resistance. The last is useful when practitioners wish to measure connectivity or identify important connective elements between areas (representing, for example, habitat

patches or reserves), rather than points on a landscape. To represent a grid as a circuit, cells with finite resistances are converted to nodes (gray), whereas cells with infinite resistance (i.e., those representing complete barriers, black) are dropped. Adjacent nodes are connected by resistors, with resistances reflecting a function (typically the mean) of the resistances of the cells they connect. Adjacent cells with zero resistance (open) are consolidated into a single node that is then connected by resistors to all nodes adjacent to the zero-resistance patch. Following this procedure, the 16-cell

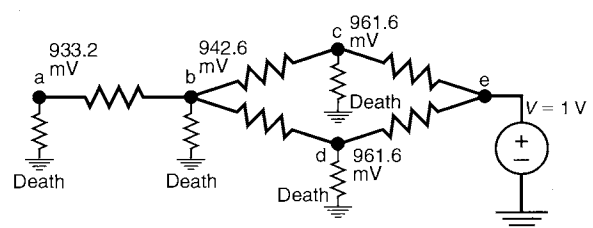


FIG. 3. The same circuit shown in Fig. 2B, but with a voltage source ( $V$ ) of one volt at node e instead of a current source at node a. Node voltages reflect the probability that a random walker, starting at each node, will successfully reach node e. Consistent with the result from Fig. 2B, the probability of successful dispersal from node a to node e is 0.9332.

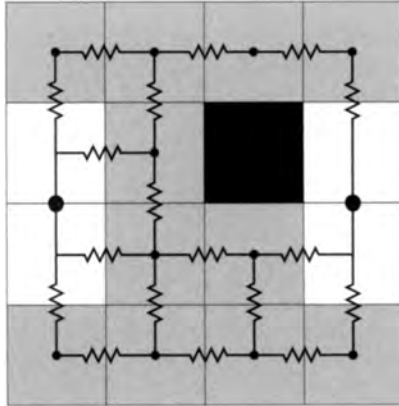


FIG. 4. A simple landscape represented as both a grid and a circuit. The landscape contains two contiguous patches of 0-resistance cells (open), dispersal habitat of finite resistance (gray), and one “barrier” cell with infinite resistance (black). Cells with finite resistance are replaced with nodes (small dots), and adjacent nodes are connected by resistors. Patches of cells with 0 resistance are each consolidated into a single node (large dots). Connections between diagonal neighbors and nonadjacent cells can also be incorporated, the latter representing “hops” over intervening cells. Current sources, voltage sources, and ground connections can be added as in Figs. 2 and 3.

grid in Fig. 4 is now represented as a circuit with 13 nodes and 18 resistors.

#### COMPUTATION

Although simple circuits can be solved by hand, *nodal analysis* is typically used to analyze larger circuits, such as those derived from raster grids (McRae 2006). Given a circuit with current or voltage sources, nodal analysis uses Kirchoff’s and Ohm’s laws in matrix form to solve for a vector, specifying voltages at each node; once these are known, Ohm’s law can be used to calculate currents passing through individual resistors or nodes. Effective resistance between a pair of nodes is given by the voltage between them when one is connected to a 1-A current source and the other is connected to ground (e.g., Fig. 2A). The method is described in standard circuit theory textbooks (e.g., Dorf and Svoboda 2003); an example of its use to calculate effective resistances is provided by McRae (2006).

Computer languages used for scientific computing such as Java, C, MATLAB, and Python include linear solver routines that can solve for effective resistances on graphs. Fast graph operations can be used to define connected components in a landscape and discard from a graph any components that are completely isolated. Very large graphs can be processed relatively easily and efficiently; we have solved for effective resistances, voltages, and current on landscapes containing over 1 million cells using Java (Sun Microsystems, Mountain View, California, USA), and up to 48 million cells using a parallel version of MATLAB (MathWorks, Natick, Massachusetts, USA) implemented using Star-P (Interactive Supercomputing, Waltham, Massachusetts, USA). Solving 1 million cells on a notebook computer

with a 2-GHz processor and 2 GB of RAM took us 16 minutes using Java and only 20 seconds using MATLAB. This calculation must be repeated for each configuration of current sources and grounds, but typical connectivity applications will require a small number of calculations (e.g., for each pair of populations or reserves between which connectivity is to be modeled). Calculations between multiple pairs can be sped up considerably using matrix preconditioning and/or parallel processing. Software implementing many of the algorithms in this manuscript is available (B. H. McRae, *unpublished data*).

#### EXAMPLE APPLICATIONS TO HETEROGENEOUS LANDSCAPES

Here we provide examples of the applications described above to predict connectivity and movement of random walkers across large raster grids. For the example analyses described next, we solved for effective resistances and node currents using code written in MATLAB R2007b. The example landscapes (i.e., resistance surfaces) were all created using ArcView GIS 3.2 (ESRI, Redlands, California, USA) and exported as ASCII raster grids, with cell values corresponding to resistances ranging from 0 to infinity (Fig. 5). For circuit analyses, cells with finite resistances were converted to nodes, whereas those with infinite resistances were dropped. Cells were connected to their eight neighbors such that the resistance between a pair of first-order neighbors was set to the mean of the two cells’ resistances, and the resistance between a pair of second-order (diagonal) neighbors was set to the mean resistance multiplied by the square root of 2 to reflect the

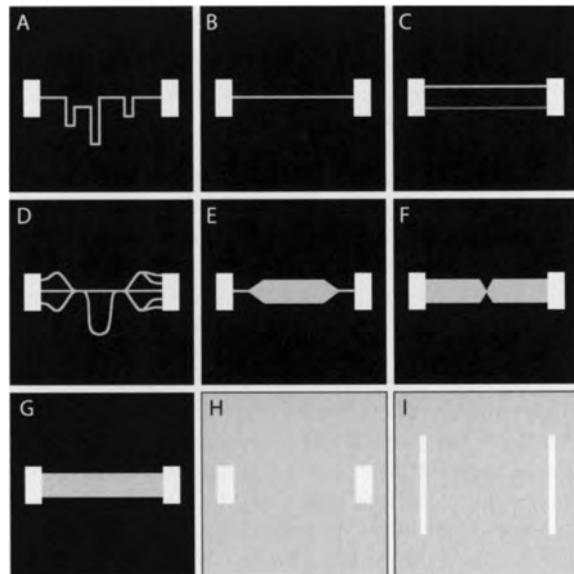


FIG. 5. Nine simple raster landscapes (A–I), consisting of  $1000 \times 1000$  cells. Habitat patches (shown in white and assigned 0 resistance, or infinite conductance) are connected by different configurations of dispersal habitat (light gray, 10 ohms/cell; dark gray [lower corridor in panel C], 20 ohms/cell; black = infinite resistance or 0 conductance).

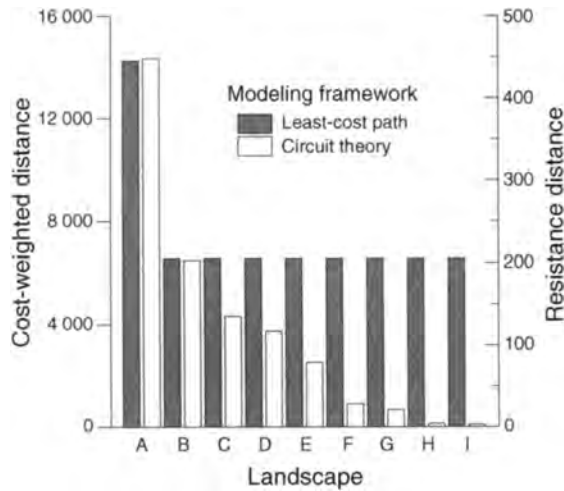


FIG. 6. Least-cost distances and resistance distances between habitat patches for the nine simple landscapes shown in Fig. 5. Least-cost distances decrease from (A) to (B) but are equivalent for all remaining maps. Effective resistances decrease not only from (A) to (B), but also from (B) to (I), reflecting the availability of more and wider pathways. Redundancy, defined here as the ratio of least-cost distance to effective resistance, would be roughly equal for cases (A) and (B) but would increase from (B) to (I). Cost-weighted distance (measured in cost units) were calculated using PATHMATRIX software. Resistance distances (measured in ohms) were calculated using Circuitscape software.

greater distance between cell centers. We converted individual cells to single nodes, except for cells in areas of zero resistance, i.e., open source/target patches; as in the simple landscape in Fig. 4, these cells were considered collectively and consolidated into a single node for the analyses. For all examples, we used the same resistance surfaces to calculate least-cost distances and map least-cost corridors using PATHMATRIX software (Ray 2005).

We started with nine simple landscapes (Fig. 5) meant to illustrate different properties of circuit models. The landscapes consisted of  $1000 \times 1000$  cells each and contained two primary habitat patches, which were always the same distance from one another and always occupied the same total area. Least-cost and resistance distances calculated between habitat patches in the nine simple landscapes illustrate some advantages of the resistance distance (Fig. 6). Although least-cost distances correctly identify decreased isolation between habitat patches in landscape B relative to A, they were identical in landscapes B through I. Resistance distances show a similar decrease from landscape A to B, but they also decrease from B to I, reflecting the availability of additional, or wider, pathways. Note that between landscapes H and I, only the shape of the primary habitat patches has changed, and not their area or the distance separating them. Yet the resistance distance differs because the greater surface area of each habitat patch in landscape I acts as a “drift fence” to better intercept or release dispersers.

Commute times ranged from 1.2 million steps (landscapes B, C, and G) to 6.2 million steps (landscape A). They were intermediate for landscapes D, E, F, H, and I, which had commute times of 2.6, 3.0, 1.6, 2.7, and 2.0 million steps, respectively. Lower commute times reflect configurations in which dispersers are efficiently channeled between habitat patch pairs, minimizing wandering time.

These same simple landscapes also demonstrate how current maps (Fig. 7) can highlight connective elements in raster maps (Fig. 7) can highlight connective elements in raster maps. As the availability of multiple pathways increases, current density—indicating cells through which dispersers are likely to pass moving from one patch to the other—decreases. Pinch points are highlighted in landscapes D–F, and the “drift fence” effect resulting from the more linear shape of the habitat patches in landscape I is evident as well. Fig. 7J shows a least-cost path map for the “braided stream” corridor configuration. The technique identifies the route with the lowest cumulative cost, but gives no information about the contribution of alternative pathways. By contrast, the current map (Fig. 7D) clearly indicates the importance of different corridor segments, with current densities at their highest in the two critical linkages and at their lowest in segments that are most redundant.

We can now illustrate how these models can be used to analyze connectivity in more realistic landscapes. Fig. 8A shows a complex landscape, with patches of high-quality habitat, lower quality “matrix” habitat, corridors, and complete barriers. Fig. 8B shows cumulative travel cost mapped between two high-quality patches using standard least-cost path techniques. The map highlights the most efficient pathway between the two patches, as well as low-cost detours that do not actually contribute to connectivity, e.g., into habitat cul-de-sacs or along “corridors to nowhere.” By contrast, the current map between the same two habitat patches (Fig. 8C) highlights critical pinch points between the two patches. Habitat cul-de-sacs and corridors that do not contribute to connectivity have minimal current flow. The current map also indicates two broad routes linking the habitat patches, whereas only one is highlighted in the least-cost map. The current map thus gives important insight into the redundancy that would be lost if the second route were to be blocked.

Often it will be useful to summarize connectivity between many habitat patches or protected areas in a single map. Fig. 9A shows the result of adding 10 pairwise current maps calculated among all pairs of five habitat patches. These maps show which landscape elements are most important for overall connectivity among the five habitat patches, indicating the net number of times random walkers are expected to move through raster cells if one random walker moves from each patch to each other patch.

We could also extend the analyses of our raster maps in much the same way as the analyses in Fig. 2A were extended in Figs. 2B and 3. Ground resistors could be added to incorporate mortality or finite probabilities of

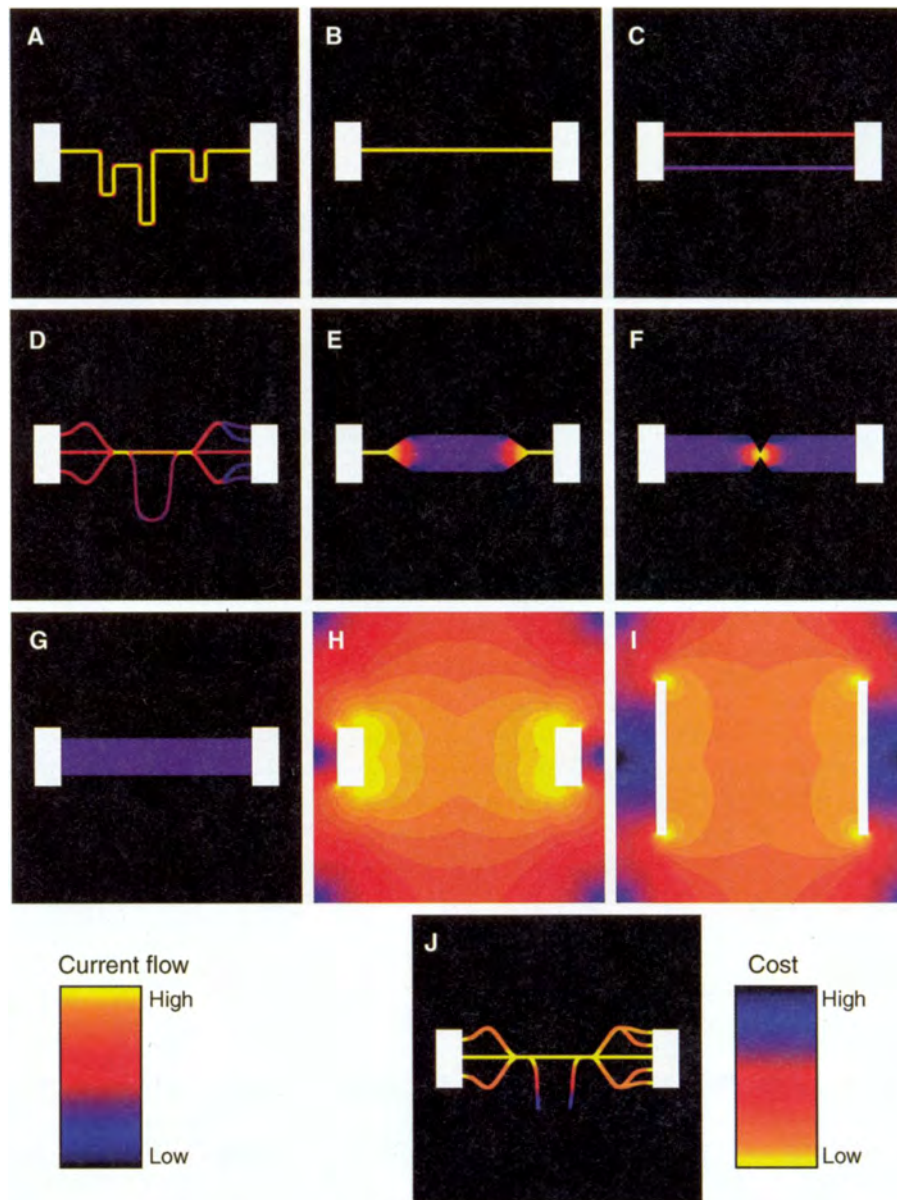


FIG. 7. Current flow through landscapes shown in Fig. 5 when 1 A (ampere) of current is injected into one habitat patch and the other is connected to ground. Current maps were log-transformed to facilitate display. Among the nine panels, three different quantitative scales are applied to the color schemes in order to most clearly illustrate differences in current densities. The three schemes are applied in panels (A)–(D), (E)–(G), and (H)–(I). Highest maximum current densities (indicating the greatest impact of habitat cell removal or conversion) are observed in (A), (B), and (D)–(E), where connectivity depends on single, narrow corridor segments. The lowest maximum current densities are observed in landscape (I), which provides the most redundancy and lowest effective resistance. This landscape also exhibits a drift-fence effect, in which the linear shapes of the habitat patches act to intercept dispersing individuals. (J) The least-cost path solution of the “braided stream” landscape shown in Fig. 5D. Whereas this technique highlights the most efficient travel path, it gives no indication of pinch points or effects of multiple parallel corridors.

settling once a disperser reaches a habitat patch or protected area. With multiple destination patches, a matrix of asymmetrical dispersal rates between all patch pairs could be generated. Or, target patches could be set to 1 V and probabilities of successful dispersal (or dispersal to one patch vs. others) from any point on the landscape could be mapped. Finally, additive maps (such as the one shown in Fig. 9A) could be adjusted to

give greater weight to important source or destination patches, with more current released or absorbed by larger or higher quality habitat patches.

#### *Model sensitivity to landscape scale*

Representing a landscape as a raster grid always involves choosing an appropriate scale of analysis (cell size and map extent). Because different species respond



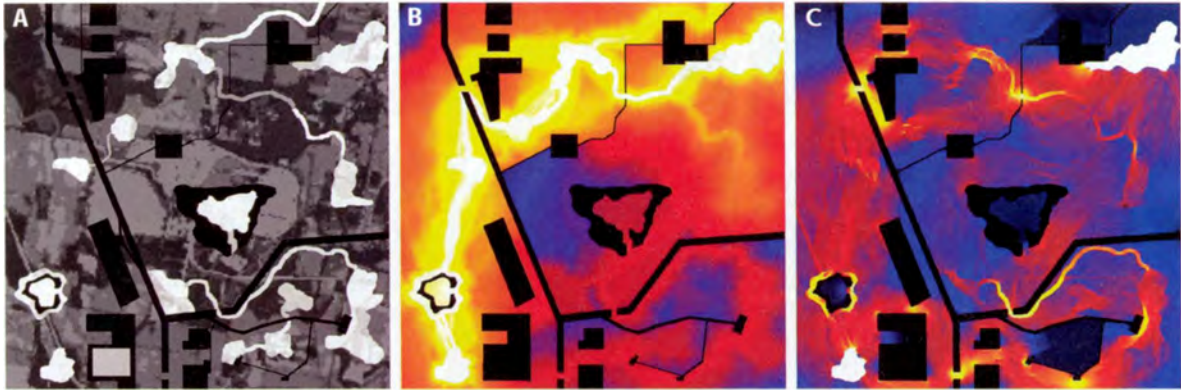


FIG. 8. Connective elements identified using least-cost path and circuit models in a complex landscape. (A) Map of the landscape, with resistances and costs for circuit and least-cost path analyses ranging from 1 (light gray) to 100 (dark gray) to infinite (black). (B) Results from least-cost modeling between habitat patches in lower left and upper right corners of the map. The value assigned to each cell indicates the cost accumulated moving along the most efficient possible route that passes through the cell from one habitat patch to the other; brighter areas indicate cells along the route of lowest cumulative cost. Some habitat cul-de-sacs are highlighted because the most efficient path connecting one patch to the other via the cul-de-sac has a low cost relative to most other features in the landscape. For the same reason, some “corridors to nowhere” are highlighted, such as the one leading off of the top of the map. (C) Current map between the same two habitat patches. Higher current densities indicate cells with higher net passage probabilities for random walkers moving from one patch to the other. The map highlights “pinch points,” or critical habitat connections, between the two patches. Habitat cul-de-sacs have minimal current flow because they do not contribute new, independent pathways between habitat patches.

to landscape structure at different scales (Wiens 1985, Wiens and Milne 1989; Beier et al., *in press*), there will be no single correct approach to this. The extent of an analysis will obviously have important consequences, since map edges will constrain potential movement routes. Cell size is also important, but our analyses indicate that as long as it remains fine enough to capture relevant landscape elements, such as narrow corridors and barriers, there is considerable robustness in the technique to changes in cell size. Fig. 9B shows the same

landscape as in Fig. 9A, but analyzed using cell sizes that are an order of magnitude larger. Notably, current densities and resistance distances calculated among habitat patches are highly correlated between the two scales, a consistent result in our analyses in a wide range of natural and artificial landscapes. However, these analyses also show that it is particularly important to capture absolute barriers to movement that may not easily be detected at coarser cell sizes. Such barriers (such as the narrow roads in Fig. 9A) were automatically

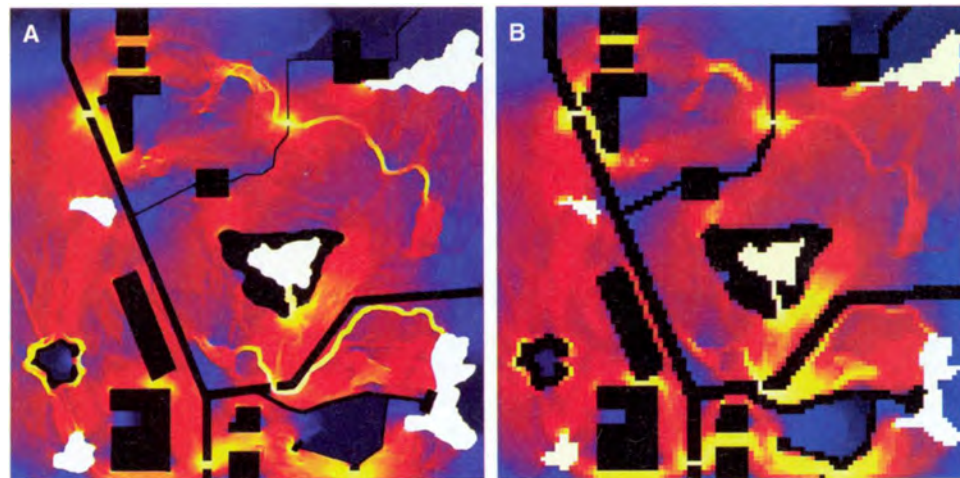


FIG. 9. Summed current from all pairwise current maps between five habitat patches, each shown in white. Calculations were performed (A) at the original  $1000 \times 1000$  cell resolution and (B) at a reduced  $100 \times 100$  cell resolution. To produce the coarser resolution habitat map, blocks of  $10 \times 10$  cells were converted to single cells, with the resistance of each new cell set equal to the mean resistance of the 100 cells it contained. The current maps at the two resolutions identify the same pinch points and important corridors, and pairwise effective resistances measured between all habitat patch pairs at the two scales are highly correlated ( $R^2 = 0.963$ ), illustrating the method's robustness to scale.





PLATE 1. Puma mother and kitten in Caspers Wilderness Park, Orange County, California. Circuit theory is being applied to inform efforts to conserve connectivity for pumas in the region. Photo credit: Donna Krucki.

incorporated into our analyses in Fig. 9B because we averaged resistances among consolidated cells, with infinite resistances “trumping” all others.

#### DISCUSSION

Although a wide variety of methods exists for predicting connectivity across landscapes, circuit-theoretic models provide some distinct advantages. First, the precise relationships between circuit theory and random walks lend theoretical justification to these models and mean that the metrics they generate can genuinely be considered to be process based. Second, these relationships also mean that circuit models will often be more straightforward to parameterize than other connectivity models because conductances and resistances assigned to edges or raster cells have clear interpretations in terms of movement probabilities. Third, unlike commonly applied least-cost path approaches, circuit methods incorporate multiple pathways, not only in generating metrics of connectivity and isolation, but also in identifying corridors and other important landscape elements connecting habitat patches or protected areas. An advantage of this property is that when dispersal pathways are lost, the predicted importance of remaining pathways increases. Finally, circuit models have an intuitive appeal in that the idea of using resistance and current to model connectivity across landscapes is readily understood by both practitioners and nonscientists. In effect, we find that the method objectively identifies important connective elements similar to those

identified by the human eye, replicating expert opinion but removing potential sources of bias once relative resistance values and scales of analysis have been defined.

#### *Niches for circuit models*

We envision several roles for circuit theory in evolution, ecology, and conservation. Circuit theory has already been shown to be useful for predicting patterns of gene flow in heterogeneous landscapes, particularly when data on absolute population sizes and migration rates are lacking, but relative population densities or permeabilities to movement are hypothesized for different landscape features (McRae 2006, McRae and Beier 2007). As discussed in the section below, the theory underlying gene flow modeling is similar to that described here, but relates resistance distances to random walks of genes over multiple generations rather than to random walks of individuals within single lifetimes.

In ecology, circuit models can be used as simple movement models, e.g., when data or time required for simulations are lacking or when the comparison of simple and complex model predictions is desirable. An example application would be to predict dispersal rates between populations based on simple landscape data in order to parameterize metapopulation models. Additionally, just as it can be used to predict gene flow, circuit theory may be useful in modeling other emergent

processes that depend on dispersal. Some ecological phenomena, e.g., community similarity and diversity, may respond to dispersal not of one species, but of several species with only somewhat similar dispersal abilities or habitat requirements. Here, simulations may be prohibitive or inappropriate because of the large number of species involved. However, analytic approaches like ours may be able to adequately capture these processes without imposing prohibitive data or computational requirements.

Measurements of resistance distances, commute times, and current densities have clear applications in conservation planning, such as corridor design or predicting the effects of different land use practices on connectivity. Circuit theory should provide an especially powerful tool for designing robust reserve networks, i.e., those that still provide for connectivity in the face of uncertainty in species distribution data and/or future habitat loss (Moilanen et al. 2006a, O'Hanley et al. 2007; Pinto and Keitt, *in press*). Importantly, circuit methods can be applied to the same resistance surfaces that are commonly employed in least-cost path analyses, and with little added computational expense.

In this paper, we limited our examples of circuit-based analyses to accessible interpretations of resistance, voltage, and current. However, there should be a large number of tools that could be derived from these basic properties. For example, metrics that combine predictions of efficient travel paths, pinch points, and mortality risks could allow practitioners to map landscape features that most effectively contribute to connectivity while minimizing mortality rates. Or, metrics derived from shortest path or least-cost distances, such as the Harary index (Ricotta et al. 2000, Jordán et al. 2003) or the integral index of connectivity (Pascual-Hortal and Saura 2006) could be modified by substituting resistance distances for least-cost distances in their calculation. Additionally, algorithms like edge and node thinning, used to evaluate impacts to connectivity of habitat loss in graph theory (Urban and Keitt 2001), can also be applied using circuit-based measures.

#### *A note about ecological vs. evolutionary applications*

It is important to be aware of subtle differences in assumptions behind applications of circuit theory to different processes. So far we have identified two distinct frameworks, one which models gene flow across population networks and the other focused on individual movement across habitat networks. The former assumes nodes (or cells) represent subpopulations (or occupied habitat for continuously distributed populations), with resistors representing numbers of migrants exchanged between adjacent nodes per generation (McRae 2006). By contrast, applications focused on individual movement will typically be implemented at finer temporal and spatial scales, with nodes (cells) mapped at the scale at which individual movement

decisions are made. Thus, the two will often be applied at different scales and with (at least somewhat) different habitat models. Similarly, predictions from the two frameworks must also be interpreted differently. For example, in applications where nodes or cells represent occupied habitat exchanging migrants, a decrease in the resistance distance between two nodes corresponds to a proportional increase in gene flow predicted between them; however, when nodes represent dispersal habitat rather than subpopulations, a decrease in the resistance distance corresponds only to an increase in available dispersal pathways, and not necessarily a commensurate increase in individual movement rates or gene flow. It does, however, indicate that there will be more pathways available to dispersers, and presumably greater robustness of the network to future habitat loss. Conservation applications may be implemented using either framework, but it is important to specify the process being modeled.

#### *Model parameterization*

A critical and challenging step in applying circuit models to landscape data will be assigning relative movement, mortality, and/or settlement probabilities to different land cover classes. Many of the same strategies for parameterizing least-cost path models using expert opinion, literature review or data on species occurrences, animal movement paths, or interpatch movement rates (reviewed by Beier et al., *in press*) will be useful in circuit modeling, particularly when viewed in light of the concrete interpretations of resistances in terms of random walk probabilities outlined here. Practitioners should also consider approaches taken to parameterize other models that consider habitat heterogeneity, such as diffusion and simulation models (e.g., Dunning et al. 1995, Schumaker 1996, Ovaskainen 2004; Arellano et al., *in press*; Ovaskainen et al., *in press*).

Connections between resistance distances and gene flow (McRae 2006, McRae and Beier 2007) should facilitate the use of genetic data to estimate relative resistances of different habitats. Still, because assumptions differ between evolutionary and ecological applications of circuit theory (as discussed here), using data from one to parameterize the other must be done with care.

Regardless of the method used to assign them, there will always be uncertainty in resistance values. We encourage uncertainty analyses to address how decisions at each modeling step affect results; Beier et al. (*in press*) reviewed strategies for conducting uncertainty analysis in least-cost path modeling, and these should be equally applicable to circuit theory. Additionally, for corridor and reserve designs, uncertainty in landscape resistances could be incorporated in much the same way as proposed by Moilanen et al. (2006b), with penalties that reflect modeled error incorporated into landscape resistance input maps.

### Limitations and alternatives

As with other methods for describing connectivity in complex landscapes, there are limitations to our approach that should be considered when deciding if it is appropriate for a given problem. First, because resistors are isotropic, i.e., their resistance to current flow is the same in both directions, the methods described here cannot accommodate movement that is biased in one direction (as in directed graphs). This will limit applications in some systems, e.g., marine environments, where directional currents play a large role in determining dispersal rates. Second, circuit models are restricted to Markovian random walks, i.e., random walks in which each step is independent of previous moves. Random walkers thus have no “memory,” and our framework cannot incorporate correlated random walks, changes in movement behavior with time, or mortality rates that increase with an organism’s age. Even when the assumption of constant mortality with time is reasonable, incorporating mortality into circuit models must be done with care. Because they have no memory or long distance perception, random walkers can retrace their steps over and over, inflating mortality rates because travel time and exposure to mortality risks are increased (Fig. 2B).

Several other connectivity modeling frameworks provide complements to ours. The conceptually and computationally simplest are based on Euclidean distances, and can be quickly calculated on grids with millions of cells (e.g., Moilanen et al. 2005, Moilanen and Wintle 2007). Least-cost path models have been applied for over a decade in connectivity analyses and have proven useful in conservation planning efforts (e.g., Beier et al. 2006, Rouget et al. 2006). Although they do not have the theoretical foundation in random walk theory that circuit models do, their intuitive appeal and ability to identify efficient movement pathways make them useful counterparts to the applications we have described here. Recently, variants on these approaches have been developed that identify and rank the importance of multiple pathways across landscapes (Theobald 2006; Pinto and Keitt, *in press*).

More sophisticated analytical and simulation models can be used to derive results similar to those produced by circuit theory, with some advantages. Markov chain models use the same data structures as those described here, but can accommodate directionality in movement along edges, providing more flexibility for modeling, e.g., effects of directed dispersal, prevailing winds, or ocean currents. Still, although Markov chain models have been available for decades, ecologists and conservationists have been slow to adopt them, whereas simpler, more intuitive least-cost path models have been widely employed. Spatially structured diffusion models (Ovaskainen 2004) are promising because they also integrate over all movement paths and can approximate correlated random walks in their long-term behavior, but their mathematical formulation can be quite

challenging. Of course, individual-based movement simulations (e.g., Schumaker 1998, Hargrove et al. 2005) offer much more flexibility than analytic models, can incorporate subtle effects of dispersal behavior and other aspects of life history, and can simulate transient effects of landscape characteristics that evolve over time. However, the data and computational requirements of such models will likely continue to limit their use in many applications (Minor and Urban 2007). Our hope is that circuit models will fill a niche between simpler Euclidean or least-cost path analyses and more powerful analytic and simulation approaches.

### Future prospects

Our focus has been on measuring connectivity in heterogeneous landscapes using models from circuit theory. Even in this context, there remain many exciting applications to explore. Nonequilibrium circuit analyses may be applicable to ecological problems (McRae and Beier 2007), and nonlinear circuit elements show promise as well (for example, diodes would allow incorporation of movement probabilities with directional bias). Additionally, analytical techniques developed to minimize effective resistances across networks (Ghosh et al. 2006) may be useful in designing optimal networks for connectivity conservation. More broadly, circuit theory will likely benefit other areas of ecology that deal with networks, such as the analysis of community interactions, food web structure, exotic invasion, or disease transmission. In the meantime, circuit models are being actively applied to conservation planning for species of concern in rapidly developing landscapes, including pumas (*Puma concolor*; see Plate 1) in southern California.

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# Where to Restore Ecological Connectivity? Detecting Barriers and Quantifying Restoration Benefits

Brad H. McRae<sup>1\*</sup>, Sonia A. Hall<sup>2</sup>, Paul Beier<sup>3</sup>, David M. Theobald<sup>4</sup>

**1** The Nature Conservancy, North America Region, Seattle, Washington, United States of America, **2** The Nature Conservancy, Washington Chapter, Wenatchee, Washington, United States of America, **3** School of Forestry and Merriam-Powell Center for Environmental Research, Northern Arizona University, Flagstaff, Arizona, United States of America, **4** National Park Service, Inventory and Monitoring Division, Fort Collins, Colorado, United States of America

## Abstract

Landscape connectivity is crucial for many ecological processes, including dispersal, gene flow, demographic rescue, and movement in response to climate change. As a result, governmental and non-governmental organizations are focusing efforts to map and conserve areas that facilitate movement to maintain population connectivity and promote climate adaptation. In contrast, little focus has been placed on identifying barriers—landscape features which impede movement between ecologically important areas—where restoration could most improve connectivity. Yet knowing where barriers most strongly reduce connectivity can complement traditional analyses aimed at mapping best movement routes. We introduce a novel method to detect important barriers and provide example applications. Our method uses GIS neighborhood analyses in conjunction with effective distance analyses to detect barriers that, if removed, would significantly improve connectivity. Applicable in least-cost, circuit-theoretic, and simulation modeling frameworks, the method detects both complete (impermeable) barriers and those that impede but do not completely block movement. Barrier mapping complements corridor mapping by broadening the range of connectivity conservation alternatives available to practitioners. The method can help practitioners move beyond maintaining currently important areas to restoring and enhancing connectivity through active barrier removal. It can inform decisions on trade-offs between restoration and protection; for example, purchasing an intact corridor may be substantially more costly than restoring a barrier that blocks an alternative corridor. And it extends the concept of centrality to barriers, highlighting areas that most diminish connectivity across broad networks. Identifying which modeled barriers have the greatest impact can also help prioritize error checking of land cover data and collection of field data to improve connectivity maps. Barrier detection provides a different way to view the landscape, broadening thinking about connectivity and fragmentation while increasing conservation options.

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\* E-mail: [bmcr@tnc.org](mailto:bmcr@tnc.org)

## Introduction

Landscape connectivity, or “the degree to which the landscape facilitates or impedes movement among resource patches” [1], is crucial for many ecological and evolutionary processes, including dispersal, gene flow, demographic rescue, and movement in response to climate change [2–7]. Many research and conservation planning efforts have focused on mapping areas important for connectivity using GIS models (e.g., [8–12]). The results of these analyses are guiding investments by governmental and non-governmental organizations to promote ecological connectivity across large areas. In the USA and Canada, for example, numerous broad-scale conservation efforts such as the U.S. Department of Interior Landscape Conservation Cooperatives, the Western Governors’ Association’s Initiative on Wildlife Corridors and Crucial Habitat, and the Yellowstone to Yukon Conservation Initiative are working to integrate and coordinate connectivity conservation actions spanning millions of acres and crossing many political and ecoregional boundaries.

Conservation practitioners employ two primary strategies to promote connectivity. The first focuses on conserving areas that *facilitate* movement; the second focuses on restoring connectivity across areas that *impede* movement (e.g., by removing a fence or building a wildlife-friendly highway underpass). Most connectivity analyses have focused on the former strategy by modeling and mapping areas important for movement under present landscape conditions. A wide array of tools have been developed for this purpose: least-cost corridor modeling [8,13,14], circuit theory [15], individual-based movement models (e.g., [16–18]), graph theory [19,20], and centrality analyses (e.g., [21,22]) have all been used to identify areas important for movement of plants and animals. Outputs from such models are now being used as inputs to reserve selection algorithms (e.g., [23]) to optimize actions to conserve connectivity.

In contrast, there has been little effort by conservation scientists towards identifying candidate areas for the second strategy: that is detecting restoration opportunities by mapping barriers that strongly reduce movement potential. We define a barrier as a



landscape feature that impedes movement between ecologically important areas, the removal of which would increase the potential for movements between those areas. Here we are concerned with movements important for access to resources, demographic rescue, gene flow, range shifts, and other ecological and evolutionary processes. In this context, barriers are distinguished from features that are impermeable but not situated such that they block biologically relevant movement routes. Barriers are thus the inverse of corridors, which delineate pathways facilitating movement. Barriers can either be complete (impermeable) or partial (e.g., land cover types that hinder movement relative to ideal conditions, but may still provide some connectivity value). Barriers may be human-made (e.g., roads, fences, or urban areas) or natural (rivers or canyons); they may be linear (e.g., highways) or span large areas (agricultural fields). As with traditional connectivity concepts [1,24], what constitutes a barrier, the impact it has, and whether it reduces connectivity through behavioral inhibition, increased mortality, or other means will differ among species.

Detecting barriers to movement would complement traditional connectivity analyses in several important ways. First, some barriers may be restorable. Knowing where barriers have the greatest impact would help practitioners decide where and how to invest scarce conservation resources to conserve and enhance connectivity. For example, it may be cheaper to restore a barrier that blocks a movement corridor through public land than to establish permanent protection of a functioning corridor that runs through private land [25]. Quantifying such trade-offs would be necessary to integrate connectivity restoration into systematic conservation planning analyses aimed at optimizing conservation investments [26–28], but tools to incorporate connectivity conservation and/or restoration into such efforts remain rare [29–31]. Second, consider that corridor modeling often produces corridors that may not be good enough to realistically support movement [32]. Barrier detection analysis could reveal such cases, allowing practitioners to ‘triage’ a landscape, focusing efforts on more viable movement routes. Finally, surprising results in a barrier analysis could alert analysts to situations in which poor land cover data or incorrect model parameterization may be causing spurious results.

In this paper, we introduce a new method to identify barriers and rank them by their impact on connectivity. Our method complements existing connectivity modeling approaches, is applicable in least-cost and other connectivity modeling frameworks, and can be extended to centrality analyses. The method can be readily applied across large landscapes, efficiently analyzing barriers among many locations and at different scales corresponding to different sizes of barriers and types of restoration activities. It also quantifies the extent to which restoration can be expected to improve connectivity. We provide example applications of the method, showing that the potential for connectivity conservation is not constrained to narrow corridors, but includes options spanning much more of the landscape when restoration options are considered. We also discuss how our approach can facilitate sensitivity analyses, data quality screening, and prioritization of areas for error checking of GIS base data.

### Method for Detecting Barriers and Restoration Opportunities

Our method identifies areas that most reduce connectivity between two locations on a landscape. Making these areas permeable to movement would therefore most increase connectivity between the locations. Thus, these are areas that practition-

ers should consider when implementing restoration to promote connectivity.

To illustrate the method, we use a least-cost corridor modeling framework [13,14,32], which is commonly used to map and prioritize areas important for connectivity conservation (e.g., [8–12]). However, our approach could also be used with other modeling frameworks capable of producing measures of effective distance, such as circuit theory and individual-based movement models (see Discussion).

As with least-cost corridor models, input data include locations to be connected (hereafter, “patches”) and a raster resistance surface (Figure 1A). The former may consist of points or polygons, and typically represent natural landscape blocks, protected areas, or core habitat for a particular species or species guild [33]. The resistance surface represents the difficulty, energetic cost, or mortality risk associated with movement through each pixel (see [34] for a review of resistance surface development).

Least-cost methods calculate the cost-weighted distance (*CWD*) of all pixels to a source location, creating a raster of *CWD* values (Figures 1B and 1C). Adding together *CWD* rasters from two locations produces a corridor (Figure 1D), showing the pathways with the lowest cumulative movement cost between the locations [14]. The minimum value of the corridor raster is the least-cost distance (*LCD*); this represents the cumulative resistance encountered moving along the optimal path from one location to the other, and is a common measure of isolation in spatial ecology (e.g., [35,36]), landscape genetics (e.g., [37,38]), and related fields.

Our method is based on this simple assumption: if a certain area (the size is defined by the user) is restored such that the resistance across it is reduced, then the *LCD* of the best route connecting the patches through the restoration area will also be reduced. Systematically quantifying the potential reduction across a landscape will allow us to detect those areas where restoration would lead to the greatest reduction in least-cost distance.

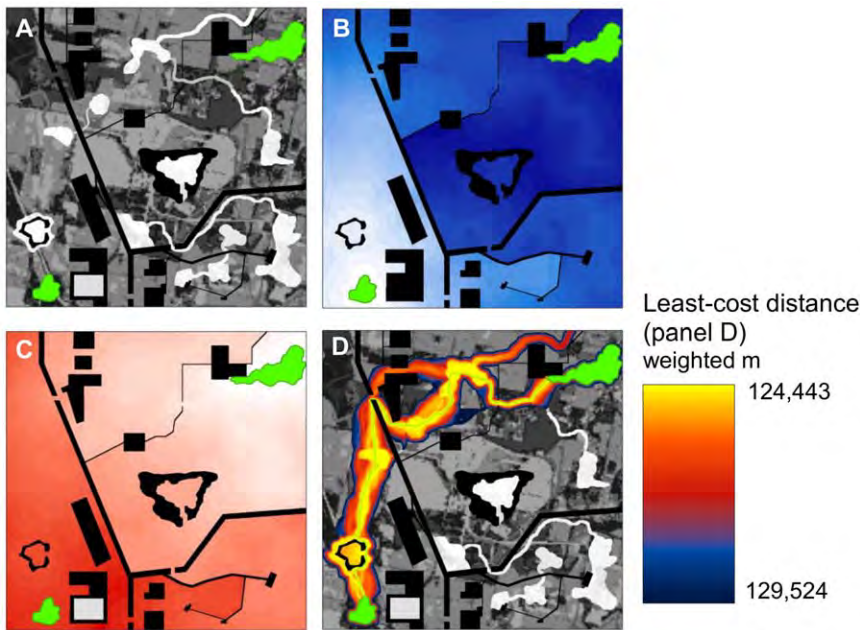
The method begins with *CWD* calculations from two patches (Figures 1B and 1C). However, rather than adding the two *CWD* surfaces together to produce a corridor, we instead calculate the minimum value of each *CWD* surface within a localized area around each pixel location (e.g., within a 500 m radius). We then add the minimum values from both *CWD* surfaces to calculate the cumulative resistance that would be incurred moving between the patches and through the focal pixel assuming the area within the search window is restored:

$$LCD' = CWD1_{MIN} + CWD2_{MIN} + (L * R'), \tag{1}$$

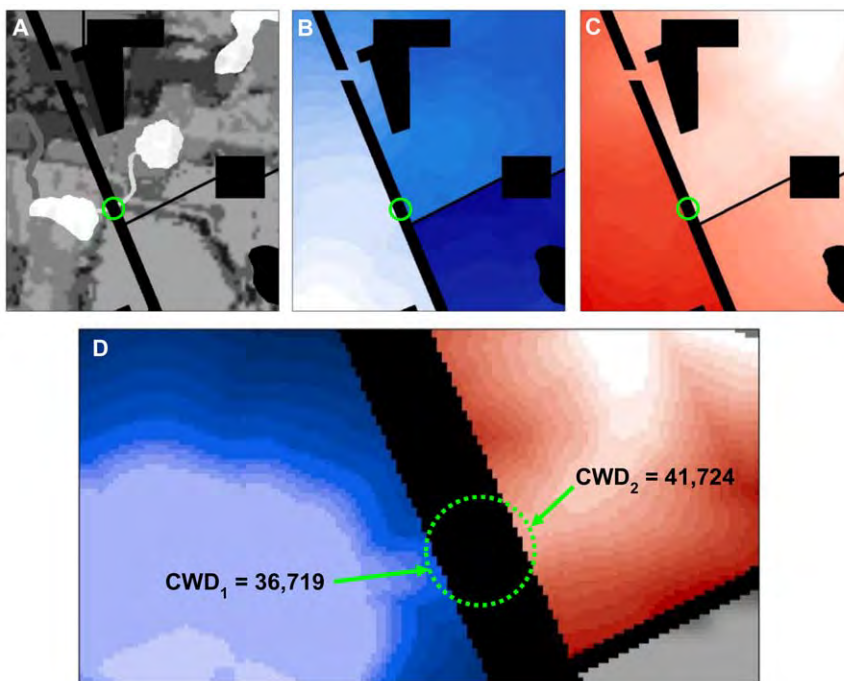
where *LCD'* is the least-cost distance of the best path between the patches passing through the focal pixel after barrier removal, *CWD<sub>X</sub><sub>MIN</sub>* is the minimum *CWD* value from patch *X* within the search window, *L* is the length of the longest axis of the search window, and *R'* is the resistance value of the feature replacing (or cutting through) the barrier. We use a circular moving window to illustrate the method (Figure 2), but consider alternative search window shapes in the Discussion. Note that the longest axis of a circle is its diameter.

For each pixel, this formula yields the cost of the best corridor that would pass through that pixel if the resistance of a strip of land crossing the search window were changed to *R'*. Including *R'* and the search window length accounts for the cost of moving across the search window, assuming restoration or removal of the intervening barrier.

If *LCD'* is less than *LCD*, then restoration across the moving window (e.g., the circle in Figure 2) would reduce effective distance and increase connectivity between the two patches. When this is



**Figure 1. Cost-weighted distance modeling.** (A) Example 3 km × 3 km landscape with a pixel size of 3 m (from [15]). Two habitat patches (green) are embedded in a matrix of land cover types with differing resistance to movement. Resistances range from 1 (white) to 100 (dark grey); complete barriers with infinite resistance (e.g., linear features representing roads and highways) are shown in black. (B) Cost-weighted distance (CWD) from leftmost patch, with darker shades representing higher cumulative resistance from the patch. (C) CWD from rightmost patch, with darker shades representing higher cumulative resistance from the patch. (D) Modeled least-cost corridor produced by adding CWD surfaces shown in panels B and C (best 20% of study area shown). The least-costly path (traced in green) has a cumulative least-cost distance (LCD) of 124,443 weighted meters. doi:10.1371/journal.pone.0052604.g001



**Figure 2. Detail of resistance and CWD surfaces with circular moving window.** For a window with a diameter of 60 m (20 pixels) centered on the barrier, the arrows show the pixels in the window that have the lowest CWD to each patch (values shown are in weighted meters). Because the lowest CWD values from each patch will always be found on the edge of a moving window, only pixels on the perimeter need to be examined, increasing processing efficiency. doi:10.1371/journal.pone.0052604.g002

the case, a simple metric of connectivity improvement that would result from restoration across the moving window is:

$$\Delta LCD = LCD - LCD' \quad (2)$$

Dividing  $\Delta LCD$  by the search diameter gives the connectivity benefit per unit distance restored; dividing  $\Delta LCD$  by  $LCD$  gives the proportional improvement relative to unrestored effective distance.

To illustrate the method, we first apply it to the relatively simple landscape described in Figure 1 using a search window with a diameter of 60 m (20 pixels at 3 m resolution; Figure 2). The search window size is chosen to match the size of the barrier that one is interested in detecting: a diameter of 20 pixels will fully incorporate effects of barriers up to 20 pixels across. We assign a resistance of 1 to optimal movement habitat, so that the cumulative cost of movement is identical to the Euclidean distance traversed when no barriers are encountered. For the circular window centered on the highway in Figure 2, the lowest  $CWD$  values from the left and right patches are 36,719 and 41,724 weighted meters, respectively. Summing these values and adding 60 (the cost of crossing the circle if it were restored to optimal movement habitat with a resistance of 1), gives the least-cost distance of the path crossing through the restored area (36,719+41,724+60 = 78,503 weighted meters). Since this is considerably lower than the least-cost distance between the patches without restoration (124,443 weighted meters), this location is a potent barrier, and the center pixel is assigned an improvement value of 45,940 weighted meters. This is repeated for every pixel on the landscape using standard GIS neighborhood analyses, resulting in a raster surface of improvement scores (Figure 3A).

The removal of the barrier where the improvement score is maximal – for example, by constructing a wildlife crossing structure – would re-route the best movement path (Figure 3B) and lower the effective distance between the two patches by 37% (45,940/124,443). Once that improvement is carried out, a second barrier analysis with the altered landscape conditions suggests that additional restorations along the highway will not further reduce the  $LCD$  at this point (Figure 3C). The next priority would be a road crossing in the upper right of the panel (dark orange in Figure 3C), connecting the rightmost patch to high-quality movement habitat above the road. The method is computationally efficient enough that different restoration scenarios can be tested iteratively: a barrier analysis with a 20-pixel search diameter across a landscape with 1 million pixels takes less than 2 seconds using a 2.7 GHz notebook computer.

### Identifying barriers across scales and across large landscapes with multiple patches

The method described above can be extended across scales and across networks of patches, and we explore a few approaches to accomplish this here. By modifying the search diameter, the method can detect barriers of different sizes (Figure 4). Windows the width of a highway will best highlight where highways act as barriers, as in Figures 2 and 3. Larger windows will best detect barriers like agricultural fields, or cases in which narrow barriers run parallel to one another. Summary maps showing barrier effects across search window sizes may be created by first dividing improvement scores by the window size to produce maps of barrier strength per unit width, and then taking the maximum pixel score across scales (Figure 4B). This puts results from different analysis scales in the same units, allowing them to be

summarized in a single map. Alternative summary metrics are possible, and we address some of them in the Discussion.

To summarize across multiple sets of patch pairs, we have implemented a similar approach in which the maximum or sum of improvement scores across all patch pairs is assigned to a pixel. Taking the maximum of improvement scores shows the features that have the greatest effect for any patch pair (Figure 4C). Summing improvement scores highlights those barriers that isolate multiple pairs of patches from one another, extending the method to quantify barrier centrality (Figure 4D).

The methods described in this paper have been implemented in Barrier Mapper software [39], freely available as a new addition to the Linkage Mapper Toolkit for ArcGIS [40].

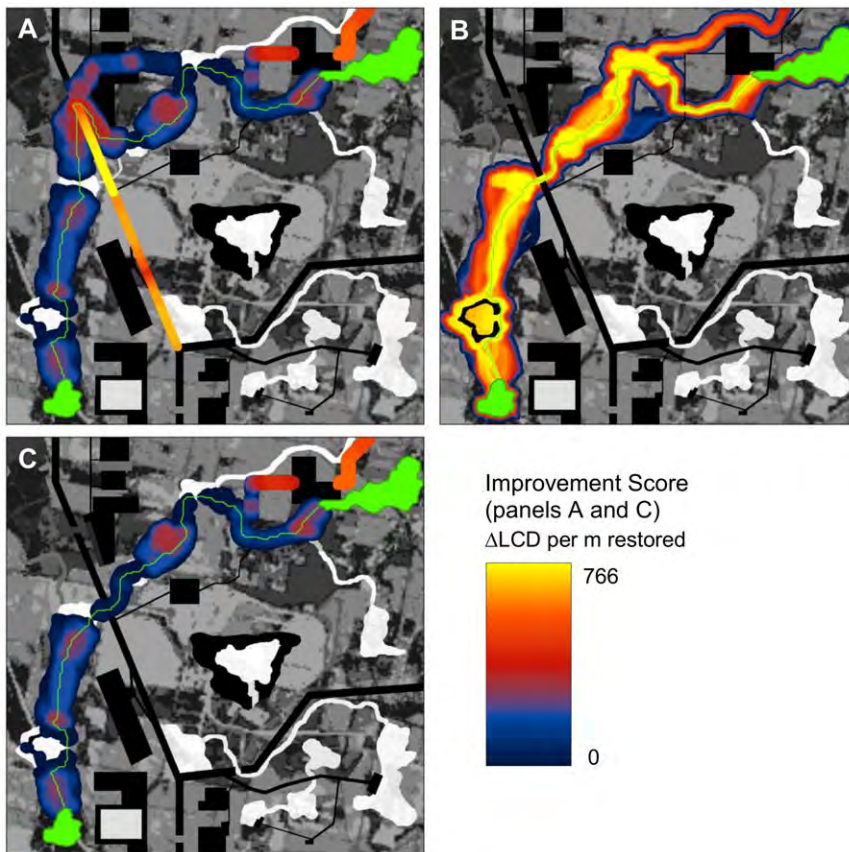
### Example application in a landscape undergoing active conservation planning

The Washington Wildlife Habitat Connectivity Working Group, a collaboration of land and resource management agencies, non-governmental organizations (NGOs), universities, and Washington treaty tribes, recently completed a connectivity analysis across the Columbia Plateau Ecoregion in Washington, Oregon, and Idaho, USA [41]. The Working Group focused on the Columbia Plateau because the ecoregion is home to a large portion of Washington's sensitive plant and animal species but is also highly fragmented by agriculture and other anthropogenic activities. The Group modeled corridors to connect habitat for 11 focal species and also to connect natural landscape blocks scoring highly on an index of landscape integrity (i.e., large areas with relatively low levels human modification). Products from the analysis are being used to inform conservation planning efforts by several state and federal agencies and NGOs. Many of the corridors identified by the analysis pass through human-dominated landscapes, where roads, agricultural fields, and other human uses likely still act as barriers to movement.

We reanalyzed results for a corridor connecting two natural landscape blocks identified by the Working Group in Douglas County, Washington (Figure 5). We chose these blocks because they have been identified as important for many species of concern; for example, the blocks contain important habitat or corridors for 8 of 11 focal species analyzed by the Working Group. Moreover, both are occupied by greater sage-grouse (*Centrocercus urophasianus*, categorized as a Species of Greatest Conservation Need in Washington and a candidate for listing under the US Endangered Species Act), and both fall within a recovery area designated for the species by Washington State [42]. In addition, this landscape contains a complex mix of native systems and agricultural lands – the latter including both annual cropland and perennial vegetation cover – and includes roads, transmission lines, and other human-made features affecting animal movement [41].

To represent species with differing degrees of sensitivity to human modification, the Working Group used different resistance surfaces for landscape integrity analyses [41]. These surfaces all contained resistance values that increased with the degrees of human modification, differing only in the range of resistances assigned. Resistance scores of 1–100, 1–1000, and 1–10,000 were used for minimum, medium, and maximum sensitivity surfaces respectively (see [41] for details). We present results from a barrier analysis using the medium sensitivity resistance surface.

The modeled least-cost corridor connecting the patches dips south from the western patch, runs east to Banks Lake, and then north along a narrow strip of native vegetation and cliffs sitting between the lake and cropland (Figure 6A). A secondary and much longer corridor follows broad swaths of native vegetation through



**Figure 3. Barrier analysis of landscape.** (A) Improvement scores ( $\Delta LCD$ ) for a 60 m search diameter using an enhanced version of Linkage Mapper software ([40]). Only positive values (indicating barriers whose removal would reduce isolation) are shown. To facilitate visualization of the barriers, scores were mapped so that they filled the search window (i.e. the maximum  $\Delta LCD$  value within the search radius of each pixel is displayed). The greatest improvement potential was detected crossing the highway. Note that a natural corridor is bisected by the highway at the point with the highest improvement potential (see detail in Figure 2). (B) Creating a new gap in the barrier where restoration potential is highest re-routes the modeled least-cost corridor and greatly reduces resistance between the patches ( $LCD = 78,503$  weighted meters compared with an  $LCD$  of 124,443 pre-restoration). Best 20% of study area shown. (C) Barrier detection at 60 m search diameter after restoration. doi:10.1371/journal.pone.0052604.g003

Moses Coulee and Beezley Hills to the south. A barrier analysis indicates numerous opportunities for improving the least-cost corridor, particularly within its east-west segment (Figure 6B). There are also opportunities outside of the main corridor, occurring along the longer route to the south and to the north as well (Figure 6B). Restoring any of these latter areas would re-route the modeled least-cost corridor, causing it to occur in a different location than it did in the unrestored landscape.

Restoration of any of several barriers identified to the south would improve connectivity as measured by  $LCD$  (Figure 6B); however, this would result in a much longer least-cost corridor. Restoration to the north has the potential to both improve  $LCD$  and shorten the distance traversed by the corridor. We simulated a restoration by changing a  $1 \text{ km}^2$  ( $500 \text{ m} \times 2 \text{ km}$ ) swath of agricultural land (indicated by the arrow in Figure 6B) to a resistance of 1. We chose 2 km because the greatest improvement was detected at the 2 km scale, and we assumed 500 m was wide enough to accommodate movement. A second corridor analysis following the simulated restoration shows the new corridor to the north (Figure 6C). The corridor has 9.4% less cumulative resistance than the original (1348 weighted km vs. 1489 weighted km), and its least-cost path is 44% shorter in un-weighted length. A post-restoration barrier analysis indicates that the highest improvement scores now fall along the new corridor (Figure 6D);

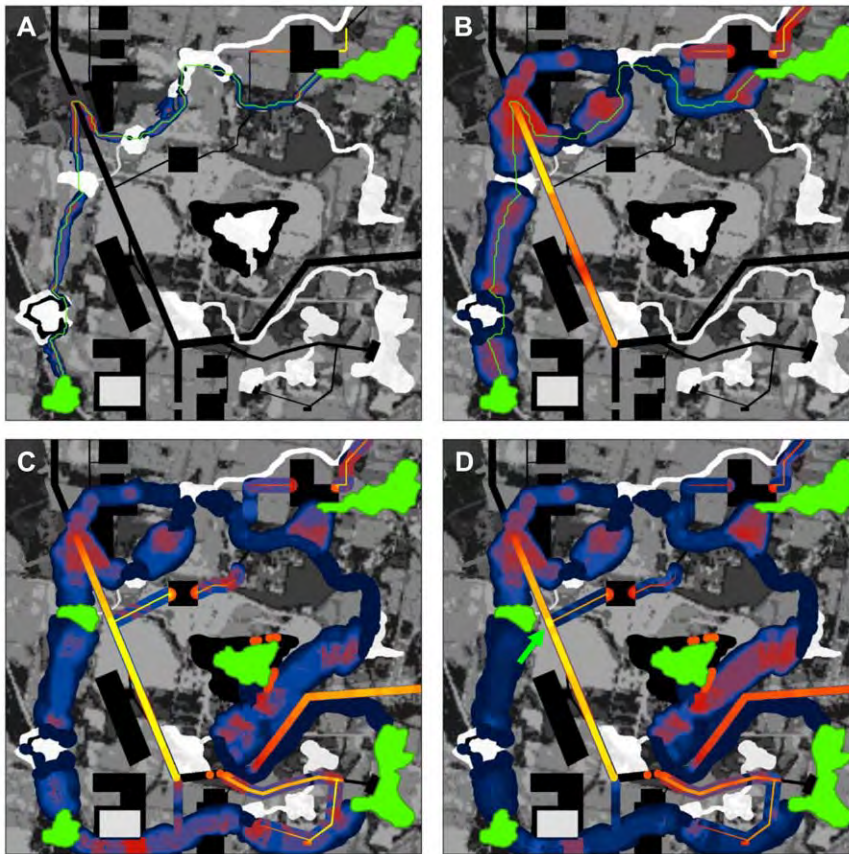
restoring a second  $1 \text{ km}^2$  swath in this new corridor at the point indicated by the arrow would further reduce  $LCD$  by 50%.

### Discussion

Connectivity models have provided valuable guidance to conservation planning efforts, as well as predictions of movement, gene flow, and isolation important to landscape genetics and other fields concerned with movement ecology. Yet they have almost exclusively emphasized identifying features that facilitate, rather than impede, movement; this emphasis gives an incomplete picture of how landscape features affect connectivity, what connectivity management strategies might be appropriate, and the uncertainty underlying model predictions. We see considerable potential for barrier detection analyses to help practitioners overcome these limitations. In particular, the ability to identify restoration opportunities can provide valuable alternatives to traditional conservation efforts focused on existing movement corridors.

Our reanalysis of the Columbia Plateau data (Figure 6) illustrates these points, showing how detecting barriers can increase conservation options available to practitioners, improve understanding of analysis products, and result in more robust conservation plans. Without a barrier analysis, conservation





**Figure 4. Barrier analyses integrating across multiple scales and patch pairs.** (A) Results of barrier analysis with original patch pair at 12 m search diameter, which detects restoration opportunities equal to or less than 12 m across (e.g., local roads). (B) Maximum per-meter improvement value across 10 search window sizes (from 6 m to 60 m, with 6 m steps between search diameters). The map highlights where actions at different scales would have highest impact per meter restored. (C) Maximum per-meter improvement value across same window sizes and 5 patches, showing where greatest improvement could be achieved for any single pair of patches. (D) Sum of improvement scores among 5 patches (green). As in Panels A–C, the maximum per-meter improvement score was calculated for each patch pair at each scale. These were then summed across patch pairs to incorporate cumulative benefit for multiple patch pairs across multiple scales. The area scoring highest (bright yellow) had high improvement scores for multiple patch pairs; we interpret this area as having high ‘barrier centrality,’ i.e. being an important restoration opportunity for keeping the overall network connected. Note that the area occurs at a road intersection; if practical, placing a wildlife crossing structure here would re-route four corridors connecting the two leftmost patches to both the central and upper-right patch. doi:10.1371/journal.pone.0052604.g004

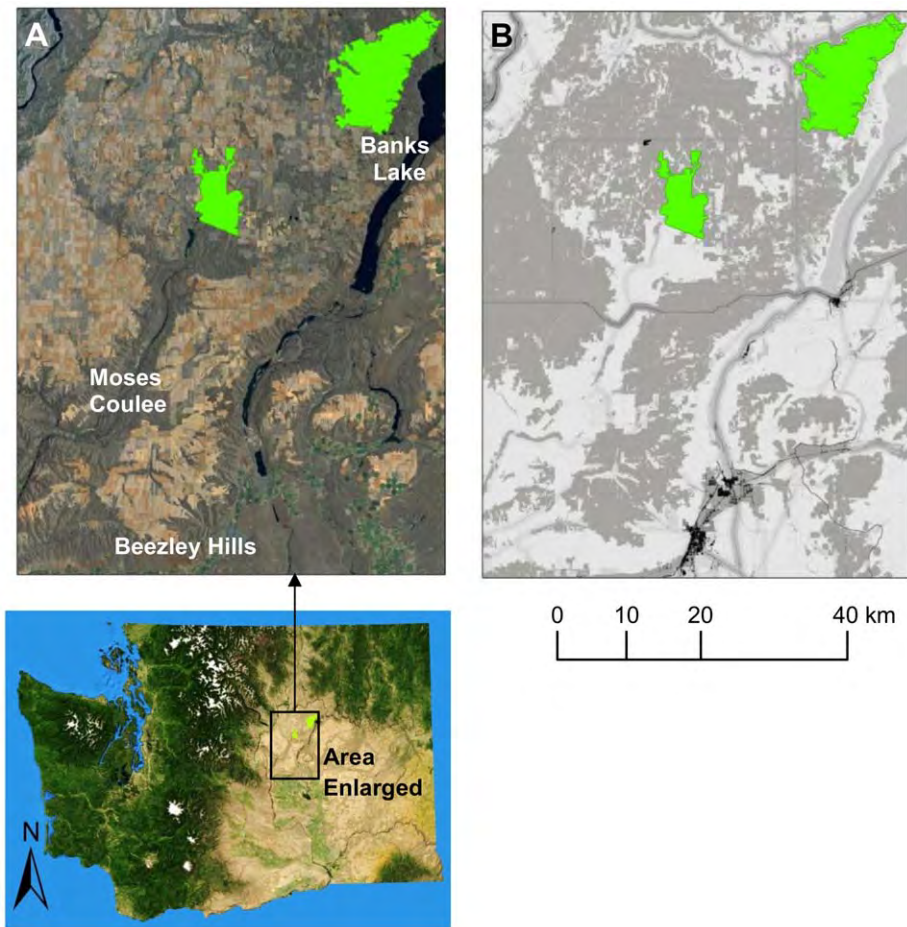
planners would likely have focused on conserving land in or adjacent to the original least-cost corridor. Our analysis revealed numerous opportunities to improve this corridor, but also that restoration of a 1 km<sup>2</sup> swath of cropland would create a new corridor with several desirable characteristics. Specifically, the new corridor has a lower least-cost distance, is shorter in length, and appears to have fewer pinch-points (narrow sections) than the original corridor—all desirable characteristics for corridor design [15,32]. Moreover, if the two original corridors remain in place, the new, northern corridor adds redundancy to connections between the natural landscape blocks. This is important because organisms seldom follow a single optimal path [43], and because redundant connections help to ensure continued connectivity in the face of unpredictable environmental changes [15].

The analysis showed that connectivity conservation options need not be limited to a small portion of the landscape, opening up much more area for actions that could conserve or enhance connectivity and illustrating tradeoffs between different conservation strategies and target locations. Beyond the corridor quality differences cited above, we note that the original corridor runs along a narrow stretch of land bordering Banks Lake, sometimes

traversing cliffs. The cliffs were assigned low resistance because the landscape integrity model used by the Working Group only quantified the degree to which pixels have been converted to human land uses. Practitioners, however, may consider cliffs to be impermeable for some species of conservation concern. The barrier analysis allows the user to quickly focus a more critical examination of corridor characteristics on areas influencing the results, and to identify options for alternative corridors that may better fit specific planning needs.

Similarly, the analysis underscored the potential sensitivity of corridor mapping to errors in GIS base data: our results show how the misclassification of a single agricultural field could have entirely altered the location of the original least-cost corridor shown in Figure 6A. The sensitivity of connectivity analysis results to landscape features at key locations has consequences for disciplines that depend on corridor maps (like conservation planning) and for disciplines that depend on connectivity measures (like landscape genetics). We discuss applicability of barrier detection methods to sensitivity analysis and error checking below.

Following the first barrier analysis and simulated restoration, a subsequent barrier analysis indicated that the restoration would



**Figure 5. Corridor analysis in a landscape undergoing active conservation planning.** (A) 60 km by 80 km study area in eastern Washington, USA, containing two natural landscape blocks to be connected (green). (B) Resistance map used to model corridors in a recent multi-partner connectivity analysis across the Columbia Plateau Ecoregion [41]; values range from 1 (white) to 1000 (black). Low resistance areas include native grassland and shrub-steppe, whereas high resistance areas include roads, developed areas, and agriculture.  
doi:10.1371/journal.pone.0052604.g005

open up further restoration opportunities of considerable value, one of which would cut *LCD* values by half. Thus, simulating restorations and re-running corridor and barrier analyses will likely improve final conservation and restoration plans.

Although we are aware of no other efforts to automate identification of terrestrial connectivity restoration opportunities, least-cost corridor analyses have been used to guide placement of crossing structures across roads to restore connectivity for wildlife. For example, Beier et al. [44] assigned a single, finite resistance value to all segments of a highway between two protected areas, regardless of whether a segment contained wildlife crossing structures. The least-cost corridor between the areas crossed the highway at the location where a crossing structure would result in the lowest ecological cost of travel. If highway crossing structures were not located in this corridor, Beier et al. [44] recommended specific structures at particular locations. This approach is useful, but does not quantify the improvement compared to existing conditions, does not identify restoration opportunities outside of least-cost corridors, and cannot be readily applied to barriers more complex than roads.

In addition to overcoming these limitations, our method is also amenable to highlighting barriers that affect multiple corridors, introducing the concept of barrier centrality. As shown in Figure 4, barriers can be mapped across all patch pairs, and the results

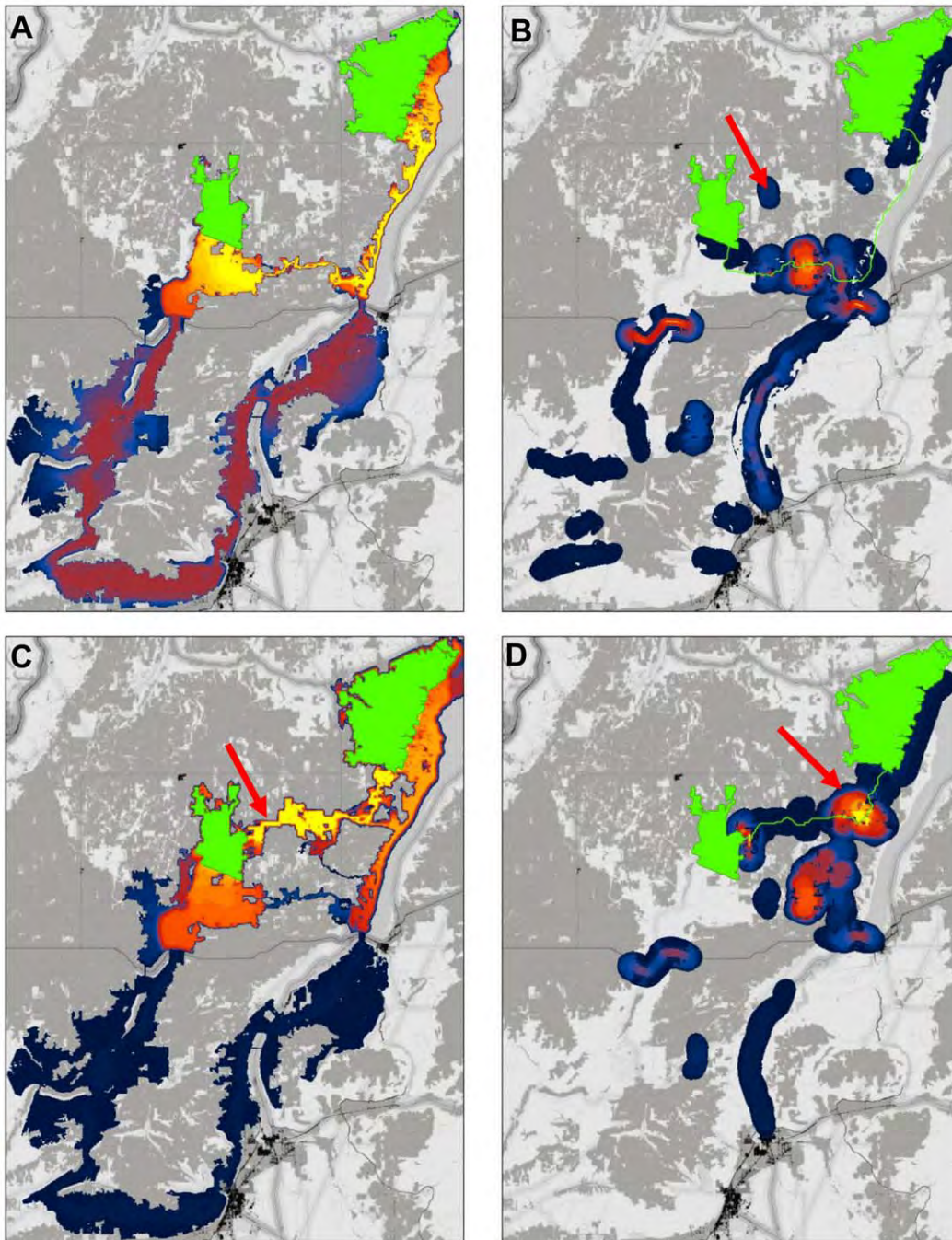
summed. This identifies barriers with high network centrality, similar to analyses that identify corridors or pathways with high centrality [21,22,45,46].

#### Applications for error checking and sensitivity analyses

GIS land cover data used to develop resistance layers for connectivity analyses are typically based on satellite or aerial imagery and often suffer from high levels of classification error [34,47]. Although our method relies on these same base data, it can help to prioritize error checking of the data by highlighting mapped features that strongly influence corridor locations. If a permeable feature is misclassified as impermeable and identified as a barrier, the misclassification could entirely alter a corridor's location. We recommend examining detected barriers, either by manually checking aerial imagery or conducting field surveys. Similarly, impermeable features misclassified as permeable that occur along least-cost paths can change corridor locations as well. Examining features along least-cost paths in tandem with barriers could thus further reduce the effects of classification error in connectivity analysis products.

Barrier detection can also be applied to parameter sensitivity analyses, important because resistances are often assigned based on expert opinion, which can be unreliable [34,47,48]. For example, if a given land cover type fell along a corridor's least-cost





**Figure 6. Reanalysis of connectivity modeling results using barrier detection algorithm.** (A) Corridor connecting natural landscape blocks, showing least-cost movement routes. Best 20% of study area shown. (B) Barriers detected at diameters from 200 m to 2 km, with original least-cost path shown in green for reference. Mitigating barriers along the least-cost path (i.e., intersecting the green line) would improve the existing corridor without changing its location; mitigating barriers away from the path would re-route the best modeled corridor. (C) Restoring a 1 km<sup>2</sup> (500 m × 2 km) swath spanning the barrier indicated by the arrow establishes a new least-cost corridor to the North. (D) A barrier analysis incorporating the simulated restoration indicates opportunities to substantially improve the new corridor with additional restorations.  
doi:10.1371/journal.pone.0052604.g006

path or encompassed an influential barrier outside of the corridor, the resistance assigned to that land cover type would be known to influence the corridor's location. The sensitivity of the corridor's location to the resistance value assigned the land cover type could then be analyzed using alternative parameterization methods as described by Beier et al. [47]. As with connectivity models, our method will depend on the grain size of the resistance raster; to

adequately resolve features that potentially impede movement, we recommend pixels no larger than  $\frac{1}{2}$  the width of barriers one is interested in detecting.

#### Potential enhancements

**Directionality of barrier effects.** Our methods could be improved to more precisely pinpoint barriers. For example,

elongated moving windows (search polygons) could perform better than circles to identify the best path for an improved corridor design. Measuring  $ALCD$  along elongate polygons placed at different angles, although more computationally complex than measuring across circles, would allow the attribution of directionality to barrier effects as well as adjustment of improvement scores at large search distances to reflect improvement achievable at smaller (nested) distances. New procedures to select the best orientation and width of such polygons could obviate the need to subjectively orient restoration polygons, like the 500 m $\times$ 2 km polygon in our simulated restoration (Figure 6).

**Restoration cost.** We measured barrier strength by conservation improvement per meter restored because it was the simplest way to illustrate our approach. An alternative metric would be conservation improvement per restoration dollar; this would reflect, for example, that the cost per meter of a 10 m road crossing structure exceeds the cost per meter of a 50 m crossing structure, which in turn exceeds the cost per meter of restoring agricultural land. This enhancement would facilitate incorporation of connectivity restoration into return-on-investment analyses [49,50], helping managers to balance improvement potential, corridor importance, costs, and risk of conversion or degradation when deciding which parts of a landscape should be conserved or restored. The disadvantage, or course, is that this metric would require more data to calculate.

**Restoration efficacy.** Different  $R'$  resistance values could be applied to different land cover types to reflect the fact that some barriers would be more permeable to movement following restoration than others. For example, a highway underpass installed to allow animal movement may still have considerable resistance, whereas a restored forest stand may have resistance similar to undisturbed forest.

**Other enhancements.** Just as areas that cannot be conserved can be removed from reserve selection algorithms [51], unremovable barriers, such as urban areas, could be excluded from barrier analyses. The metrics described in equation (2) could be modified to incorporate restoration costs that vary by feature type, or land prices mapped using parcel data. Metrics of corridor importance (e.g., link centrality) could be integrated by multiplying improvement scores by such metrics, which would highlight opportunities to restore the most potent barriers in the most important corridors. Or, rather than focusing on pairs of patches, the method could be altered to focus on the connectedness of each patch by summing barriers detected between each patch and all others. Lastly, improvement scores may be expressed in terms of absolute improvement or percent improvement relative to unrestored corridor resistance. An advantage of the latter approach is that it would favor restoration in corridors in which  $LCD$  values are already low, presumably meaning they are more viable.

Which of these enhancements are most valuable will depend on the objectives of individual users and projects.

### Application in other connectivity modeling frameworks

Although least-cost corridor models are by far the most commonly applied connectivity planning tool, they rely on simple assumptions about animal movement and other processes [43,48,52,53]. However, our approach can be applied in any connectivity modeling framework that produces measures of effective distance. For example, circuit-based connectivity analyses can model the relative proximity of each pixel to two patches by setting the voltage of one patch to 1 and the other to ground (see [15] for details on applying circuit modeling to landscapes). The resulting voltage surface gives the probability that a random

walker will reach one patch before reaching the other [15,54]. Strong gradients in voltage indicate barriers that separate areas relatively accessible to one patch from areas relatively accessible to the other. If removed, such barriers would reduce effective resistance between the patches, an analog to  $LCD$  that takes into account the availability of multiple, parallel connections. A similar approach is widely used in microchip design: simulated voltage levels reveal areas with strong voltage gradients (known as IR drops) where electrical connectivity must be enhanced [55]. Thus barrier analysis using circuit theory can identify opportunities to provide valuable redundant connections even when  $LCD$  would not be reduced. In contrast, barrier analysis using least-cost methods will not identify these opportunities.

Individual-based movement models provide a more complex but also more powerful framework for modeling connectivity, capable of incorporating more biological realism and behavioral information than least-cost or circuit analyses [56]. As long as an individual-based model can produce maps of effective distance (e.g., based on the probability of, or energetic expenditure associated with, reaching different locations from a source patch), the approach described here could be applied to the model. Models such as PATH [16] and HexSim [17] can be used to derive such measures.

### Potential for integration with systematic conservation planning

Our method is not a substitute for algorithms like Marxan [57] or Zonation [51], which are designed to optimize selection of reserves or sets of conservation actions. Although our method identifies and ranks candidate areas for restoration actions, it does not select optimal *sets* or portfolios of conservation actions to achieve given conservation goals while minimizing cost. The same can be said for algorithms designed to map areas that most facilitate movement and connectivity (e.g., [22,40,46,58–60]); rather than incorporating optimization routines, such algorithms instead produce maps that must be interpreted by practitioners, who then make conservation decisions in light of costs, benefits, and other management objectives.

Although it has long been recognized as important to reserve network design [61], incorporating connectivity directly into optimization algorithms has proven difficult. Most such efforts can be characterized as minimizing local fragmentation by either considering the geographic proximity of candidate areas to other areas (e.g., [62–64]) or maximizing the compactness and contiguity of reserves by favoring selection of adjacent cells or using boundary quality or length penalties (e.g., [29,57,65,66]). Because these algorithms favor conserving or restoring contiguous natural areas, they may neglect areas that, although fragmented, contribute to connectivity between natural areas. Thus, relying solely on maximizing the proximity or contiguity of protected areas could lead to elimination of movement routes that cross human-dominated landscapes.

Progress toward synthesizing connectivity and optimization algorithms has likely been hampered by the ‘network’ nature of connectivity planning: conservation in one area can affect the function and value of distant areas, contingent upon the conservation status and characteristics of the intervening landscape. Incorporating this complexity into optimization algorithms becomes computationally prohibitive with large numbers of planning units [67]. Still, practitioners are beginning to use outputs of multi-species connectivity models as inputs to optimization algorithms like Zonation [23,68]. Such examples are promising, and should be equally applicable with restoration-oriented algorithms such as ours.

An alternative to our approach that would seek to develop a near-optimal set of conservation actions would be to employ a routine similar to that used by Zonation software, which begins with an intact landscape and iteratively removes grid cells with low conservation value [51,69]. Starting with a landscape in which all restorable barriers have been removed, different sets of barriers could be added back in and connectivity metrics recalculated at each iteration. As with traditional connectivity models, however, this would be computationally prohibitive with large numbers of patches or restoration sites because of the computational time required for recalculating connectivity metrics. A promising hybrid approach could be to use the method described in this paper to identify sets of pre-screened restoration opportunities, which could then be removed from a resistance surface and added back in using an algorithm like Zonation's.

### Practical considerations for improving conservation and restoration decisions

Managing for connectivity to facilitate gene flow, climate adaptation, and other processes is challenging without reliable maps to guide practitioners [33]. Connectivity analyses have provided valuable implementation guidance in the past; barrier mapping can increase the rigor of such analyses and the range of conservation options they reveal. It can help practitioners a) decide if connectivity conservation is a worthy investment in a landscape; b) identify opportunities to restore vs. conserve different areas; c) reduce uncertainty due to errors in GIS base data; and d) balance potential improvement against costs so that investments can be prioritized.

The goals of managers and planners can be used to guide applications of barrier detection methods. For example, if a transportation agency is interested in determining which highway segments are likely to have the greatest impact on wildlife movement, the search window should correspond to the width of highways, with outputs clipped to highways and the  $R'$  value determined based on the estimated resistance of the kind of crossing structure (or alternative structures) being considered. If a land management agency is prioritizing restoration of degraded native vegetation, the search window should relate to the size of appropriate restoration projects, and outputs should be clipped to the eligible land base (e.g., limited to the type of vegetation the restoration would target). If an NGO is identifying landowners interested in obtaining voluntary incentive payments for wildlife-friendly management, the window should reflect the scale of such management. Summarizing barrier analyses across multiple scales will be desirable for collaborations among organizations with differing goals and mandates. As noted above, iterative application of the model with simulated restorations will likely provide the most informative results and most robust conservation plans.

Similarly, the method may have potential to help adapt results from coarse-filter connectivity assessments, such as landscape integrity/human modification-based connectivity maps, to more

fine-filter objectives (see [70] for a review of coarse- and fine-filter conservation planning). Alternative corridors revealed by the method could be assessed for their suitability under different planning constraints (e.g., corridors for species that must avoid cliffs, as in the Columbia Plateau example). While not a replacement for species-specific connectivity analyses, such an approach could help land managers evaluate alternatives if a mapped corridor is deemed unsuitable for their particular needs.

Connectivity maps do not always identify functioning routes that need to be maintained and protected; rather, they frequently map routes that may not be currently viable, but appear to provide the best opportunities for future work toward enhancing connectivity. In this sense connectivity maps often represent visions and goals for desired future conditions [71]. Barrier detection can add insight into the practicality of these goals, and identify specific options for achieving them. It can also help practitioners to 'triage' a connectivity plan, identifying corridors that traverse numerous barriers – and therefore would require significant investment to fully restore – so that efforts may be focused on more viable movement routes.

Perhaps most importantly, the ability to detect options to re-route corridors also opens up a broader suite of potential actions to improve connectivity. It can help managers identify new corridors that add additional movement pathways in areas important to the overall connectivity of a landscape (i.e. linkages with high centrality). Combined with spatially explicit land cost data, the method could help to improve conservation efficacy while reducing costs.

We hope barrier analyses will expand conservation options available to managers, and broaden conversations about restoration of connectivity more generally. By identifying new ways to improve connectivity in a particular area, the method can allow managers to consider different suites of strategies, or engage with new sets of stakeholders with interests in different areas. Both from the perspective of entities mandated to carry out conservation actions, and from the perspective of stakeholders with interests in the lands that are the focus of such actions, broadening the suite of alternatives and tools can only increase the opportunities for finding common ground in pursuit of multiple objectives.

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### Author Contributions

Conceived and designed the experiments: BHM. Performed the experiments: BHM. Analyzed the data: BHM. Contributed reagents/materials/analysis tools: BHM. Wrote the paper: BHM SAH PB DMT. Suggested refinements to methods and analyses: SAH, PB, DMT.

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**Improving the Success of Wetland Creation and Restoration with  
Know-How, Time, and Self-Design**



William J. Mitsch; Renee F. Wilson

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## IMPROVING THE SUCCESS OF WETLAND CREATION AND RESTORATION WITH KNOW-HOW, TIME, AND SELF-DESIGN<sup>1,2</sup>

WILLIAM J. MITSCH AND RENÉE F. WILSON

*School of Natural Resources and Environmental Science Program, The Ohio State University, 2021 Coffey Road, Columbus, Ohio 43210 USA*

**Abstract.** The creation and restoration of new wetlands for mitigation of lost wetland habitat is a newly developing science/technology that is still seeking to define and achieve success of these wetlands. Fundamental requirements for achieving success of wetland creation and restoration projects are: understanding wetland function; giving the system time; and allowing for the self-designing capacity of nature. Mitigation projects involving freshwater marshes should require enough time, closer to 15–20 yr than 5 yr, to judge the success or lack thereof. Restoration and creation of forested wetlands, coastal wetlands, or peatlands may require even more time. Ecosystem-level research and ecosystem modelling development may provide guidance on when created and restored wetlands can be expected to comply with criteria that measure their success. Full-scale experimentation is now beginning to increase our understanding of wetland function at the larger spatial scales and longer time scales than those of most ecological experiments. Predictive ecological modelling may enable ecologists to estimate how long it will take the mitigation wetland to achieve steady state.

**Key words:** *achieving successful wetland mitigation; creating wetlands; ecological engineering; ecological modelling; freshwater marshes; functional analysis of wetlands; mitigation of wetland loss; Olentangy River Wetland Research Park, Ohio; wetland succession.*

### INTRODUCTION

The way in which we measure “success” of created or restored wetlands and our ability to achieve success are two issues that have come under increased discussion in recent years by wetland scientists and managers. Success in the general sense here means the establishment of a biologically viable and sustainable wetland ecosystem. Some call a wetland a success when it replaces the functions lost in a wetland that is being replaced; others would gauge success of a created or restored wetland against natural reference wetlands in the region. Unfortunately, there has been little formal published follow-up of the poorly named (see Renner 1994) “mitigation wetlands” that are constructed to replace wetlands that are unavoidably lost and there are few satisfactory methods for assessing replacement of the functions lost with the original wetland (Mitsch and Gosselink 1993). Regulators and consultants have chosen to use simple indicators of “success” to expedite the process and to keep monitoring costs low. Normally 3–5 yr of simple once- or twice-per-year monitoring is required, with easily measured parameters such as plant lists, animals witnessed, and percentage vegetation cover as the overall indicators. Assessing success is then based on comparing these easily measured parameters with a relatively simple set of criteria that were stipulated in the original permit for

the project; these criteria may or may not accurately reflect wetland function.

After reviewing pertinent literature, we discuss three fundamental requirements for achieving success of wetland creation and restoration projects: understanding wetland function, giving the system time, and appreciating the idea of self-design. Our hypothesis is that most attempts to measure and achieve success of created and restored wetlands—caused by a lack of application of good wetland science to the problem and compounded by the existing construction-schedule-driven process—are flawed because of misunderstanding or misapplication of these factors. We then argue that ecosystem-level research and ecosystem modelling may provide better guidance on when created and restored wetlands can be expected to comply with criteria that measure their success.

### STUDIES ON WETLAND MITIGATION SUCCESS

Most studies suggest that there is much room for improvement in the building of wetlands. Maguire (1985) used area, vegetative cover, and implementation of permit conditions to estimate mitigation success in Virginia and found that only 50% of 23 mitigation wetlands were “successful.” In most unsuccessful cases, the mitigation project had not been implemented. An additional study by Reimold and Cobler (1985) conducted for the U.S. Environmental Protection Agency (EPA) gave similar results. Glubiak et al. (1986) and Quammen (1986) both suggested the need for better management of mitigation wetlands. Additionally Glubiak et al. (1986) predicted that while the protection

<sup>1</sup> Manuscript received 10 June 1994; revised 3 April 1995; accepted 12 April 1995.

<sup>2</sup> For reprints of this group of papers on wetland mitigation, see footnote 2, page 33.

of wetlands through a permit process—Section 404 of the Clean Water Act enacted by the U.S. Congress in 1972—was somewhat effective, it would not prevent wetland area losses as effectively as it should.

In the mid-1980s some scientists involved in wetland restoration and mitigation believed that mitigation was working (Harvey and Josselyn 1986), while others suggested that more research needed to be done and that, if not properly conducted, a wetlands mitigation project could easily fail (Race 1986). Kusler and Groman (1986) raised concerns about the granting of Section 404 permits to contractors when alternative sites are available. Many questions and issues were raised by Kusler and Groman (1986) and Golet (1986) regarding permitting processes and the actual success of wetland mitigation projects. Their major issues were: When should destruction/damage and subsequent creation/restoration be permitted? How is the damage to the original system measured and how is the creation/restoration deemed sufficient? Golet (1986) suggested that under no circumstances should damage to a wetland be allowed unless there is absolutely no alternative.

While there are many factors that could be used to monitor progress of mitigation wetlands, observing vegetation has often been the easiest and probably the most common method (see, e.g., Wentworth et al. 1988, Jarman et al. 1991, Atkinson et al. 1993). This concept has already been codified in several parts of the country. For example, in Massachusetts, vegetation cover of  $\geq 75\%$  is the major success criterion, even if vegetation composition is very different from that of the original wetland (Jarman et al. 1991). Reinartz and Warne (1993) argue that while vegetation cover may be an easy measure of success, it is a poor indicator of function.

Recent investigations of wetland mitigation projects, as a greater number of mitigation sites have become available for scrutiny, generally reinforce the early concerns. For example, Erwin (1991) found that, of 40 mitigation projects in south Florida involving wetland creation and restoration, only about half of the required 430 ha of wetlands had been constructed and that 24 of the 40 projects (60%) were judged to be incomplete or failures. The most significant problems identified with created wetlands were improper water levels and hydroperiod. Sifneos et al. (1992) collected information from permits on Louisiana, Alabama, and Mississippi wetland mitigation projects and found that in Louisiana (their primary area of interest) only 8% of areas impacted by dredge-and-fill activity was compensated for, and  $>50\%$  of the areas receiving permits covered  $<0.4$  ha. Additionally, only 10% of the mitigation wetlands were monitored by at least one site visit. The lack of standardized record-keeping from state to state made the study difficult. The study suggests that follow-up monitoring and information on wetland functions be required in future permit decisions. Kentula et al. (1992) investigated several mitigation wetlands in Or-

egon and Washington and found a net loss in wetland area of 43% for Oregon and 26% for Washington. Data were either incomplete or of poor quality and up-to-date standardized databases were recommended. In a similar study, but without field checks, Holland and Kentula (1992) examined  $>300$  Section 404 permits issued in California from 1971 to 1987 and found that while 1260 ha of compensatory mitigation (wetland creation, restoration, or preservation) had been required for impacts to 1180 ha of wetlands over that period, there was little follow-up of the permits and fewer than one-third (31.5%) required any field monitoring. Confer and Niering (1992) found that when comparing five created freshwater marshes with five nearby natural ones, the created marshes generally had greater water depth and thus more open water. They state that most of their created wetlands were highly dependent on highway runoff as a water source. Roberts (1993), quoting several ecologists, summarizes the skepticism by calling wetland trading “a loser’s game.”

#### IMPROVING THE ODDS OF WETLAND SUCCESS

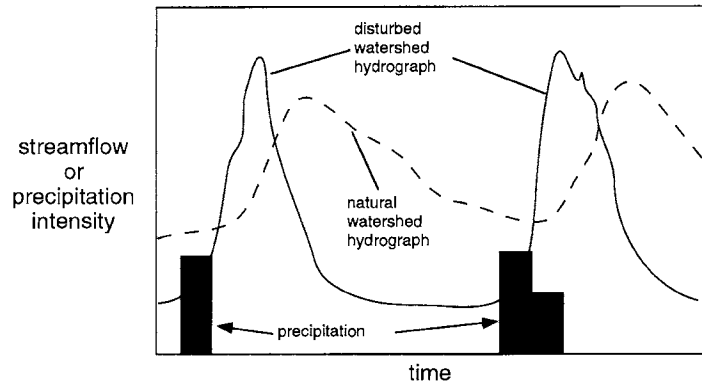
We propose three general concepts that will need attention of those involved in wetland mitigation if we are truly going to address the issue of creating and restoring viable wetland ecosystems: (1) Understand wetland function; (2) Give the system time; and (3) Allow for the self-designing capacity of nature. These points are discussed in detail below.

##### *Understand wetland function*

Mitsch and Cronk (1992) proposed that the “know-how” of building and restoring wetlands is based on an empiricism with little scientific backing, and is learned and relearned every time a new wetland is built. Wetland restoration and creation are relatively new fields and few engineers are trained in ecology and few ecologists have any experience in engineering methods. Engineers, consultants, scientists, and landscape architects can, and frequently do, claim to be experts with little experience or little knowledge of wetland ecology; without any certification standards for individuals involved in wetland creation and restoration, projects are often carried out by organizations and individuals not well versed in wetland ecology. A relatively high number of “failures” of mitigation wetlands can be attributed to a general lack of understanding of first principles of wetland science.

For example, an understanding of wetland hydrology as the fundamental forcing function of wetlands is well understood conceptually (Mitsch and Gosselink 1993) yet not always put into practice by many of those involved in wetland mitigation. The importance of hydrology is discussed in detail in a companion paper by Bedford (1996). Erwin (1991) pointed out that a number of Florida wetlands were considered failures in his Florida study because they lacked suitable hydrology. In so-called “on-site mitigation,” wetlands are devel-

FIG. 1. Comparison of a hypothetical stream hydrograph in a natural watershed vs. one from a highly disturbed urban or suburban watershed. Placing the wetland in either of these two watersheds would probably lead to significantly different wetland structure and function.



oped in watersheds near the wetlands being drained or lost; their success is often problematic because of the usual proximity of the mitigation project to a human-altered landscape and the accompanying changes in hydrologic conditions. In these settings, created and restored wetlands can be subjected to "flashy" streams and human-regulated hydrologic conditions. In urban and suburban settings, floods are often greater and occur more quickly after precipitation; low-flow conditions are drier than in a "natural" hydrology (Dunne and Leopold 1978). Both of these conditions lead to generally greater water level fluctuations compared to those in more natural settings (Fig. 1). Unpredictable and rapidly fluctuating hydrology can lead to washouts, scouring, planting failure, and animal and macroinvertebrate emigration, leading to decreased biodiversity and even loss of water quality function.

#### *Give the system time*

A flaw in the measurement of mitigation wetland success is the limited amount of time that regulators and the land development process allow for newly created wetlands to develop before passing judgment. The legal and economic necessities seem to dictate the ecological patterns of nature, encouraging "quick-fix" wetlands while not allowing for the stochasticity of nature. Engineers have long recognized the probabilistic nature of hydrologic events (e.g., precipitation and streamflow) yet relatively deterministic indicators such as wetland plant viability, open water area, endangered species, and waterfowl are expected to develop in a relatively short time span, usually 5 yr. The very best that we can have after 5 yr of monitoring a mitigation wetland is a general idea of the wetland's ecological trajectory and even less understanding of its function.

In one of the longest-running documentations of a constructed wetland in this country, an 8-ha freshwater tidal marsh (Windmill Point), was constructed in 1974–1975 within dikes in the James River in eastern Virginia, USA. Early indications, from 1978 to 1982, considered the wetland a success as it supported a diversity of herbaceous vegetation typical of tidal freshwater

marshes (Newling and Landin 1985). At that time the monitoring was referred to as "long-term." But the dikes were breached in 1986 due to flooding on the James River, eliminating the vegetation and submersing the wetland in the river (Landin 1994, *personal communication*). Sixteen years after construction the project could be termed by some as a hydrologic and ecological failure if long-term survival of the wetland was one of its goals.

Because of the stochastic nature of hydrologic events and the slow development of ecosystems, sometimes in spurts, sometimes in the slow process of recruitment and growth, the 5-yr time horizon can be viewed as arbitrary and probably much too short. As ecological models show (see e.g., Jørgensen 1994), the further initial conditions are from steady-state, the longer it will take for that system to reach or approach steady state (Fig. 2). Short monitoring times favor measuring success with transplanted vegetation and pioneer organisms; long-term success is less dependent on these initial conditions.

#### *Allow self-design*

There are two general approaches for introducing vegetation (and other organisms) in wetland creation and restoration projects. One is the "designer" approach of introducing species and expecting their survival in Gleasonian zones, akin to gardening or landscape architecture. The other emphasizes the "self-design" or "self organization" capacity of Nature to both recruit species on its own and to make choices from those species introduced by humans (Odum 1989, Mitsch 1993). In self-design the emphasis is on the introduction of as many species as possible, knowing that natural forces will help in the ultimate design by choosing the most appropriate species. Self-design also recognizes the importance of natural colonization of species in wetlands.

In one of the few studies to make a preliminary comparison of these two general approaches, Reinartz and Warne (1993) compared 11 created wetlands in southeastern Wisconsin that were naturally colonized with 5 wetlands in the same region where 22 species were

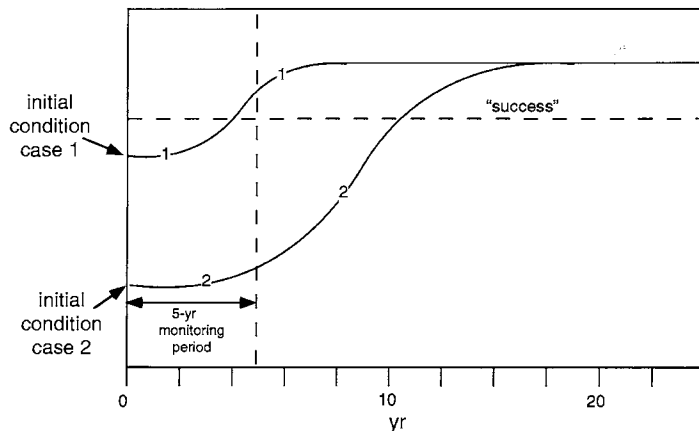


FIG. 2. Hypothetical comparison of the pattern of one wetland criterion for "success," e.g., percentage vegetation cover, for two different initial conditions at the same hypothetical wetland site. In Case 1 the wetland would be considered a "success" after 5 yr, while in Case 2 the wetland would be considered a "failure." Each wetland case could end up eventually at the same level, but well after 5 yr. In reality, a multiplicity of criteria would be used in this comparison.

introduced by seeding. The diversity and richness of plants in the colonized wetlands increased with age, size, and proximity to the nearest wetland source even though *Typha* spp. comprised 15% of the vegetation for 1-yr-old wetlands, and 55% for 3-yr-old wetlands. Seeded wetlands had a high species diversity and richness after 2 yr and *Typha* cover in the seeded sites was lower than in the naturally colonized sites after a 2-yr period.

Many studies to date (e.g., Confer and Niering 1992, McKnight 1992), especially those on restoration of non-coastal wetlands, have probably over-predicted—because of short time horizons and small spatial scales—the survivability of transplanted species in "designer" wetlands. (An exception to this short time horizon is the long-term observation of Frenkel and Boss [1988], through aerial photography, of the spread of *Spartina patens* in areas along Oregon's coastal wetlands.) With enough time and space, introduced species may be less successful than we initially believed. A better idea is to give the wetland system many possibilities through multiple-seeding, multiple-transplanting, and establishment of hydrologically open systems; this allows nature to participate in the wetland design.

#### PROVIDING THE NEEDED RESEARCH TOOLS

In addition to the above suggestions for wetland managers and ecological engineers who are attempting to design and monitor wetlands, there are some important approaches that wetland scientists can use to reduce the uncertainty of wetland mitigation.

##### *Select the proper experimental scale*

The limited ability of science as we generally practice it to both understand and solve our dilemmas in natural resource conservation was argued by Ludwig et al. (1993) and debated in the pages of *Ecological Applications* (Levin 1993). Taking the cue from Holling (1993) and Costanza (1993) in that discussion, we question whether reductionistic experimental science, with its short time scales (often the time required for

a Ph.D. dissertation) and its small spatial scales (often in laboratories or small field plots) can correctly prescribe how to build large wetlands. A holistic systems approach, with the appropriate time and space scales, should at least have equal emphasis.

As one example, a number of studies of wetland function were carried out with four full-scale constructed wetlands at the Des Plaines River Wetland Demonstration Project in northeastern Illinois (Sanville and Mitsch 1994). Hydrologic conditions were varied for high- and low-flow conditions for entire wetlands (average size: 2.4 ha), not just experimental plots; the studies were carried out over 3 yr. Researchers had important findings in estimating detention and mixing (Kadlec 1994), water quality function (Hey et al. 1994, Phipps and Crumpton 1994), sedimentation (Brueske and Barrett 1994, Fennessy et al. 1994a), vegetation development (Fennessy et al. 1994b), aquatic metabolism (Cronk and Mitsch 1994a, b), and avian success (Hickman 1994) in created wetlands, most as a function of hydrology.

In a comparison of two natural tidal marshes with a 0.65-ha constructed marsh in coastal Virginia 5 yr after construction, Havens et al. (1995) found seasonal differences in fish and shellfish abundances between natural and constructed marshes, with lower numbers in the latter. They attribute the differences to relative lack of organic carbon and less morphometric heterogeneity (e.g., stream rivulets, microtopography) in the created marsh.

We recently initiated a full-scale comparison of "self-design" and "designer" approaches to wetlands at the Olentangy River Wetland Research Park at The Ohio State University (Fig. 3; Mitsch and Wu 1995, Mitsch 1995). In one newly constructed wetland basin (1 ha), we planted, in approximately the stratification that we would find in nature,  $\approx 2500$  individuals representing 14 species of wetland plants. In an identical constructed wetland basin nearby, we planted nothing. Hydrologic conditions are being maintained as similar as possible in the two basins and there is no predeter-

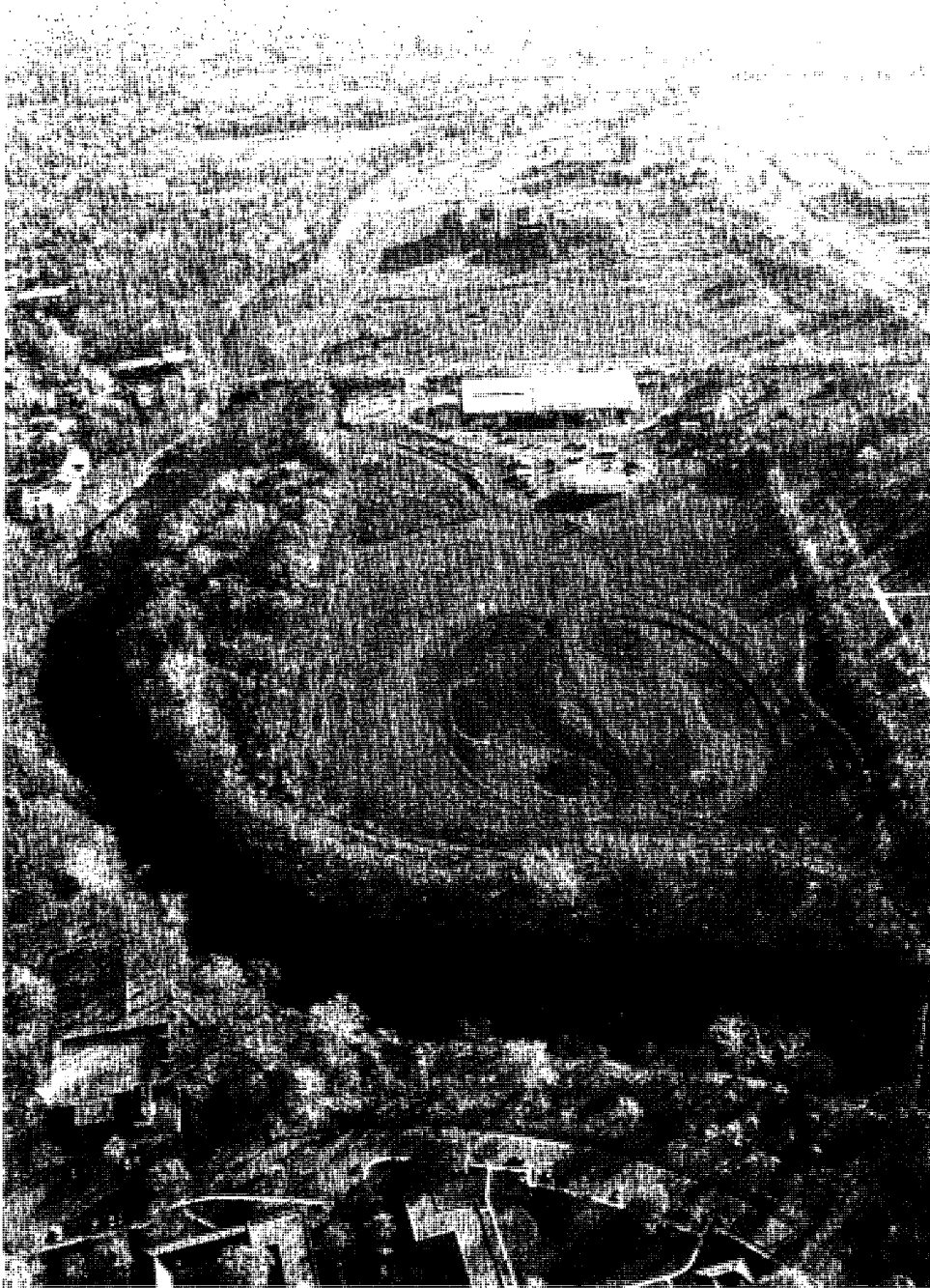


FIG. 3. The Olentangy River Wetland Research Park at The Ohio State University in Columbus, Ohio, USA, is a whole-ecosystem long-term experiment begun on 14 May 1994 with the planting of one of the deep-water marshes shown in foreground (right basin) with  $\approx 2500$  plants representing 15 wetland species. The second deep-water marsh (left basin) remains unplanted. Each basin is 1 ha in size and water is supplied by pumps in the lower right-hand corner of the site to create a similar hydrology for each basin. The Olentangy River, shown flowing from bottom right to the top of the picture (with the university  $\approx 0.5$  km downstream of the site on the horizon of the picture), is the source of the water, which is pumped in proportion to the river flow in the same patterns for each wetland basin. The photo was taken in November 1993 prior to the introduction of water to the wetlands (photo by Mark Myers, Apex, Columbus, Ohio).

mined completion date to our experiment. We believe that our "experiment" is closer to the scale necessary for documenting the forces, e.g., plant recruitment, geese and muskrat invasions, etc., that influence eco-

system development. Working at this full scale precludes extensive replication because of land and construction costs, yet our understanding of ecosystem development and other wetland functions will come only



from studying spatial scales and longer time scales to supplement traditional ecological experiments.

#### *Develop predictive modelling*

Little attention has been paid to ecological modelling—the one tool that can expand the time horizon—in predicting success of created and restored wetlands. While this approach must be used with caution and proper qualifications, it enables ecologists to project into the future and estimate how long it will take the mitigation wetland to achieve some type of steady state. A few publications (Costanza and Sklar 1985, Mitsch et al. 1988, Mitsch 1994) have reported on the state of the art of simulation modelling in wetland ecology, but this powerful “systems” tool has rarely been used to predict mitigation success. Stochastic inputs, adaptive model structure (Jørgensen 1994), higher-order modelling languages (e.g., STELLA) and spatially dynamic models are useful advances in ecological modelling, but simple-structure models that aggregate components into overall variables such as “vegetation” or “nutrients” can be just as effective (Mitsch et al. 1995). In an application of modelling for a mitigation project in central Ohio, Niswander and Mitsch (1995) used simulation models both to “fill in” information to make calculations about ecosystem function (phosphorus retention) of a created freshwater marsh and to “enhance the time horizon” by predicting one structural aspect of this project well into the future—the survival of planted wetland trees over the next 50 yr. Modelling, of course, will not provide an exact prediction of conditions well into the future but, when used with good wetland ecology and sufficient field monitoring, it can provide another tool for those interested in predicting the future of created and restored wetlands.

#### CONCLUSIONS

There is optimism that wetlands can be created and restored and that wetland function can be replaced, despite a recent spotty record in the United States with the mitigation of wetland loss. The spotty record is due, in our opinion, to little understanding of wetland function by those constructing the wetlands, insufficient time for the wetlands to develop, and a lack of recognition or underestimation of the self-design capacity of nature. Understanding wetlands enough to be able to create and restore them requires a substantial training in plants, soils, wildlife, hydrology, water quality, and engineering. We should give mitigation projects involving freshwater marshes enough time, closer to 15–20 yr rather than 5 yr, before judging their success. Restoration and creation of forested wetlands, coastal wetlands, or peatlands may require even more time. For example, the restoration of certain coastal salt marshes has been suggested to require at least 50 yr (Frenkel and Morlan 1991). Finally, we should recognize that Nature remains the chief agent of both self-

design and ecosystem development; humans are not the only participants in the design process.

Science will need to make significant contributions to the process of reducing our uncertainty about predicting wetland success. Wetland mitigation needs to become part of an applied ecological science, not a technique that is relearned each time without theoretical underpinnings. Scientists need to make the connections between structural measures (e.g., vegetation density, diversity, productivity) and functions such as wildlife use, organic sediment accretion, or nutrient retention in quantitative and carefully designed experiments. Simply having a list of plant species is inadequate for regulators or managers to estimate ecosystem function. Simulation models and experimentation at the proper spatial and temporal scales should be able to help us predict the behavior of these wetlands and estimate proper designs.

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# Geometry of Forest Landscape Connectivity: Pathways for Persistence

Deanna H. Olson and Kelly M. Burnett

## Abstract

Streamside areas may be dispersal funnels or runways for a variety of species. For over-ridge dispersal, headwaters offer the shortest distance links among riparian zones in adjacent drainages. We summarize landscape designs for connectivity of habitats using headwater riparian linkage areas as the foundation for a web of landscape-scale links. We developed management considerations for placement of headwater linkage areas including: 1) providing connections between larger basins; 2) maintaining habitat connectivity in the face of climate change; 3) incorporating place-based disturbance regimes such as headwater debris-flow-prone areas; 4) targeting connectivity areas to address sensitive species conservation strongholds; and 5) accounting for geometry at the forest-stand scale of a single project or proposed timber sale, including managing habitats to connect lands on adjacent federal ownerships, by means of connecting corners of checkerboard landscape blocks along diagonals. Although our proposed linkage areas are designed to target headwater species, the resulting web of connections across the landscape is expected to benefit many forest-dependent species.

**Keywords:** watersheds, forest, headwaters, biodiversity, linkage areas, dispersal.

## Introduction

Biodiversity retention and restoration is an emerging priority for global ecosystems. Astounding losses within major taxonomic groups have been reported nationally and internationally (41 percent of amphibians, 25 percent of mammals, 15 percent of bony fishes, 13 percent of birds: Hoffmann et al. 2010; 50–60 percent of turtles: Kiester and Olson 2011). In particular, protection and restoration of forests and forest biodiversity has become a paramount concern worldwide (e.g., Convention on Biological Diversity: [www.cbd.int/forest/](http://www.cbd.int/forest/)). A toolbox of management approaches has been developed to conserve forest biodiversity, largely through

a mixture of fine- and coarse-grained habitat protections (e.g., United States Northwest Forest Plan: USDA and USDI 1993, 1994; Cissel et al. 1998; Lindenmayer and Franklin 2002; Raphael and Molina 2007; Lindenmayer et al. 2007) and site-specific designs to maintain or restore forest structural heterogeneity (McComb 2001; Lindenmayer and Franklin 2002; Brockerhoff et al. 2008).

Development of landscape designs to manage habitat connectivity for multiple species is an especially active research topic in forest biodiversity conservation, due to continuing trends of forest fragmentation and to an upswing

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**Deanna H. Olson** is a research ecologist and **Kelly M. Burnett** is a research fish biologist (emeritus), USDA Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331; [dedeolson@fs.fed.us](mailto:dedeolson@fs.fed.us).

in world reforestation efforts. Managing forested landscapes for connectivity functions benefiting biodiversity requires incorporating several fundamental conservation concepts. These basic conservation tenets include identifying the critical habitats used throughout species' life histories (breeding, foraging, overwintering, and dispersal habitats), and commensurate habitat protections to ensure that these biotic functions are retained. If an organism uses different habitats through its life cycle, then maintaining connectivity among these habitats is essential to ensure its persistence. Of particular relevance is the characterization and retention or restoration of dispersal habitat. This includes the home ranges of individuals and the broader dispersal of offspring or individuals that tie sub-populations and populations together over larger areas. This broader-scale dispersal function maintains genetic variation within natural populations, which may foster resiliency needed to adapt to changing environmental conditions. The future of species may rely on our careful attention to managing for connectivity now.

Defining the adequacy of dispersal habitat in forests is a complex topic (Noss et al. 1997) and may address a variety of elements, including habitat condition, corridor sizes (length, width), and corridor redundancy (Pinto and Keitt 2008). Redundancy is especially relevant because multiple connectivity pathways can assist dispersal across landscapes by organisms in different locations and increase the probability of movement in the face of many interacting site-specific factors (microsite features, disturbances). Redundancy of habitat connectivity hedges against catastrophe, uncertainty, and stochastic processes that can affect individuals and sub-populations that vary in their movement propensities, possibly related to patch size, habitat quality, and population demography.

Low-mobility species may merit special attention devoted to the placement and redundancy of connectivity corridors, because barriers to dispersal may arise as a result of their

basic biology and ecology (Raphael and Molina 2007). These species may move slowly and require refugia along corridors because it may take them years to move between optimum habitat patches. Due to a potentially longer residency time within connectivity corridors, low-mobility species may be particularly vulnerable to sub-optimal corridor conditions and stochastic processes. Hence, redundancy of connections may be critically important to increase their likelihood of successful movement across landscapes for such low-mobility species. Patches of higher-quality habitat within dispersal corridors may be used as stepping stones for such species and may be an essential aspect of their long-term persistence (e.g., Grant et al. 2010). Such stepping stones may function as habitat refugia or "stopover reserves" (Dobson et al. 1999), which promote survival of individual organisms as they move through the environment. Stepping stones may have more suitable physical habitat conditions than the surrounding area, or may allow individuals to forage to replenish energy reserves or survive harsh seasons (summer, winter) in localized refugia, from which they may disperse again later.

Herein, we synthesize our ongoing studies of the utility of headwater riparian areas as proposed connectivity corridors, or linkage areas, for dispersal of riparian-associated and low-mobility species in Pacific Northwest forests. Once designed, such headwater linkage areas may benefit many taxa. Our studies also conceptually integrate aquatic network and upland-forest habitats, functions, and processes. The combination of protections for aquatic and upland systems is providing new insights into forest ecosystem management approaches. We summarize the key considerations for the geometric orientation of connectivity pathways to assist migration of species across watersheds and across webs of connections, to maintain linked aquatic-terrestrial populations at landscape scales. Our goal here is to provide

a summary of these conceptual designs, while research continues to address these issues and advance design effectiveness.

### **Utility of Watersheds as Redundant Landscape-scale Linkage Units**

Watersheds are widely accepted units for monitoring and evaluating the effects of land use on aquatic resources (Omernik and Bailey 1997). Where their boundaries can be clearly mapped, watersheds are increasingly common units for forest management planning and conservation designs. For example, in the U.S., the Aquatic Conservation Objectives of the federal Northwest Forest Plan (USDA and USDI 1994: p. B-11), address connectivity among watersheds:

*“Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.”*

Hydrologic units (HUs), delineated by the U.S. Geological Survey (Seaber et al. 1987), are also a convenient and widely used basis for forest assessment and planning (e.g., Maxwell et al. 1995; Suring et al. 2011). The HU coding describes a hierarchical system of units nested by drainage area; larger code numbers designate smaller drainage areas. Watersheds or segments of watersheds comprise HUs. Even though the majority of HUs at each level of the hierarchy are not true topographic watersheds, such a perspective can aid biodiversity conservation designs, especially as smaller headwater basins are delineated and used for replicating protected areas (e.g., 6<sup>th</sup>-code HUs: Suzuki et al. 2008) and creation of redundant connections across

landscapes (via 6<sup>th</sup>- and 7<sup>th</sup>-code HUs: Olson and Burnett 2009).

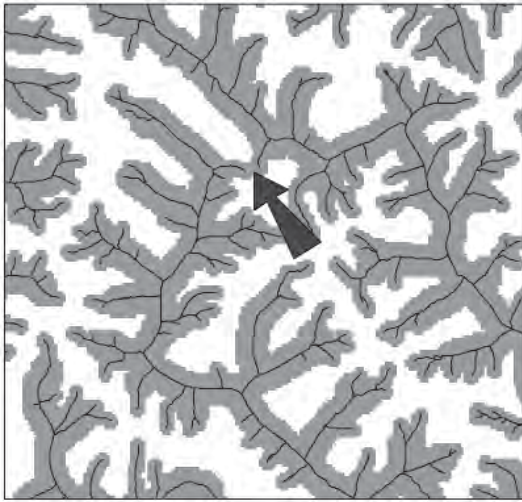
The value of using headwater basins as the premise for establishing connectivity corridors across forested landscapes is due to their habitat conditions, potential use by a variety of organisms, frequency of occurrence on the landscape, and minimization of dispersal distances (fig. 1). Olson et al. (2007) summarized some of the merits of headwater riparian habitats for species in the northwest, including providing cool, moist microclimates for interior-forest dependent organisms and aquatic-riparian associated species such as amphibians. Some taxa may use these areas due to their habitat suitability; others may respond to streams as movement barriers, and then move along banks parallel to such barriers. Streamside areas may be dispersal funnels or runways for a variety of species. For example, we have seen terrestrial salamanders (species that do not use stream or pond habitats for breeding or other life-history functions) moving predominantly through near-stream areas (D. Olson and M. Kluber, unpubl. data). Additional taxa that use riparian corridors in northwestern forests include a variety of lichens, bryophytes, fungi, vascular plants, mollusks, mammals (e.g., ground-dwelling mammals: Wilk et al. 2010), birds, and general forest-obligates that may occur in legacy forest attributes such as wolf trees along riparian buffer zones. As a minimum estimate across taxonomic groups, over 100 species were identified as likely to benefit by habitat protections of combined intermittent and perennial streams provided by riparian reserves in federal forest lands in the range of the Northern Spotted Owl (*Strix occidentalis caurina*) (table 1) (USDA and USDI 1997). Species with restricted dispersal abilities were identified for special consideration relative to utility of riparian reserves during watershed analyses under the Northwest Forest Plan (USDA and USDI 1997).

Furthermore, the high density of small streams in upland northwest forests has been widely recognized over the last 20 years, as our basic

**Table 1**—Species benefitting from interim riparian reserves developed for the federal Northwest Forest Plan (from table B1 in USDA and USDI 1997). Riparian reserve protection includes a one site-potential tree-height or 30.5 m (100 ft) buffer, whichever is greater, as an interim measure along all intermittent streams, and a two site-potential tree-height buffer as an interim measure along perennial streams (see USDA and USDI 1993, page III-9).

<b>Taxonomic group</b>	<b>Species</b>
<b>Bryophytes</b>	<i>Antitrichia curtipendula</i> , <i>Douinia ovata</i> , <i>Kurzia makinoana</i> , <i>Scouleria marginata</i> , <i>Tritomaria exectiformis</i>
<b>Fungi</b>	
Rare chanterelles	<i>Polyozellous multiplex</i>
Rare gilled mushrooms	<i>Clitocybesubditopoda</i> , <i>C. senilis</i> , <i>Neolentinus adherens</i> , <i>Rhodocybe nitida</i> , <i>Rhodocybe speciosa</i> , <i>Tricholomposis fulvenscens</i>
Rare cup fungi	<i>Helvella compressa</i> , <i>H. crassitunicata</i> , <i>H. elastica</i> , <i>H. maculata</i>
Jelly mushroom	<i>Phlogiotis helvelloides</i>
Moss-dwelling mushrooms	<i>Cyphellostereum leave</i> , <i>Galerina atkinsoniana</i> , <i>G. cerina</i> , <i>G. hetrocysis</i> , <i>G. sphagnicola</i> , <i>G. vittaeformis</i> , <i>Rickenella setipes</i>
<b>Lichens</b>	
Riparian lichens	<i>Certelia cetrarioides</i> , <i>Collema nigrescens</i> , <i>Leptogium burnetiae</i> var. <i>hirsutum</i> , <i>L. cyanescens</i> , <i>L. saturninum</i> , <i>L. teretiusculum</i> , <i>Platismatia lacunose</i> , <i>Ramalina thrausta</i> , <i>Usnea longissima</i>
Aquatic lichens	<i>Dermatocarpon luridum</i> , <i>Hydrothyria venosa</i> , <i>Leptogium rivale</i>
<b>Vascular plants</b>	<i>Bensoniella oregano</i> , <i>Botrychium minganense</i> , <i>B. montanum</i> , <i>Coptis trifolia</i>
<b>Mollusks</b>	<i>Ancotrema voyanum</i> , <i>Cryptomastix devia</i> , <i>C. henersoni</i> , <i>Monadenia fidelis salmonensis</i> , <i>Verspericola depressa</i> , <i>V. sierranus</i> , <i>Fluminicola</i> spp. nov. 1-20, <i>F. seminalis</i> , <i>Helisoma newberryi newberryi</i> , <i>Juga (C.) acutifilosa</i> , <i>J. (C.) occata</i> , <i>J. (O.)</i> spp. nov. 2-3, <i>J. (Oreobasis) orickensis</i> , <i>Lanx alta</i> , <i>Lyogyrus</i> sp. nov. 1, 3, <i>Pyrgulopsis intermedia</i> , <i>Vorticifex klamathensis sintisini</i> , <i>V.</i> sp. nov. 1
<b>Amphibians</b>	
Riparian	<i>Aneides flavipunctatus</i> , <i>Rhyacotriton cascadae</i> , <i>R. kezeri</i> , <i>R. variegatus</i> , <i>Dicamptodon copei</i> , <i>Plethodon vandykei</i> , <i>Ascaphus truei</i>
<b>Fish</b>	Coho Salmon ( <i>Oncorhynchus kisutch</i> ), fall and spring Chinook Salmon ( <i>O. tshawytscha</i> ), resident and sea-run Cutthroat Trout ( <i>O. clarkii clarkii</i> ), resident Rainbow Trout ( <i>O. mykiss</i> ), summer and winter Steelhead (anadromous <i>O. mykiss</i> )
<b>Birds</b>	Common Merganser ( <i>Mergus merganser</i> ) [Marbled Murrelet, <i>Brachyramphus marmoratus</i> ; Northern Spotted Owl, <i>Strix occidentalis caurina</i> ]
<b>Bats</b>	Fringed, Long-eared, and Long-legged Myotis ( <i>Myotis thysanodes</i> , <i>M. evotis</i> , <i>M. volans</i> ), Hoary Bat ( <i>Lasiurus cinereus</i> ), Pallid Bat ( <i>Antrozous pallidus</i> ), Silver-haired Bat ( <i>Lasionycteris noctivagans</i> )
<b>Other mammals</b>	Fisher ( <i>Martes pennanti</i> ), Marten ( <i>Martes americana</i> ), Red Tree Vole ( <i>Arborimus longicaudus</i> )





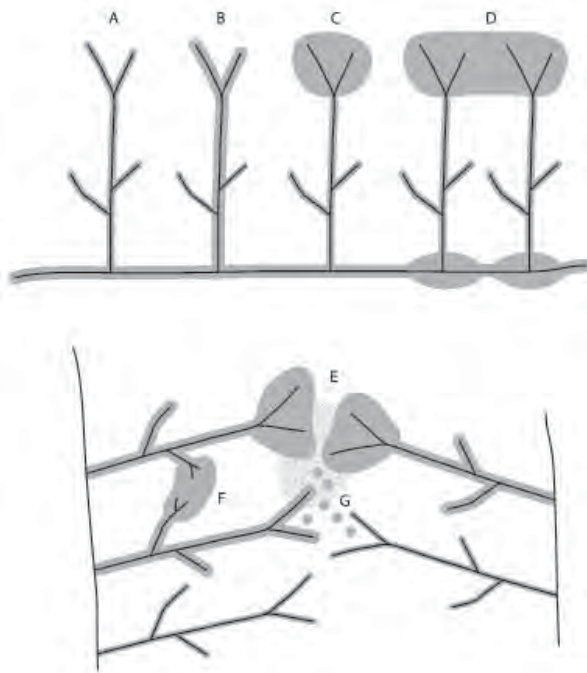
**Figure 1**—Example interim riparian reserve network from the US federal Northwest Forest Plan implemented in the Pacific Northwest, showing frequency of headwater streams on the landscape and the resulting one and two site-potential tree-height buffers along streams (upper left quadrant). Arrow indicates example over-ridge area where the distance between headwater riparian reserves in different watersheds is small and over-ridge connectivity may be more easily achieved. These headwater riparian areas can be used to facilitate landscape linkage area designs for organism dispersal and aquatic-terrestrial habitat connectivity functions.

knowledge of stream and forest ecology has expanded. In some areas, headwaters comprise 80 percent of a stream network (Gomi et al. 2002). This realization intersected with forest management practices when mapping of Northwest Forest Plan scenarios revealed that large percentages of watersheds were being incorporated into interim riparian reserves due to the high density of headwater stream networks (fig. 1). An additional value of using headwater drainages to plan landscape connectivity designs is that the distance from headwater streams to ridgelines is the shortest within a watershed, hence reducing travel distances for overland dispersal to neighboring stream-riparian areas or forest reserve blocks. Distance analysis tools, such as for “least-cost path” in landscape modeling (e.g., ArcGIS, Environmental Systems Research Institute, Inc., Redlands, CA), have been developed to assess distances between habitat patches. These tools would be useful for designing least-distance

headwater linkage areas. Least “cost” path is a relevant term applied to the economics of animal movements, to minimize the distance moved—especially for mobility-restricted organisms. This term may also apply to the economics of forest management if identification of a dispersal corridor results in a financial cost for on-the-ground implementation or affects revenue from resource extraction in a managed forest context.

Northwest Forest Plan riparian reserves were intended as major contributors to the maintenance and restoration of aquatic conservation objectives, including aquatic network connectivity (USDA and USDI 1994). The importance of linking headwater stream functions and processes to those of downstream stream networks has been a focus of much work in the last two decades. Welsh (2011) captured many elements of the developing history of stream network theory and the role of aquatic connectivity in summarizing the conceptual frameworks of geomorphic channel processes (transfer and depositional zones), nutrient cycling (upstream marine influence via salmonid migration, downstream nutrient spiraling via down wood movements), aquatic-riparian linkages via reciprocal subsidies, and the intersection of herpetofaunal distributions with the classic stream continuum concept of taxonomic patterns that vary with stream order. As we look up the aquatic network into headwater streams and beyond, we summarize how extending riparian buffers up drainages and connecting them over ridgelines can both maintain terrestrial connectivity and functionally link aquatic-terrestrial systems.

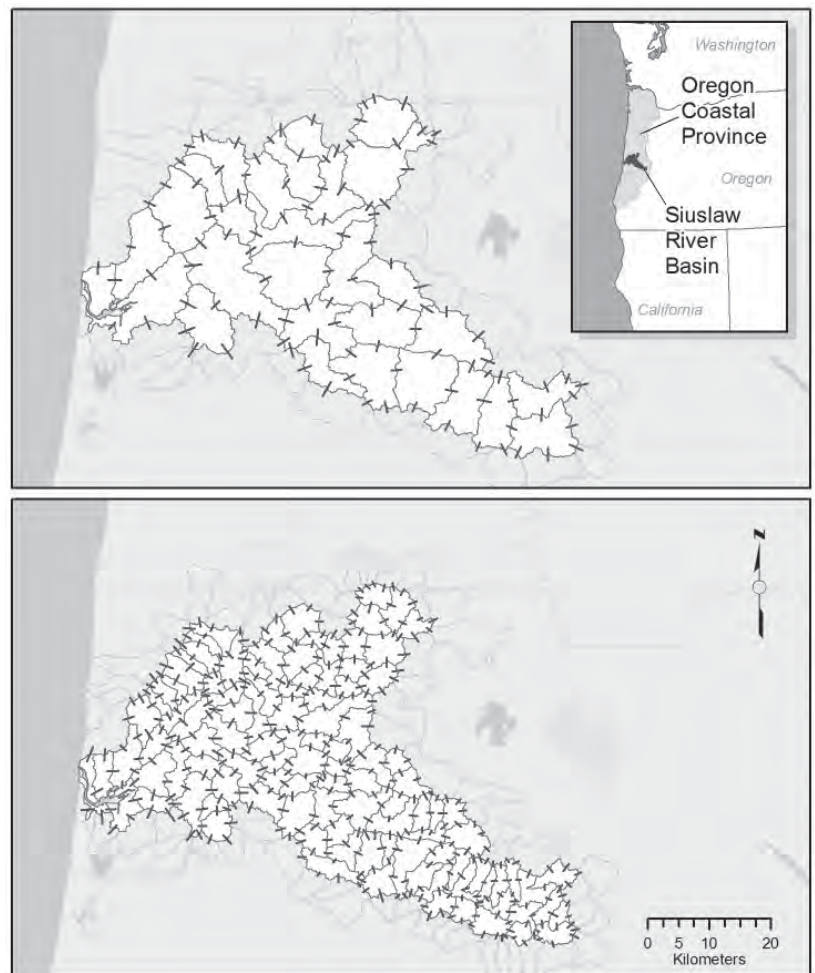
Several conceptual designs of riparian buffer widths and patch reserves have been proposed to assist over-ridge migration of organisms within forests (fig. 2; Olson et al. 2007). Over-ridge connectivity considerations were further developed by Olson and Burnett (2009), and modeled for the Oregon Coastal Province. This model of connectivity linked every 6<sup>th</sup>- and 7<sup>th</sup>-code HU to each neighboring HU. Focusing on the Siuslaw River basin, a 4<sup>th</sup>-code HU within



**Figure 2**—Headwater management considerations to retain aquatic-riparian biodiversity by stream buffers of different widths (A, B) and provide linkage areas between adjacent basins (C-G) using alternative forest management practices including uncut blocks (C, D, F), thinning (E), and leave islands (E, G) (from Olson et al. 2007).

that area, the linkage design illustrated where one over-ridge link could connect each adjacent HU (fig. 3). At the 7<sup>th</sup>-code HU scale, one link between each adjacent 7<sup>th</sup>-code watershed resulted in roughly 15 percent of headwater streams being extended and connected. For the Oregon Coastal Province, this resulted in over 5,000 links, with about one link per 4.6 km<sup>2</sup>. This is an example of redundant connectivity, essentially creating a web of connections across the landscape. Using the 6<sup>th</sup>-code HU scale, the amount of connectivity created is approximately halved, with one link per 9.3 km<sup>2</sup> for the Oregon Coastal Province.

There are no defined guidelines for how many links or how much habitat connectivity is necessary to maintain populations. The amount of dispersal habitat that might be needed to sustain even highly researched species, such as



**Figure 3**—Linkage areas between watersheds can provide connectivity of headwater habitats across landscapes. In the Oregon Coast Range Province, the Siuslaw River basin, a 4<sup>th</sup>-code Hydrologic Unit (HU), is used to illustrate: A) a single connection between adjacent 6<sup>th</sup>-code HUs; and B) a single connection between adjacent 7<sup>th</sup>-code HUs, which results in 376 connections across the basin and if expanded to the entire province, about 5000 links within 23 000 km<sup>2</sup> (from Olson and Burnett 2009).

the northern spotted owl, is unknown; a “more is better” attitude prevails in the face of this uncertainty. Nevertheless, research is accruing about how much dispersal may be needed to maintain genetic diversity within and among populations. The “one migrant per generation” rule has been offered as a minimum level to reduce genetic isolation, inbreeding, and bottlenecks (e.g., Mills and Allendorf 1996). However, such a rule has many underlying assumptions that may not be supported when the complexities of natural systems are considered (e.g., Wang 2004).

Furthermore, relating effective migration rates to habitat protections in managed systems is not a straightforward exercise: if we build corridors, will they be used? Ongoing mark-recapture, radio tracking, and genetic studies are helping us to answer this question. For example, genetic connectivity analyses of stream-associated Rocky Mountain Tailed Frogs (*Ascaphus montanus*) in Idaho supported this species’ affiliation with intact forested habitats: their path of connectivity followed riparian corridors in managed forests (Spear and Storfer 2010). This pattern supports the “riparian corridors as funnels” concept, but it contrasted with Coastal Tailed Frog (*A. truei*) genetic connectivity pathways in the Olympic Peninsula, Washington, which were primarily overland in areas that had timber harvest activities (Spear and Storfer 2008). Precipitation and population differences between these areas were hypothesized as accounting for these differences, as the more mesic conditions that prevail in northwestern Washington may facilitate the upland dispersal of moisture-reliant tailed frogs. Other studies (Wahbe et al. 2004; Johnston and Frid 2002; Dupuis and Steventon 1999; Nauman and Olson 2004) also found differences in riparian-corridor associations of various amphibian species in response to climate and forest conditions, generally supporting their ability to respond to microsite gradients with an apparent affiliation to cool, moist local conditions (e.g., riparian “funnels”) (Olson et al. 2007). Furthermore, Spear et al. (2012) reported

that Coastal Tailed Frogs track remnant tree patches in their migration pathways after the volcanic blast at Mount St. Helens, Washington. So, if we build it, will they come? The early answer is “yes, but...” —meaning that a variety of organisms appear to be occurring in or moving along pathways of retained habitats, but with geographic, taxonomic, and population-specific contexts being important considerations. A similar conclusion has recently been supported for hedgerows as corridors between woodland fragments (Davies and Pullin 2007). More research on the design of effective linkage areas will be needed. In the interim, conceptual priorities for landscape connectivity designs can be identified, and these relate directly to emerging research priorities.

### **Priority Areas for Habitat Connectivity**

Prioritizing linkage area placement may be important to address connectivity objectives under economic constraints, and to advance research into the effective design of linkage areas. Because linking all adjoining watersheds at small HU scales may be difficult for land managers to plan and implement in the face of myriad conflicting resource objectives, priorities may guide the first steps in connecting habitats. Olson and Burnett (2009) itemized linkage area considerations at two spatial scales, landscape and drainage area (table 2). Here, we further develop five of these priority considerations:

1. “Triads,” where three large basins, with limited or no aquatic connectivity, converge at their headwaters;
2. Climate change considerations including north-south, east-west, and altitudinal linkages;
3. Landslide-prone areas;
4. Species conservation strongholds; and
5. Diagonal considerations.

**Table 2**—Design considerations for placement of headwater linkage areas to assist migration of forest-dependent species in the Pacific Northwest (Olson and Burnett 2009). **Bold-face type** indicates new concepts discussed further in text.

<b>Linkage Area Design Considerations</b>	<b>Priorities</b>
<i>Landscape scale</i>	
1. Connections across large basins	<b>“Triads”</b> – headwater locations that link three adjoining basins having no aquatic connectivity.
2. Climate change migration corridors	North-south (latitudinal) dispersal routes. Altitudinal dispersal routes. Migration across ecoregion boundaries. <b>East-west dispersal routes.</b>
3. Linking landscape fragments	Connecting remnant late-successional and old-growth (LSOG) forest patches to other patches or restored habitats may aid dispersal of LSOG-associated species, especially those with dispersal limitations such as lichens, bryophytes, and mollusks; creation of connected archipelagos of patches.
4. Disturbance frequency	Correlating frequency of connections with rates of landscape-scale disturbances, natural or anthropogenic; i.e., more linkage areas in more-disturbed places.
5. <b>Redundancy</b>	Planning for multiple paths across landscapes will improve dispersal probabilities.
<i>Drainage-basin scale</i>	
6. Known sites for target species	Low-mobility species. LSOG-associated species. Species with status of concern. <b>Biodiversity hotspots</b> – communities. <b>Species “strongholds”</b> – priority species management areas such as key watersheds
7. Existing protections	Co-location of linkages on current set-asides (e.g., federal late-successional reserves, owl “cores”, Survey and Manage species sites, botanical set asides, landslide-prone areas included in riparian reserves)
8. Short connections	For economy of space, with economic and ecological benefits, shorter connectivity corridors are preferred; ecologically, shorter distances for dispersal may reduce energetic costs for individual movements and time needed for propagules to disperse.
9. Paths of least resistance	Easier dispersal routes may be lower-gradient or lower-elevation “saddles” across ridgelines. Wind-dispersers may have least resistance in paths that follow wind directions during seasons of dispersal.
10. Risk of disturbance	Use hazard models for disturbances such as landslides, debris flows, ice/wind damage, and fire in placement of linkage areas, or in decisions about the need for redundant linkages. For example, debris-flow-prone areas may be headwater set-asides during riparian reserve delineation, and such areas may be co-located with dispersal corridors; redundant links may be considered in fire-prone areas. Mapped overlays of roads, recreation areas, human development, and mining might be avoided during linkage area delineation, when alternative locations exist.
11. Land ownership patterns	Co-location of links on federal and state lands, where possible. <b>Diagonal linkage areas across checkerboard ownerships.</b>



Each of these five considerations results in a geometric view of how connectivity webs may be arranged across landscapes.

These five considerations are not mutually exclusive; how they may interact during prioritization exercises also is developed briefly here. Although they were derived for northwest forest landscapes, these concepts may have broader utility worldwide.

### 1. “Triads”

In the Oregon Coastal Province, Olson and Burnett (2009) highlighted the potential importance of linking larger river basins, which have no freshwater connectivity, through existing riparian buffer networks. Over-ridge forest habitat linkages may be absent unless reserves are placed in the area. Streams in such basins may flow directly to the Pacific Ocean or into a much larger river without a forested riparian area, and so have headwaters that are functionally disconnected. Here, we examined 4th-code HUs for the Oregon Coastal province, the scale of the Siuslaw River basin highlighted above. We then looked for locations where three of these 4th-code HUs joined at their headwaters: we call this a “triad” location. For example, headwaters of the Siuslaw River, Yaquina River, and Marys River converge at Marys Peak (between Corvallis, Newport, and Waldport, OR), which would be one such triad. Only 18 of these headwater triads exist for the Oregon Coastal Province (fig. 4). We suggest that such triads be considered priorities for habitat linkage areas because these would be spatially economical for land managers to implement and potentially ecologically efficient as connections across three watershed boundaries simultaneously.

A current research priority is to empirically assess the proposed linkage-area function of landscape locations such as headwater triads. Using a genetic approach, we have sampled northwestern amphibians from headwater streams of adjacent drainages that are potentially connected across ridgelines in the Oregon Coast Range, including

three adjoining headwaters in triads (such as Marys Peak). Preliminary genetic analyses of the Coastal Giant Salamander, *Dicamptodon tenebrosus*, generally support our contention of over-ridge connectivity among drainages (L. Knowles and M.R. Marchán-Rivadeneira, Univ. Michigan, unpubl. data). Previous studies have supported overland connectivity of stream-breeding amphibians (e.g., Spear and Storer 2008, 2010), and such animals have been found up to 400 m from streams (Olson et al. 2007), but no previous published study has designed

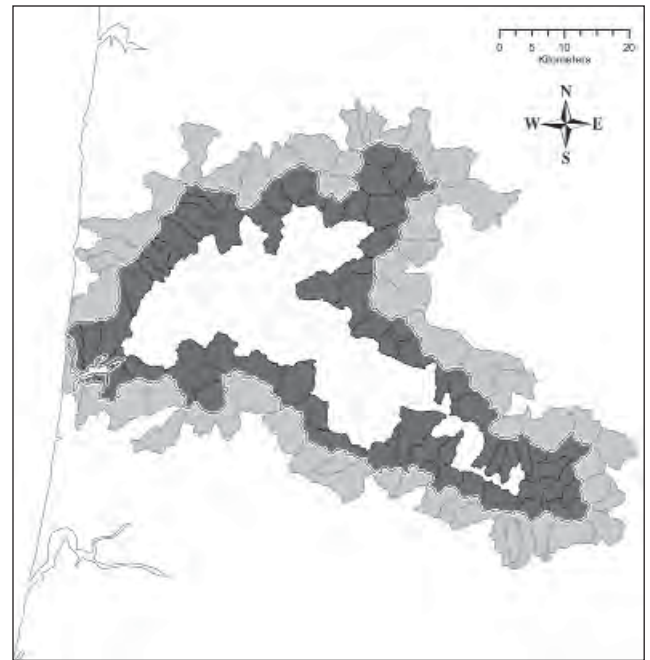


**Figure 4**—“Triads” are indicated (squares) where three 4th-code Hydrologic Units in the Oregon Coast Range Province meet at their headwaters. Triads are priority locations for linkage area or ‘species stronghold’ placement to effectively manage for species dispersal simultaneously across three distinct watershed boundaries.

sampling to specifically address headwater over-ridge connectivity among discrete drainages. This remains an information gap that could be addressed for all forest taxonomic groups, and would aid the adaptive management of the triad connectivity concept.

## 2. Climate Change

A second priority consideration for northwest forest connectivity is assisting migration in the face of climate change (Olson and Burnett 2009). Predicted climate change effects on northwest forest habitats include drought, insect, and fire effects on forest stands, with large conifers and high-elevation trees being vulnerable to losses (Spies et al. 2010). Aquatic habitat changes in forested landscapes are anticipated in cold-water mountain streams (Spies et al. 2010) and in headwaters (Olson and Burnett 2009). Increasing stream temperatures, with negative implications for cold-water fauna, are already apparent across the northwest (Isaak et al. 2011). Given uncertainty in the geographic specificity of climate change trajectories due to complex El Niño and Pacific Decadal Oscillation cycles, “dynamic and adaptive thinking” (Spies et al. 2010) is needed. A prudent course for linkage area placement may be to consider connected routes in north-south, east-west, and altitudinal directions within and among watersheds (fig. 5). Such consideration may allow multiple potential pathways of movement for species facing changing conditions. Pockets of suitable microhabitats for species persistence may be related to local conditions, and may occur as “stepping stones” along these linear trajectories, like beads along a string. Providing connectivity paths adjoining both riparian areas and north-facing slopes is one such example, with both near-stream areas and hill shading resulting from topographic relief providing cool, moist conditions for target species such as some late-successional and old-growth (LSOG)-associated salamanders (e.g., Suzuki et al. 2008). Landscape-scale monitoring of forest conditions and species distributions may inform



**Figure 5**—Designs for assisted migration of species in the face of climate change might include prioritizing headwater linkage area placement across north-south and east-west watershed boundaries. The Siuslaw River basin, a 4th-code Hydrologic Unit in the Oregon Coast Range Province, is shown highlighting perimeter sub-drainages (dark grey) where linkage areas could be made to discrete drainages to the north, south, and east.

adaptive management of likely climate change refugia for different taxa.

## 3. Managing Disturbances: Landslide-Prone Areas

A third priority consideration for the design of linkage areas is to integrate their placement with local disturbance regimes. Landslides and debris flows can be dominant disturbance processes affecting headwater streams in forested, mountainous regions (e.g., Benda 1990; Iverson et al. 1997). The Northwest Forest Plan directs that riparian reserves incorporate landslide-prone areas to reduce the probability that activities associated with timber harvest will alter wood and sediment inputs to streams by changing the rate, magnitude, composition, or timing of debris flows. Co-locating linkage areas with existing riparian reserves, where these include steep areas prone to landsliding, can provide

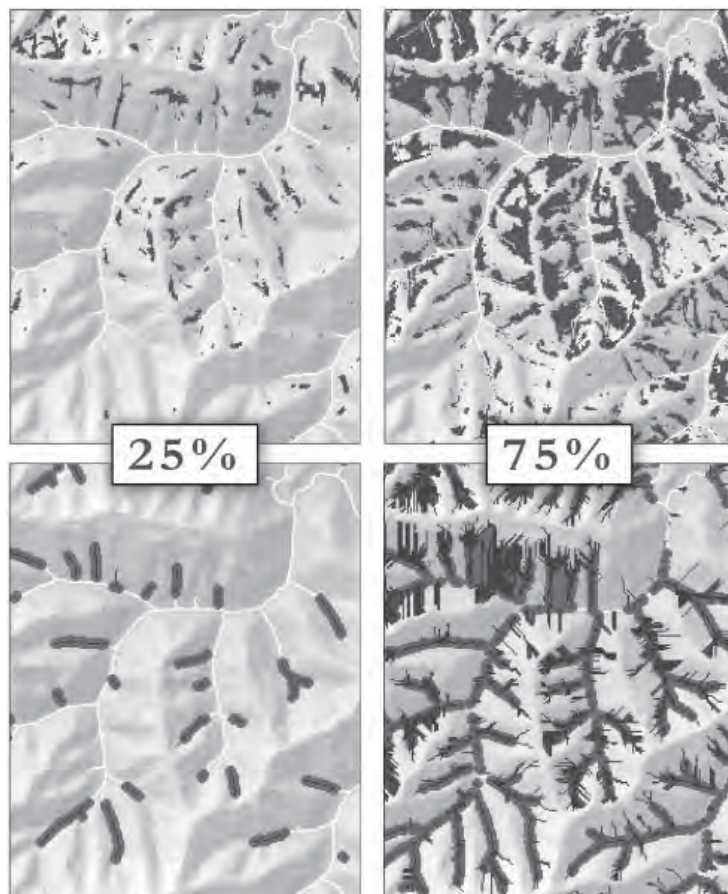


economic efficiency and conservation synergy for land and resource managers. Burnett and Miller (2007) modeled differences among hill slopes and headwater channels in probabilities of initiating and transporting debris flows that deliver to fish-bearing channels for the Oregon Coastal Province (fig. 6). Those headwaters with the highest likelihood of affecting downstream areas important for fish might be high priorities for extending riparian reserves over ridgelines. Because debris flows can be important sources of large wood (May and Gresswell 2003; Hassan et al. 2005), a fundamental component of stream habitat complexity (Bilby and Bisson 1998; Gregory et al. 2003), managing these expanded riparian reserve areas to accelerate tree growth could be an additional consideration. Redundancy of connections would be important when planning ground-disturbing activities for linkage areas with a high probability of landsliding. To aid identification and adaptive

management of landslide-prone areas, these areas have been mapped for many northwest forests by the NetMap interactive web-tool developed by Earth Systems Institute (<http://netmaptools.org/>).

#### 4. Species Strongholds

“Species strongholds” are areas where biodiversity conservation is a priority, and where thriving populations can occur to anchor species persistence in the region. Retaining connectivity among species strongholds enhances the likelihood of persistence under the uncertainty of stochastic events (catastrophic fire, disease outbreaks) or emerging patterns of disturbance (climate change) that may affect any particular stronghold. Managing stronghold-to-stronghold connectivity is a fourth priority to consider in developing linkage area designs across forest landscapes. Species strongholds may be created for communities of diverse taxa at larger spatial scales by land-use allocations such as



**Figure 6**—Placement of between-drainage links might consider other landscape-scale provisions such as management scenarios to retain the natural disturbance regime, including landslide-prone areas managed to deliver wood and sediment to streams. Top figures show models of 25 percent and 75 percent of the landslide-prone hillslopes in an example forest landscape, and bottom figures show their likely traversal paths to streams (Burnett and Miller 2007). Headwater riparian buffers of these areas provide long-term wood and sediment inputs for stream biota. From Olson and Burnett 2009.

Congressionally reserved lands (wilderness areas, national parks), or the Northwest Forest Plan late-successional reserves or key watersheds (USDA and USDI 1993, 1994). At smaller spatial scales, strongholds for a targeted species of concern may be critical habitat areas, such as caves, ponds, meadows, botanical set-asides, or areas managed for Survey and Manage species under the federal Northwest Forest Plan (USDA and USDI 1993, 1994). Riparian buffers themselves might be considered as strongholds, but here, we expand that perspective to other areas.

Developing new species strongholds is particularly important when considering connectivity issues. Three examples follow. First, areas with high “intrinsic potential,” the capacity to support high-quality habitats for salmon (Burnett et al. 2007), may serve as nuclei for designing linkage areas. Intrinsic potential models have been developed and broadly applied for salmonids in the Pacific Northwest and elsewhere (e.g., Mollot and Bilby 2008; Sheer et al. 2009; Busch et al. 2011; Barnett and Spence 2011). Streams with high intrinsic potential can be identified and then targeted, as appropriate, for salmon conservation across a landscape. Such areas of high intrinsic potential are essentially “species strongholds” from which aquatic-terrestrial linkage areas can originate. Areas of high intrinsic potential for some salmonid species may occur in larger streams, but tools exist to easily identify headwater streams that feed into these both laterally and from upstream (Clarke et al. 2008).

Second, criteria for Priority Amphibian and Reptile Conservation Areas (PARCAs) are under development for nationwide application (Riley et al. 2011). PARCAs are being discussed for integration into the landscape planning processes of other entities, such as the U.S. Department of Interior Landscape Conservation Cooperatives (<http://www.doi.gov/lcc/index.cfm>), which is a partnership network to sustain America’s land, water, wildlife, and cultural resources. Once established, PARCAs would function as species

strongholds. Similarly, the International Union for the Conservation of Nature (IUCN) is developing criteria to identify sites of global significance for biodiversity conservation, called Key Biodiversity Areas. Such areas are synonymous with the concept of species strongholds. The additional element that we suggest is to provide connectivity among such areas.

Third, triads, as we previously described, could be ideal locations for species strongholds, as these occur at the ridgeline junction of three large basins. However, we note that triads are not established biodiversity hotspots, and are proposed here as a conceptual design.

Development of landscape-scale linkage webs from either new or existing species strongholds is needed to reduce isolation of those areas, and as possible to allow them to function as potential “source” habitats with optimal conditions that can anchor species over time and also connect to adjoining areas, in a metapopulation context. Linking dispersal pathways from strongholds up and over ridgelines to adjacent watersheds and neighboring strongholds is a direct approach that may offer a least-cost path. Relevant to our proposed headwater linkage areas concept, connecting such species strongholds to headwaters which then extend and connect over ridgelines is another consideration. Additionally, strongholds may be linked to protected riparian areas along larger streams that are subsequently extended upstream into headwaters and connected over ridgelines. Multiple connectivity pathways may be conceived. As a web of connections is considered relative to species stronghold connectivity, the previous priorities discussed above and outlined in table 2 can be overlain, including large basins and triads, linear trajectories to address for climate change gradients, and occurrence of landslide-prone areas.

Adaptive management of strongholds may need to be addressed over the long term as future conditions unfold. As applied here, the concept of a stronghold evokes less of an immovable fortress than an anchor. A species stronghold intended

to anchor habitat may need to function as do real anchors on occasion, and be repositioned or “drag” across landscapes in response to changing conditions or management priorities (Olson et al. 2007). The temporal scale of strongholds can be addressed at the time of their development, and interact with the spatial scale of stronghold designs and the frequency of strongholds. For example, habitat anchors designed to drag across landscapes may be implemented more easily if they are smaller and more numerous. Olson et al. (2007) suggested considering 6th-code watersheds (HUs) as a spatial scale for amphibian habitat anchors. The anchor concept warrants testing, with a sufficient timeframe to weigh success at the landscape scale, in addition to replication. It may have greater success if it were to be implemented in areas with more resilient ecosystems.

## 5. Thinking Diagonally: Funnels and Chains

The geometry and land-management context of land-use and land-ownership parcels on the landscape is a final set of priority considerations for linkage-area placements that we will develop briefly here. The northwest forest landscape is a patchwork of land ownerships and land-use allocations, each with differing management priorities, which creates a complex challenge for biodiversity conservation (Suzuki and Olson 2007). During planning for large blocks of forest land, and during planning of individual projects at smaller spatial scales, managing for connectivity within and among ownership areas can be difficult due to differing priorities across boundaries. To diminish the dilemma of achieving effective biodiversity conservation in such a multi-ownership landscape, it may help to think of streams as dispersal “funnels” that serve to channel organisms along protected riparian areas, and connectivity corridors or linkage areas as “chains” functionally moving animals up and over ridgelines (Olson and Kluber, unpubl. data).

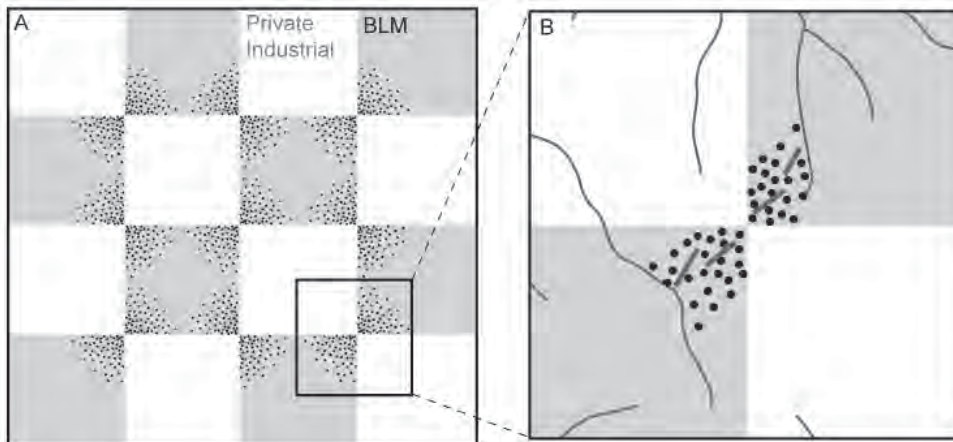
Overlaying many of the previously discussed priorities can provide an integrated perspective for addressing the challenges of land-ownership/ allocation geometries.

Diagonal linkage areas are of specific relevance in a landscape with a checkerboard ownership pattern (fig. 7), and in other landscape geometries that abut at corners or other edge types (Olson and Kluber, unpubl. data). Species dispersal along such diagonals might be promoted by forest management actions that retain habitat elements toward the corners of such lands. For example, weighted green-tree retention, leave islands, and directional felling of down wood (recruitment of large logs, in particular) from corners may assist migration of species along the diagonal by providing chains or stepping stones of suitable microhabitats for species refugia. Linking chains of habitat elements from corners to stream- and riparian-protected areas, especially headwaters (fig. 7B), may functionally extend and connect riparian buffers. Organisms that are funneled along riparian areas may venture through corners via these habitat chains. A chain of habitat need not extend from headwaters, but could extend from any part of a riparian buffer, or from a species stronghold, as discussed above.

It may be neither feasible nor desirable to address habitat connectivity at all corners of adjacent lands within an ownership. Similarly, when land parcels are in close proximity but do not adjoin, it may not be possible to consider linkage areas along their entire boundaries. Several additional design concepts arise and interface with ideas presented above.

First, linkage areas among land parcels might be “stream-lined” if streams align through corners (fig. 8), or connect nearby land blocks. When streams follow diagonals in a checkerboard landscape, riparian protection may more effectively promote multi-species diagonal dispersal: funnels without the added chains linking across diagonals. Streams that loosely follow diagonals, not intersecting exactly at corners, could be quite functional to assist species





**Figure 7**—In a checkerboard ownership pattern, such as that created by the Oregon and California Lands Act (1937) where US Bureau of Land Management (BLM) and private industrial forestlands are intermixed, management for connectivity along diagonals may improve likelihood of species dispersal within ownerships. A: Corners are shaded to show linkage area considerations. However, routes along selected diagonals to species strongholds, reserves, or triads might be used to prioritize which corners are chosen for connectivity emphasis. B: Forest management options to facilitate species dispersal from stream corridors (which may serve to funnel species movements) to corners might include chains of habitat structures provided by green tree retention, directional log placement from corners to streams, or both. Concepts could be applied to other ownership geometries with corners or edges in proximity.



**Figure 8**—Connectivity designs to aid species dispersal among ownership blocks may overlay on streamside riparian management zones. This US Bureau of Land Management study site for the Density Management and Riparian Buffer Study of western Oregon (Cissel et al. 2006) shows riparian buffers extending along the full diagonal (A) as well as laterally toward an opposing corner (B), with leave islands and dispersed tree retention aiding habitat connectivity, and to a neighboring private land block (C). “Stream-lined” connectivity (A) may aid within-watershed dispersal, but overland connectivity designs (B and C) may warrant consideration to link or “chain” habitats overland between watersheds. Photo provided by Oregon Bureau of Land Management.

migration, in this regard. Streams that link disconnected parcels may similarly function to funnel organisms’ movements. The context of the adjoining lands may need to be assessed, however. Managing such a stream-line to promote its potential connectivity function is a consideration,

but such stream-lined connectivity does not address overland dispersal. Chains from streams to ridgelines are needed to fully integrate aquatic and terrestrial landscape connectivity functions. Collaborative management of such stream-lines and overland chains among ownerships and

across land-use allocations within ownerships, remains a challenge.

Second, in multi-ownership landscapes, road densities may be higher than in single owner landscapes. An assessment of the effects of roads on species connectivity designs may be particularly important in these landscapes. In particular, paved roads or high-use unpaved roads may be barriers to low-mobility species. As roads intersect streams, aquatic organism passage may be affected, with consequences for overland connectivity. Site-specific designs can include these considerations.

Third, as hazard models of disturbances are developed for a landscape, it may be helpful to ask how hazards align with land-ownership boundaries, land-use allocations, and existing connectivity webs. For example, how are landslide-prone areas arranged relative to the geometry of lands by ownership and land-use allocation? As discussed above, can priority linkage areas be designed to overlay on landslide-prone areas that are already set-asides for riparian reserve management, and now also serve “to chain” habitats to adjoin land-ownership blocks?

Fourth, in a larger landscape context, it may be useful to know how larger basins, climate change projections, and species strongholds are arranged and whether these be used to prioritize connectivity area pathways. Can dispersal routes be conceived from streams and then through land-ownership diagonals or between ownership blocks to foster connections relative to these issues?

Multiple overlapping considerations are emerging, and a stepwise process may be needed to integrate them. Limitations may emerge due to topography, geometry of land configurations at local scales, or pre-existing conditions. For example, a dispersal barrier such as a road may need to be considered first. The existence of under-road culverts may create spatially explicit bottlenecks for connectivity planning. Routing linkage area pathways to those stream corridors and culverts may be needed to increase the odds

of dispersal across the road. Culverts that act as dispersal nodes in this way could be prioritized for enhancement to provide passage for non-aquatic species. Similarly, triads and species strongholds, as discussed above, are essentially dispersal nodes. Routing dispersal routes via headwater linkage area pathways to triads and strongholds could increase the overall effectiveness of these conservation measures.

## Conclusions

Forest biodiversity conservation is an ecosystem service that will continue to be addressed at local-to-landscape scales in the coming century. Retaining organisms across managed forest landscapes requires a toolbox of approaches including fine- and coarse-scale habitat protections and restoration practices, retaining or creating structural elements that are critical habitats for species, and development and management of connectivity pathways to allow gene flow. Renewed efforts to address communities of organisms as well as species of concern are called for as emerging stressors need evaluation, new knowledge is accrued, and adaptive management of existing forest plans are needed.

We review the numerous benefits of forest connectivity designs that rely on headwater linkage areas, and emphasize priorities for their placement at landscape scales. The benefits of headwater linkage areas include their likely functional role in integrating aquatic and terrestrial systems, their potential use by multiple taxonomic groups, their utility for creating webs of connections across forested lands to increase their effectiveness for biodiversity conservation, and their efficiency in minimizing both the distances that animals must move overland and the financial burdens of forest manager.

Placement of headwater linkage areas may include consideration of a variety of factors (table 2). Prioritizing linkage areas can provide a starting point for managing connectivity among

critical habitat areas, suggest directional routes for dispersal among areas, or identify dispersal nodes as anchors for connectivity webs. The five priority considerations that we developed include triads that effectively link three larger basins, north-south and east-west directional routes to address climate change scenarios, linkages overlaid on management of disturbances such as landslide-prone areas, links among species strongholds, and diagonal links that route dispersal across management boundaries. These five concepts can be integrated into an overall geometry of landscape connectivity designs. Our conceptualization of headwater linkage area utility and these priority considerations are posed as hypotheses warranting further study and development. We offer these ideas with the caveat that they will not benefit all taxa in forested landscapes. Extremely rare or patchily distributed organisms with low mobility may need a finer-grained, site-by-site conservation approach (Raphael and Molina 2007).

### Acknowledgments

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# Beyond the least-cost path: evaluating corridor redundancy using a graph-theoretic approach

Naiara Pinto · Timothy H. Keitt

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**Abstract** The impact of the landscape matrix on patterns of animal movement and population dynamics has been widely recognized by ecologists. However, few tools are available to model the matrix's influence on the length, relative quality, and redundancy of dispersal routes connecting habitat patches. Many GIS software packages can use land use/land cover maps to identify the route of least resistance between two points—the least-cost path. The limitation of this type of analysis is that only a single path is identified, even though alternative paths with comparable costs might exist. In this paper, we implemented two graph theory methods that extend the least-cost path approach: the Conditional Minimum Transit Cost (CMTC) tool and the Multiple Shortest Paths (MSPs) tool. Both methods enable the visualization of multiple dispersal routes that, together, are assumed to form a corridor. We show that corridors containing alternative dispersal routes emerge when favorable habitat is randomly distributed in space. As clusters of favorable habitat start forming, corridors become less redundant and

dispersal bottlenecks become visible. Our approach is illustrated using data from a real landscape in the Brazilian Atlantic forest. We explored the effect of small, localized disturbance on dispersal routes linking conservation units. Simulated habitat destruction caused the appearance of alternative dispersal routes, or caused existing corridors to become narrower. These changes were observed even in the absence of significant differences in the length or cost of least-cost paths. Last, we discuss applications to animal movement studies and conservation initiatives.

**Keywords** Agroecosystems · Atlantic forest · Brazil · Functional connectivity · Corridors · Cost distance · Dispersal · Fragmentation · Graph theory · Matrix · Migration · Shortest path

## Introduction

Animal movement can occur at a range of temporal scales, influencing foraging, migration, and gene flow (Crooks and Sanjayan 2006). The dispersal routes associated with these processes can be strongly constrained by the landscape matrix. Thus models specifying the effect of matrix heterogeneity on movement rates can more successfully predict patch occupancy (Ricketts 2001; Verbeylen et al. 2003), metapopulation dynamics (Vandermeer and Carvajal

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N. Pinto (✉) · T. H. Keitt  
Section of Integrative Biology, University of Texas,  
Austin, TX 78712, USA  
e-mail: Naiara.Pinto@jpl.nasa.gov

*Present Address:*  
N. Pinto  
Jet Propulsion Laboratory, 4800 Oak Grove Dr.,  
Pasadena, CA 91109, USA

2001), genetic structure (Stevens et al. 2006), and persistence in fragmented landscapes (Laurance et al. 2002). The role of behavior and natural history in shaping species' responses to the matrix has recently motivated the concept of functional connectivity (Calabrese and Fagan 2004). While many connectivity studies have described the influence of different land cover types in channeling or repelling movement of particular species (e.g., Burel 1996; Lees and Peres 2008), few tools are available to integrate data on matrix heterogeneity and species' habitat preferences to model dispersal routes.

A challenge in modeling animal dispersal routes is that individuals rarely use a single optimum route (e.g., Driessen et al. 2007), and connectivity measures focusing on optimum routes fail to incorporate variation in individual behavior (Belisle 2005). In this paper, we model the location of multiple dispersal routes across a heterogeneous matrix. We employ a movement model that assumes successfully dispersing organisms are more likely to use the route of least resistance when moving between two points, or the least-cost path. Despite its simplifying assumptions, the least-cost path has been successfully used to predict patch occupancy (Chardon et al. 2003; Verbeylen et al. 2003) and inter-patch movement rates (Sutcliffe et al. 2003). The least-cost path is identified using a graph theory algorithm, Dijkstra's breadth-first search (Cormen et al. 2001). Many GIS software packages have functions to locate the least-cost path between two points. Although only one path is obtained, Dijkstra's algorithm can be easily modified to output multiple paths with similar costs. We describe this modification and its two outputs, the Conditional Minimum Transit Cost (CMTC) and the Multiple Shortest Paths (MSPs).

We propose that corridors are heterogeneous structures that may contain multiple dispersal routes. However, we do not advocate a method for designing corridors (including few or many dispersal routes), neither do we attempt to quantify corridors' role in conserving biodiversity. Rather, our goal is to integrate information on species' habitat preferences into regional-scale depictions of habitat connectivity. This paper has three parts. First, we applied our method to artificial landscapes in order to illustrate the effect of matrix heterogeneity on the cost and spatial distribution of dispersal routes. Second, we studied the effect of small, localized disturbance on

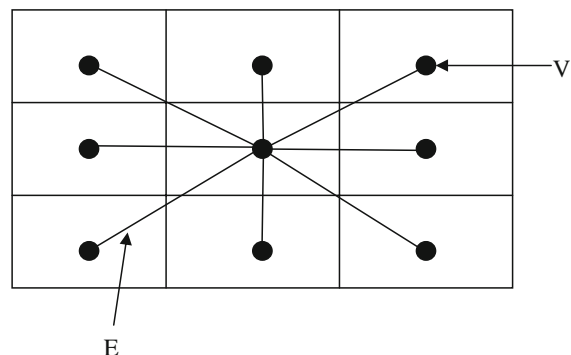
large-scale dispersal routes. This was performed using data from the highly fragmented Brazilian Atlantic forest (Morellato and Haddad 2000). Last, we discussed how the approach proposed here can be refined and incorporated in animal movement studies and conservation initiatives.

## Methods

### The landscape graph

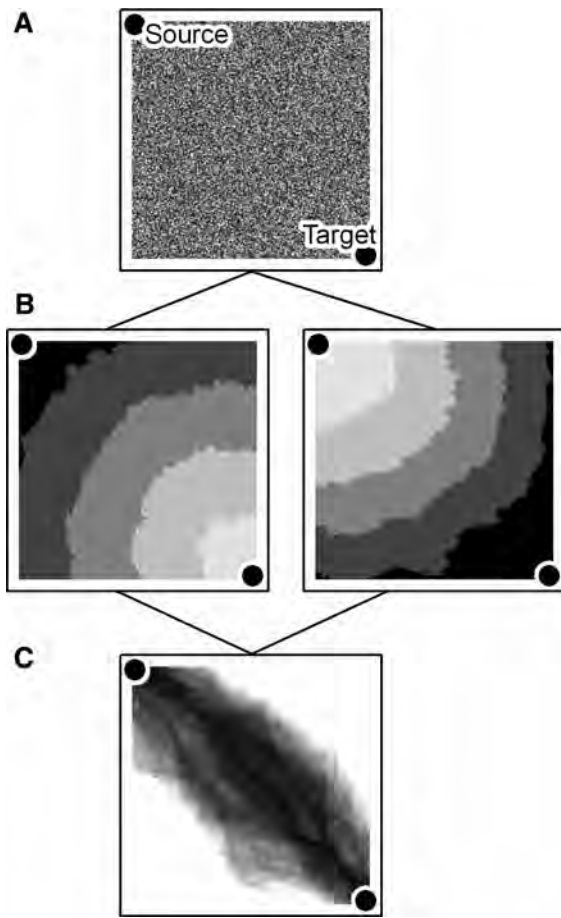
In this section, we describe the approach routinely employed to perform any type of distance calculations on grids. Most GIS software packages use graphs (Urban and Keitt 2001) to represent grid maps. Graphs are composed of vertices ( $V$ ) placed on cell centers, and edges ( $E$ ) that connect each vertex to its eight nearest neighbors (Fig. 1). Using this representation, we define two cost grids:

- Relative cost grid (Figs. 2a, 3a), also referred to as a friction layer (Verbeylen et al. 2003). Each vertex contains the relative cost to cross it in any direction.
- Cumulative cost grid (Figs. 2b, 3b). Consider a source ( $S$ ) composed of one or more vertices. Each vertex in the cumulative cost grid contains the minimum cumulative cost to reach  $S$ . This is calculated in two steps: first, the cost to move between pairs of vertices is stored as edge weights. The weight  $W$  for an edge connecting vertices  $V1$  and  $V2$  is calculated as:



**Fig. 1** The landscape graph. In most software packages, grid maps are internally represented as a graph. Vertices ( $V$ ) are located in cell centers. Each vertex is connected to its eight nearest neighbors by an edge ( $E$ ). Edge weights (not shown) hold information on the cost to move between pairs of vertices





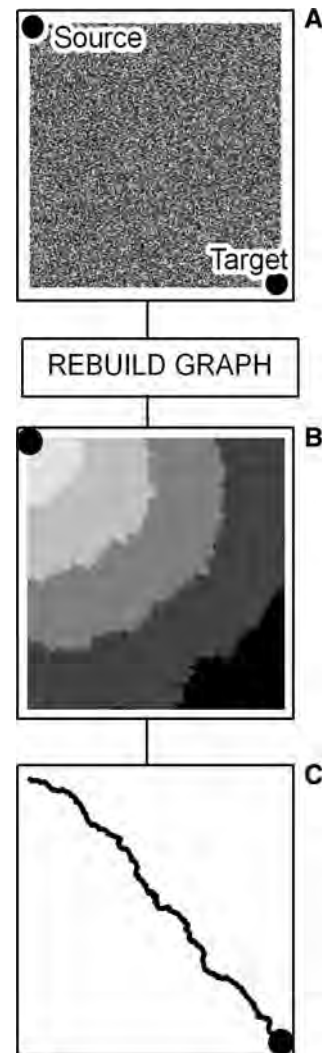
**Fig. 2** Illustration of the procedure for calculating the CMTC. **a** Relative cost grid. **b** The cumulative cost grid for the target (*left*) and the source (*right*). Lighter shades indicate lower cumulative cost. **c** The two grids from (**b**) are added to produce the CMTC grid

$$W = [\text{Relative Cost (V1)} + \text{Relative Cost (V2)}] / 2 \quad (1)$$

For diagonal edges, edge weights  $W'$  are calculated as:

$$W' = W \times \sqrt{2} \quad (2)$$

Second, Dijkstra's breadth-first search algorithm (Cormen et al. 2001) is used to calculate the least-cost path between  $S$  and each vertex in the graph. The minimum cumulative cost between  $S$  and a given vertex ( $V$ ) is the sum of all edge weights in the least-cost path connecting  $S$  and  $V$ . To calculate the



**Fig. 3** Illustration of the procedure for locating MSPs. **a** Relative cost grid, **b** cumulative cost grid for the source. Lighter shades indicate lower cumulative cost. This was calculated after rebuilding the graph that represents the landscape, **c** with the cumulative cost grid, we trace the least-cost path between source and target, **b** and **c** are repeated 100 times to produce 100 least-cost paths

least-cost path between two habitat patches  $P1$  and  $P2$  we define all vertices in  $P1$  as sources and all vertices in  $P2$  as targets. The least-cost path between patches  $P1$  and  $P2$  will most likely link the two patches' most external vertices.

In the next two sections, we build on the above representation and describe two methods that extend Dijkstra's breadth-first search algorithm.

### Conditional minimum transit cost (CMTC)

Consider a vertex ( $V$ ) located between groups of source vertices ( $S$ ) and target vertices ( $T$ ). The Conditional Minimum Transit Cost (CMTC) for  $V$  is the cost-weighted distance to move from  $S$  to  $T$ , conditional on the route forming the shortest passage between  $S$  and  $T$  while passing through  $V$ . It is calculated as (Fig. 2):

$$\text{CMTC}(V, S, T) = \text{Cumulative cost}(V, S) + \text{Cumulative cost}(V, T) \quad (3)$$

The final CMTC grid was obtained by masking out all cells with CMTC values larger than the minimum CMTC value plus 10% (Fig. 2c). The remaining values were then divided by the grid's maximum CMTC. According to Forman (1995), a corridor is "a narrow strip of land that differs from the matrix on either side". We assume that areas within the 10% threshold form corridors, but emphasize that our choice of corridor width was arbitrary.

Our analysis generates corridors that are highly heterogeneous. Visually inspecting the CMTC grid (Fig. 2c) enables identification of contiguous cells with low CMTC value. We refer to these cell groups as "dispersal routes", while recognizing that distinction between routes that are close together is arbitrary. The least-cost path is invariably located within one dispersal route.

In practice, obtaining a CMTC grid is straightforward with modules such as spatial analyst within ArcGIS (Esri, California). Some conservation biologists strongly advocate the CMTC approach for designing wildlife corridors (Majka et al. 2007). But to our knowledge, the relationship between matrix heterogeneity and the distribution of dispersal routes as predicted by the CMTC has not yet been explored.

### Multiple shortest paths (MSPs)

We developed a stochastic version of Dijkstra's algorithm (Fig. 3) that outputs multiple realizations of the least-cost path, or Multiple Shortest Paths (MSPs). As described above, the least-cost path is obtained from a relative cost grid. Dijkstra's breadth-first search algorithm (Cormen et al. 2001) proceeds by iteratively marking vertices in the order of their cumulative distance from the source. At each step, the algorithm must identify the set of neighbors

associated with the marked vertices. Standard algorithms use a static definition of the neighborhood, typically the nearest eight cells on a rectangular grid (Fig. 1). Our approach is to redefine the neighborhood as a stochastic function such that adjacency is non-deterministic and is instead determined randomly in proportion to edge weights. The algorithm proceeds as follows (Fig. 3):

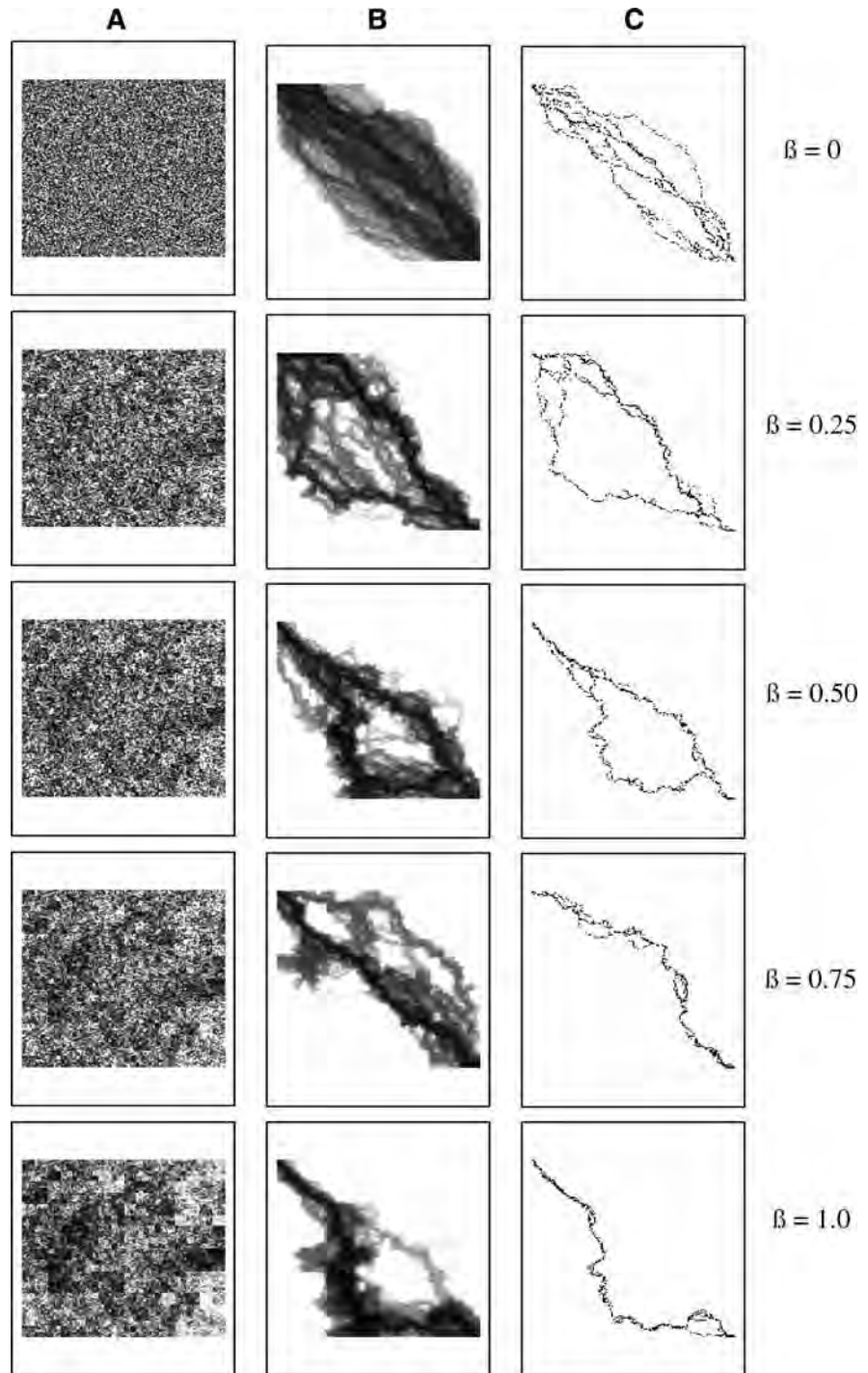
1. Draw a number ( $U$ ) between 0 and 1 from a random uniform distribution.
2. Delete edges in the graph. An edge with weight  $W$  connecting two adjacent vertices  $V1$  and  $V2$  is deleted if  $W > U$ . That is, connections with lower costs are more likely to be maintained.

A program implementing Dijkstra's algorithm (with the above modification) was run 100 times in order to produce 100 MSPs for each study case (Fig. 3c shows one path). The cumulative cost associated with each path is a measure of effective distance and is calculated by adding the weights of all edges in the path. The programs used to obtain both CMTCs and MSPs were written in the Java programming language.

### Applications to artificial landscapes

We generated artificial landscapes with different degrees of spatial autocorrelation using the method of wavelet synthesis (Keitt 2000). We started with a grid containing values between 0 and 1, drawn from a random uniform distribution. Using this grid, each landscape was created in four steps: (a) apply the discrete Haar wavelet transform; (b) obtain wavelet coefficients; (c) multiply coefficients by  $2^{-L} \beta$ , where  $L$  is the coefficient level (higher levels representing low-frequency variation); (d) apply the inverse Haar wavelet transform on the modified coefficients; (e) map results to a random uniform distribution (min = 0; max = 1). The last step is taken to ensure that the distribution of quality values is consistent across all landscapes. The values of the parameter  $\beta$  were 0, 0.25, 0.50, 0.75, and 1. A  $\beta$  value of zero generates a white noise landscape with no spatial autocorrelation. Increasing  $\beta$  produces autocorrelated landscapes, where clusters of favorable habitat can be identified. Each artificial landscape represents one relative cost grid that served as input in calculations of CMTC and MSPs (Fig. 4a). We used ANOVA to test for differences among landscapes, in terms of

**Fig. 4** Relative cost grids generated with the use of wavelet transforms (a), and the values of CMTC (b) and location of MSPs (c) for each landscape. A  $\beta$  value of 0 is a landscape with no spatial autocorrelation in habitat quality values, and landscapes become “patchier” as  $\beta$  values increase

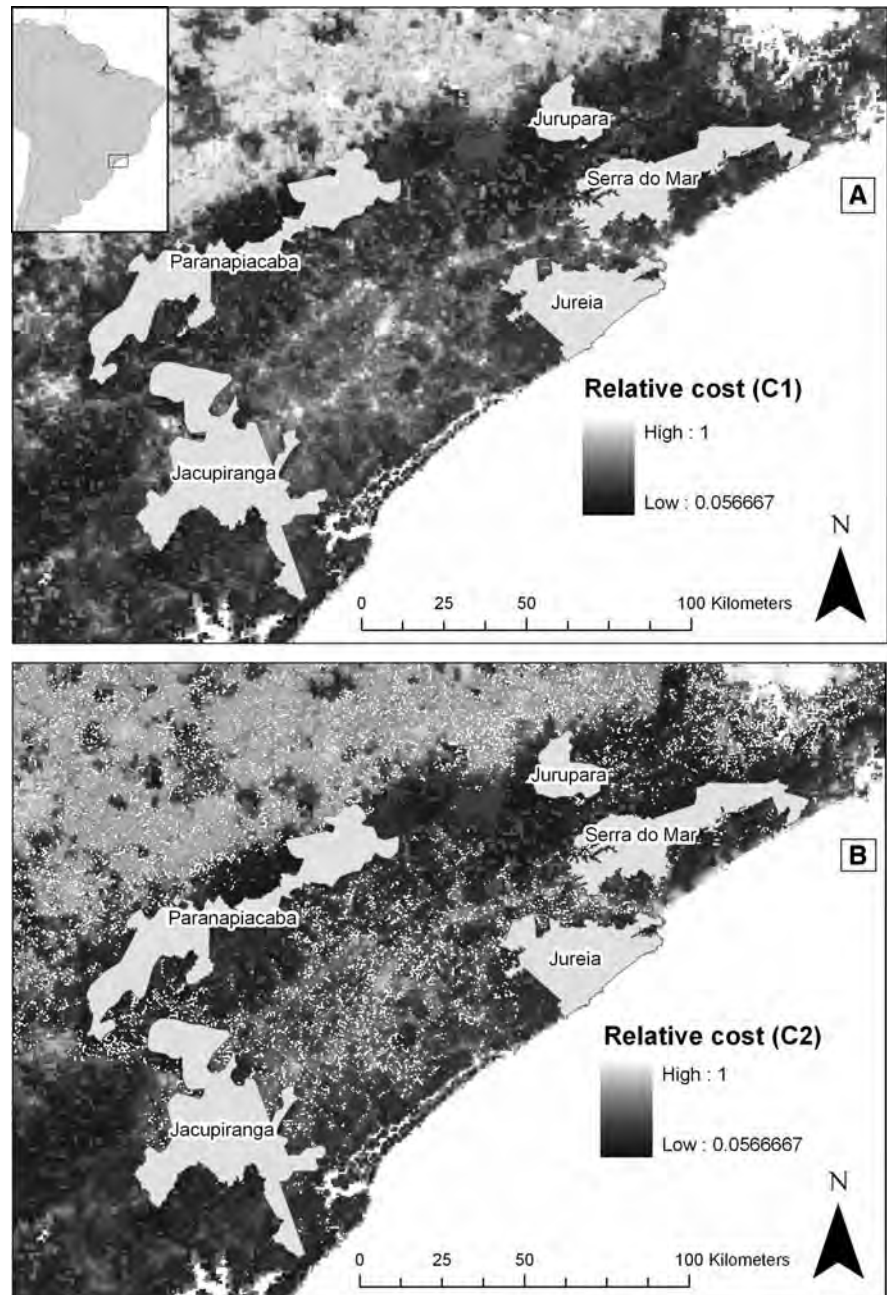


cumulative costs associated with MSPs and mean CMTC. The generation of artificial landscapes and ANOVA tests were performed using the R programming language (R Core Development Team 2008).

#### Applications to real landscapes

We studied a real landscape (Fig. 5) that covers 111 km<sup>2</sup> of the Brazilian state of São Paulo (upper

**Fig. 5** Study site in the Brazilian Atlantic forest, showing conservation units in Sao Paulo State. **a** Relative cost values for scenario C1. **b** Relative cost values for scenario C2 (after deletion of small forest fragments)



left coordinates: 23.60S, 49.00W; lower right coordinates: 25.40S, 46.20W). Remaining forests are part of the Atlantic forest biome (for a description, see Oliveira-Filho and Fontes 2000). Despite its location in highly industrialized São Paulo state, the study area still contains large forest tracts and rural properties. A recent vegetation map (Eva et al. 2002) estimates that 11.1% of the study area is devoted to intensive agriculture, 7% contains a mix of

agriculture and degraded vegetation, 23% is a mix of agriculture and degraded forest, and 46% is covered with forest. Excluding São Paulo's metropolitan area, human populations per municipality range in size from 3,403 to 412,243 (mean = 60,410; IBGE 1991). Five conservation units are considered here: Pedro de Toledo Nucleus within Serra do Mar State Park (868 km<sup>2</sup>), Jureia-Itatins Ecological Reserve (801 km<sup>2</sup>), Jurupara State Park (259 km<sup>2</sup>),



Jacupiranga State Park (1,552 km<sup>2</sup>), and the contiguous units Intervales State Park, Carlos Botelho State Park, Ecological Station Xitué, and Alto do Ribeira Touristic State Park (1,282 km<sup>2</sup>), referred together here as “Paranapiacaba” due to their location along the Paranapiacaba Valley.

Our analyses consisted of modeling dispersal routes between all pairs of conservation units. We have built a relative cost map in an attempt to capture the habitat preferences of species that move in forested areas and suffer higher mortality when crossing disturbed habitat. In the discussion, we describe how more detailed models can be built and refined to reflect the habitat preferences of a particular species. Three land use/land cover maps were the main input for our analyses (Table 1).

1. The Modis continuous fields, (Hansen et al. 2003) contains estimates of percent tree cover. Values were manipulated (Table 1) in order to obtain a grid with values ranging between 0 (=100% tree cover) and 1 (=no tree cover).
2. The human footprint map (Sanderson et al. 2002) is a global dataset with estimates of anthropogenic impact ranging from 0 (pristine land) to 100 (most disturbed land), normalized per ecosystem. These estimates were based on patterns of human population density, land use, and transportation networks. We divided original values by 100 (Table 1) to obtain a grid with values ranging from 0 (=pristine land) to 1 (=most disturbed land).
3. The South American vegetation map (SAVM; Eva et al. 2002) contains information on forest distribution, degree of forest disturbance, and mixture with agricultural lands. We assigned

each class in the SAVM grid (Table 1) a relative cost value ranging from 0 (=closed or dense forest) to 1 (intensive land use or non-forested ecosystems).

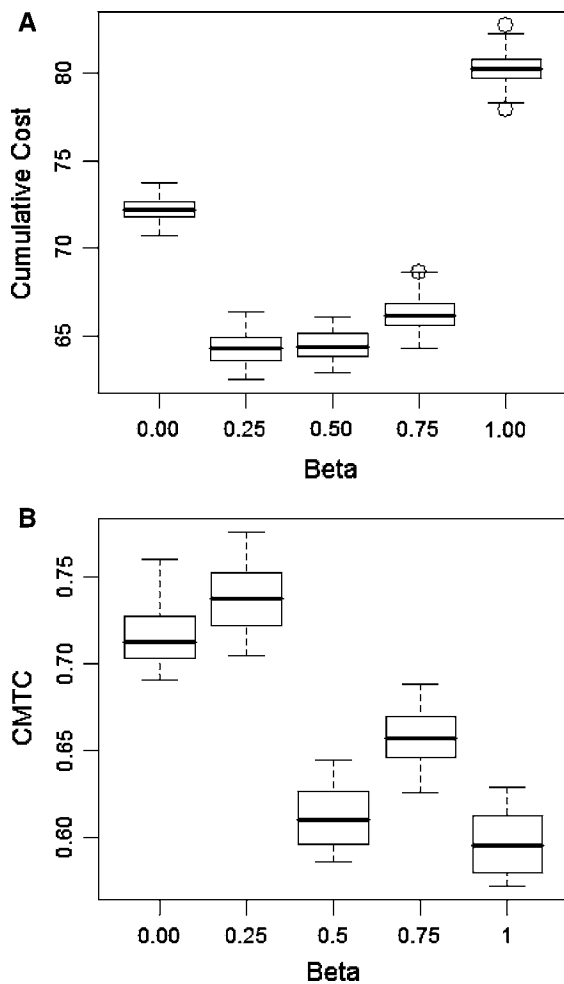
The Footprint and SAVM grids were rescaled so as to bring their spatial resolution to 500 m. The first relative cost map (C1; Fig. 5a) was obtained by averaging the values in the three grids described above (Table 1). As a result, we obtained a grid where cell values ranged from 0.057 (minimum relative cost to cross) to 1 (maximum relative cost to cross).

The second cost map (C2; Fig. 5b) simulated the removal of small forest fragments from C1, which could result from clear cutting, selective logging, or road construction. Results do not necessarily reflect actual land cover changes taking place in the Atlantic forest, but they enable us to explore the effect of small, localized disturbance on regional connectivity patterns. The C2 map was built in three steps. First, we produced a binary map with areas classified as “forest” or “non-forest” based on the SAVM map. This binary map was eroded and dilated (Serra 1982) by 0.5 pixel, resulting on the deletion of fragments with area <5 ha and linear elements (such as riparian corridors) <500 m wide. Last, C2 was obtained by assigning the maximum relative cost (1) to the deleted cells. All other cells contained the same values as C1, and the range of relative cost values for the entire grid remained unchanged (0.057–1). It was assumed that individuals could not move through water, thus a cost value of positive infinity was assigned to cells representing water bodies in both C1 and C2 scenarios. Finally, we calculated the CMTC and MSPs for both C1 and C2 scenarios. All GIS layers were processed using programs written in Java

**Table 1** Grids used to construct the relative cost maps used in the present study, their original spatial resolution (pixel size), period of data collection, and operations performed on original grid values

Layer	Resolution (m)	Years	Operations performed on the original raster values
South America vegetation map	1,000	1995–2000	0 = closed, dense, transitional forest 0.25 = open forest 0.5 = mosaic agriculture/degraded forest 0.75 = shrubland, savannah, grassland 1 = intensive agriculture, mosaic agriculture/ degraded vegetation, desert, urban
Human footprint	1,000	1960–2001	Final value = (original value)/100
Modis continuous fields, % tree	500	2000–2001	Final value = (100 – original value)/100





**Fig. 6** The distribution of values of **a** Multiple Shortest Paths **b** and Conditional Minimum Transit Costs. A  $\beta$  value of 0 is a landscape with no spatial autocorrelation in habitat quality values, and landscapes become “patchier” as  $\beta$  values increase

programming language, and illustrations were produced in ArcMap (Esri, California).

## Results

### Artificial landscapes

The two graph theory approaches proposed here outlined the influence of matrix heterogeneity on dispersal routes. We detected a significant difference in mean cumulative costs associated with Multiple Shortest Paths (MSPs) among the five artificial landscapes (ANOVA,  $F = 6,934.5$ ;  $P < 0.001$ ). MSPs with lowest costs were observed when

landscapes had intermediate patchiness (Fig. 6a; Tukey multiple comparisons of means, 95% family-wise confidence level,  $P < 0.001$ ). We also observed significant differences in mean Conditional Minimum Transit Cost (CMTC) values (ANOVA,  $F = 474,104$ ;  $P < 0.001$ ). The most autocorrelated landscapes produced the lowest CMTC values (Fig. 6b; Tukey multiple comparisons of means, 95% family-wise confidence level;  $P < 0.001$ ). In addition, we observed differences in the spatial distribution of dispersal routes. Landscapes with little autocorrelation in relative habitat quality produced redundant corridors with more alternative dispersal routes (Fig. 4;  $\beta$  closer to 0). As clusters of favorable habitat started to form, corridors became restricted to fewer routes (Fig. 4;  $\beta$  closer to 1). This was evidenced in the outputs of both the CMTC and MSPs calculations.

### Real landscapes

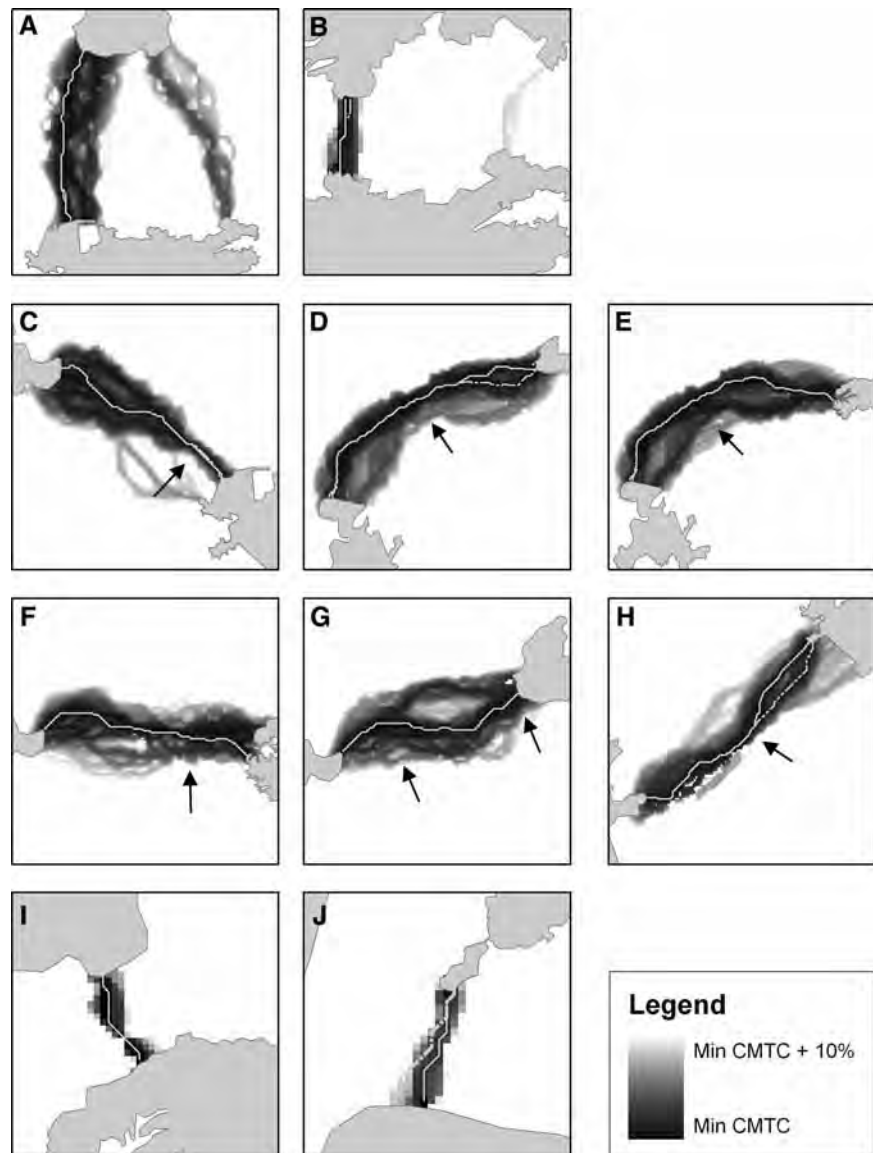
We tested the influence of small, localized disturbance on corridors connecting five conservation units in the Brazilian Atlantic forest (Fig. 5). There were no significant differences in mean cumulative path costs calculated from MSPs, or in mean CMTC values ( $t$ -test,  $P > 0.05$ ) between scenarios C1 and C2. But in most cases, simulated fragment removal influenced the spatial distribution of dispersal routes. Since small fragments were not homogeneously distributed in the study area, corridors obtained under scenario C1 were differentially affected by simulated fragment removal in scenario C2 (Table 2).

**Table 2** Conservation units included in the present study

	Jacupiranga	Jurupará	Serra do Mar	Paranapiacaba
Juréia	72.321	35.391	6.905	3.993
	5	3.6	10.4	5.5
Jacupiranga		115.502	104.800	7.868
		4.0	5.0	21.0
Jurupará			7.263	43.739
			2.0	1.2
Serra do Mar				51.183
				2.3

Each unit in a pair can serve as a source or a target for dispersing organisms. The first line contains the straight-line distance between units (in kilometers), and the second line shows the percentage of 500-m<sup>2</sup> cells deleted from the corridor as a result of simulating fragment removal

**Fig. 7** CMTC grids for the corridor connecting conservation units in São Paulo, Brazil. The pairs are: **a** Jurupará–Juréia, **b** Juréia–Serra do Mar, **c** Juréia–Paranapiacaba, **d** Jacupiranga–Jurupará, **e** Jacupiranga–Serra do Mar, **f** Paranapiacaba–Serra do Mar, **g** Paranapiacaba–Jurupará, **h** Juréia–Jacupiranga, **i** Serra do Mar–Jurupará, **j** Paranapiacaba–Jacupiranga. *Gray lines* show the least-cost path. *Solid lines* represent least-cost paths obtained for scenarios C1 and C2, whereas *interrupted lines* represent sections of the least-cost path obtained for scenario C2 only. *Arrows* indicate potential dispersal bottlenecks



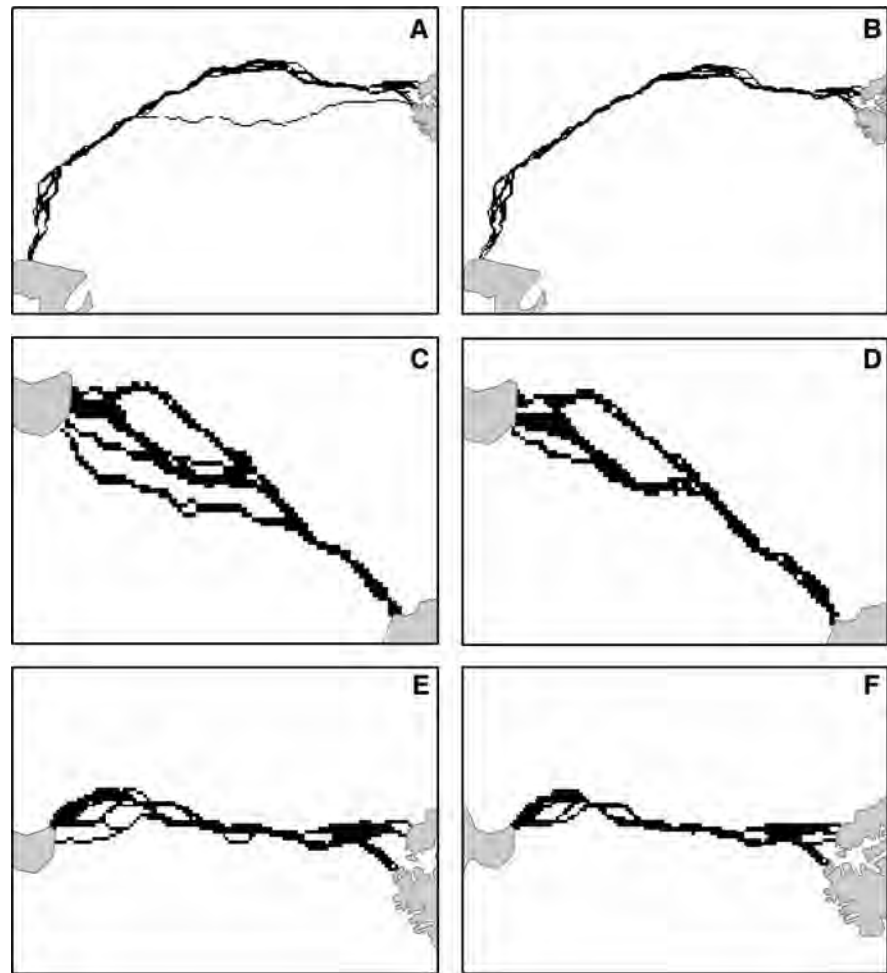
In most cases, the CMTC grid displayed more than one alternative route between conservation units, one of them being the least-cost path (Fig. 7a–h). When conservation units were close, the distance between them was small with respect to the variation in their shape. In this case, the CMTC grid produced narrow corridors, coinciding with the links representing the shortest Euclidian distance (Fig. 7b, i, j). When corridors contained alternative routes, these were rarely disjoint (Fig. 7a, b). The constriction zones where dispersal routes merged represented potential dispersal bottlenecks (Fig. 7c–h). In most cases, the

location of the least-cost path did not change substantially as a result of small fragment removal (Fig. 7a–c; e–g; i, j). But in two cases, the least-cost path for scenario C2 was displaced to an alternative route located a few kilometers away from the least-cost path for scenario C1 (Fig. 7d, h).

We also identified the MSPs between pairs of conservation units. Compared to the CMTC calculation, this tool provided a better assessment of the impact of fragment removal on corridor redundancy. Examining the MSPs produced for the scenarios C1 and C2, we observed two trends. In some cases,

**Fig. 8** Location of the first 100 least-cost paths connecting conservation units in São Paulo, Brazil.

**a** Jacupiranga–Serra do Mar, scenario C1; **b** Jacupiranga–Serra do Mar, scenario C2; **c** Juréia–Paranapiacaba, scenario C1; **d** Juréia–Paranapiacaba, scenario C2; **e** Serra do Mar–Paranapiacaba, scenario C1; **f** Serra do Mar–Paranapiacaba, scenario C2



fragment removal led to the disappearance of external dispersal routes; corridors became narrower and less redundant (Fig. 8). In other cases, new, more external routes emerged after fragment removal (Fig. 9).

## Discussion

Analyses of artificial landscapes show the influence of matrix heterogeneity on landscape connectivity. Redundant corridors with multiple alternative dispersal routes emerged in white noise landscapes, where favorable habitat is randomly distributed (Fig. 4,  $\beta$  closer to 0). As patches of favorable habitat started forming, corridors became narrower and less redundant (Fig. 4,  $\beta$  closer to 1). The cumulative cost of MSPs was on average lower in landscapes with intermediate degree of

autocorrelation (Fig. 6a). This is because paths in white noise landscapes will often cross areas of high cost, whereas the presence of contiguous habitat patches in autocorrelated landscapes can lead to longer, more tortuous paths (Fig. 4c). The CMTC was on average lower in autocorrelated landscapes (Fig. 6b). This follows from our choice of CMTC value used to delimit corridors—under a 10% threshold, white noise landscapes produced wider corridors with higher CMTC values.

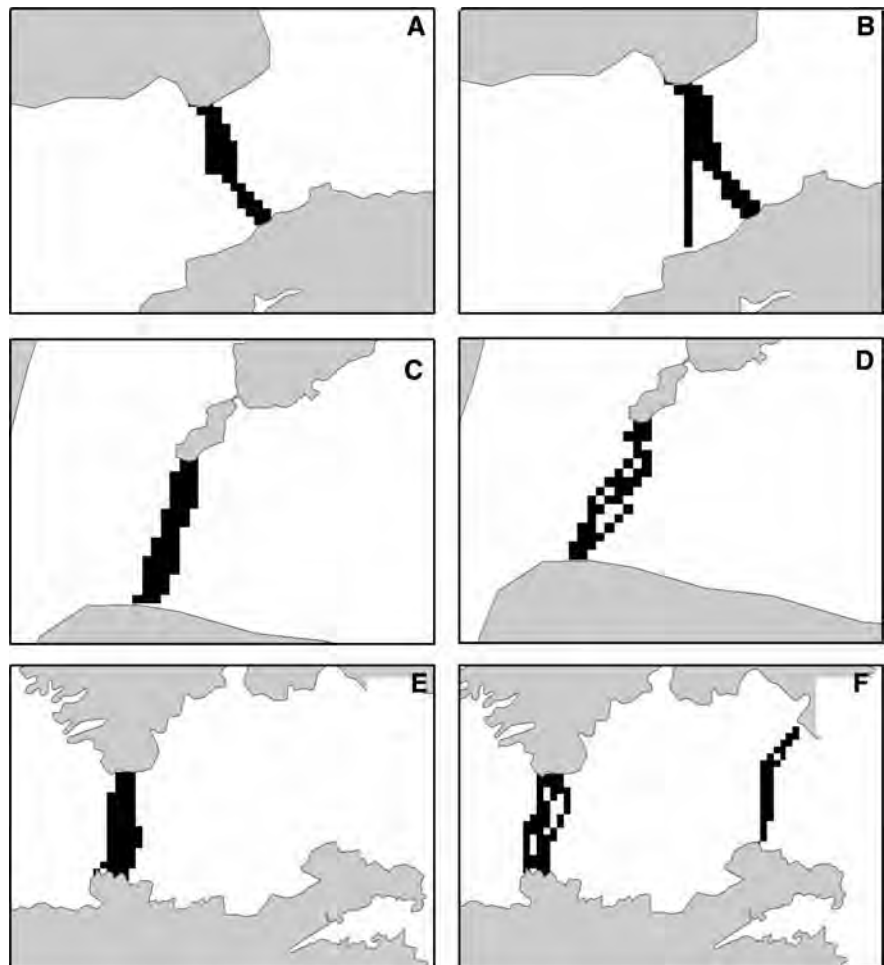
In addition to studying artificial landscapes, we illustrated our methods using data from a real landscape in the Brazilian Atlantic forest. In this region, a complex landscape matrix produced dispersal routes that were not apparent in land use/land cover maps (Fig. 7a–f, h–j), with the exception of the pair Paranapiacaba–Jurupará that is separated by an artificial dam (Fig. 7g). CMTC maps revealed highly

heterogeneous corridors displaying bottlenecks to animal movement (indicated by arrows in Fig. 7c–h). Removing small fragments did not produce a significant increase in the mean cumulative cost of MSPs but led to changes in their spatial distribution (Figs. 8, 9). Our work illustrates two possible large-scale effects of small, localized disturbance on the landscape matrix. Narrower corridors were produced (Fig. 8), and the importance of external dispersal routes increased (Fig. 9). The latter case included the two pairs of conservation units with the largest amount of deleted habitat in the scenario C2 (Table 2; Fig. 9c–f).

Results of least-cost path analyses are strongly dependent on the selection of relative cost grids (Adriaensen et al. 2003; Rae et al. 2007). Our choice of relative cost grids (Table 1) was made as an attempt to approximate the habitat preferences of a

forest specialist. Relative cost grids can be further refined and validated for a particular species using patch occupancy data (Verbeylen et al. 2003) or from ecological niche modeling and tools such as the Mahalanobis distance (Farber and Kadmon 2003). In addition to habitat preference estimates, an important issue is the time scale over which individuals are expected to disperse. Here, we were not concerned with the time interval or number of generations that individuals (or populations) took to move between source and target fragments (conservation units). More realistic models can be obtained by adjusting the maximum Euclidian distance allowed between source and target fragments so as to match the maximum distance that can be crossed by a species given a particular time interval (Keitt et al. 1997). The issue of time scale is related to the question of whether corridors should function as habitat or as

**Fig. 9** Location of the first 100 least-cost paths connecting conservation units in São Paulo, Brazil. **a** Serra do Mar–Jurupara, scenario C1; **b** Serra do Mar–Jurupará, scenario C2; **c** Paranapiacaba–Jacupiranga, scenario C1; **d** Paranapiacaba–Jacupiranga, scenario C2; **e** Juréia–Serra do Mar, scenario C1; **f** Juréia–Serra do Mar, scenario C2



conduits (Hess and Fischer 2001)—i.e., individuals are expected to spend more time in habitat corridors. Corridor width can be adjusted by increasing the CMTC threshold to ensure that corridors contain minimum habitat requirements.

The ability to identify multiple dispersal routes can be desirable in conservation studies, for three main reasons. First, least-cost paths have been employed in the design of linked reserve systems (Hector et al. 2000; Schadt et al. 2002; Larkin et al. 2004). This approach, however, can lead to very narrow linkages (Alagador and Cerdeira 2007) that might not be located in land tracts available for purchase. Second, dispersal routes that appear similar may differ in terms of their conservation value. For example, field studies in Canada (Clevenger et al. 2001) show that drainage culverts can act as habitat linkages for several mammal species, but culverts near roads with higher traffic volume and noise levels are less commonly used. Third, the approach shown here enable the visualization of functionally unique landscape structures (Manning et al. 2006): narrow corridors or dispersal bottlenecks within corridors (e.g., Fig. 7).

Considerable attention has been given to quantifying the role played by agroecosystems in conservation (i.e., Bestelmeyer and Wiens 1996; Reitsma et al. 2001; Mas and Dietsch 2003). Agricultural lands can help support wild populations by providing critical habitat (Moguel and Toledo 1999) and influencing neighboring fragments, in which case potential outcomes depend on the spatial configuration and degree of mixture with pristine habitat (Perfecto and Vandermeer 2002; Perfecto et al. 2003; Tscharrntke et al. 2005). Our study of the Brazilian Atlantic forest shows that private lands can collectively influence ecological processes occurring at large spatial scales and supports the assertion that small fragments can potentially shape regional patterns of gene flow (Bodin et al. 2005). This raises the necessity to view agricultural lands' contribution to biodiversity in a larger context.

Movement behavior is a key aspect in functional connectivity studies, but detailed data on animal movement remains hard to collect, especially for large spatial scales. In fact, the ability to produce accurate movement models has long been recognized as one of the main challenges of population biology

studies (Turchin 1998). There is no consensus on the amount of biological detail that should be used in functional connectivity studies. It has been suggested that movement models ought to increase in complexity in order to capture the behavior of particular species (Goodwin 2003). At the same time, conservation biologists have raised the need for rigorous methods that predict the location of dispersal routes for many species (Boitani et al. 2007). Clearly a compromise is needed, which requires determining how much simplification can be made before losing predictive power (Baguette and Van Dyck 2007). Least-cost path predictions can be derived for many species, given the ever growing maps of habitat quality produced by ecological niche modeling. Also, rigorous protocols already exist to compare least-cost predictions with field data (Driezen et al. 2007).

## Conclusions

In the present paper, we extended the graph theory algorithm that serves as the basis for least-cost path calculations. The two outputs are the Conditional Minimum Transit Cost (CMTC) and the Multiple Shortest Paths (MSPs). Our goal was to integrate information on habitat preferences to model dispersal patterns across a heterogeneous matrix. In addition to the path of least resistance between two points, the methods presented here outlined additional paths with similar length and relative cost. Results from artificial landscapes show that the location and relative cost of dispersal routes are strongly influenced by the spatial distribution of favorable habitat in the matrix. In addition, study of a real landscape shows that small, localized disturbance such as removal of small fragments can affect large-scale dispersal routes. Models producing multiple dispersal routes present a practical advantage over models assuming optimum behavior. Although the choice of number of dispersal routes or their location is application specific (and beyond the scope of this paper), our results suggest that the least-cost path is a flexible approach with a wide range of applications.

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# Effects of Urbanization and Habitat Fragmentation on Bobcats and Coyotes in Southern California

SETH P. D. RILEY,\*§ RAYMOND M. SAUVAJOT,\* TODD K. FULLER,† ERIC C. YORK,\*  
DENISE A. KAMRADT,\* CASSITY BROMLEY,\* AND ROBERT K. WAYNE‡

\*Santa Monica Mountains National Recreation Area, 401 West Hillcrest Dr., Thousand Oaks, CA 91360, U.S.A.

†Department of Natural Resources Conservation, Holdsworth Natural Resources Center, 160 Holdsworth Way, Amherst, MA 01003-4210, U.S.A.

‡Department of Biology, University of California, 621 Circle Drive South, Los Angeles, CA 90095, U.S.A.

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**Abstract:** *Urbanization and habitat fragmentation are major threats to wildlife populations, especially mammalian carnivores. We studied the ecology and behavior of bobcats (*Lynx rufus*) and coyotes (*Canis latrans*) relative to development in a fragmented landscape in southern California from 1996 to 2000. We captured and radiocollared 50 bobcats and 86 coyotes, determined home ranges for 35 bobcats and 40 coyotes, and measured their exposure to development ("urban association") as the percentage of each home range composed of developed or modified areas. Both species occupied predominantly natural home ranges. Adult female bobcats had low levels of urban association, significantly lower than coyotes, adult male bobcats, and young female bobcats. Home-range size was positively correlated with urban association for coyotes and adult male and young female bobcats, suggesting that human-dominated areas were less suitable than natural areas in some important way. Animals more associated with non-natural areas had higher levels of night activity, and both bobcats and coyotes were more likely to be in developed areas at night than during the day. Survival rates were relatively high and were not related to urban association, at least for animals >6-9 months of age. Mortality rates from human-related causes such as vehicle collisions and incidental poisoning were also independent of urban association. In this region, even the few animals that had almost no human development within their home range were vulnerable to human-related mortality. Carnivore conservation in urban landscapes must account for these mortality sources that influence the entire landscape, including reserves. For bobcats, preserving open space of sufficient quantity and quality for adult females is necessary for population viability. Educating local residents about carnivores is also critical for conserving populations in urban areas.*

Efectos de la Urbanización y la Fragmentación del Hábitat sobre Gatos Silvestres (*Lynx rufus*) y Coyotes en el Sur de California

**Resumen:** *La urbanización y la fragmentación del hábitat son las amenazas más grandes para las poblaciones de animales silvestres, especialmente de mamíferos carnívoros. Estudiamos la ecología y conducta de gatos silvestres (*Lynx rufus*) y coyotes (*Canis latrans*) en relación al desarrollo en un paisaje fragmentado del sur de California entre 1996 y 2000. Capturamos y colocamos collares de radiotelemetría en 50 gatos silvestres y 86 coyotes, y determinamos los rangos de hogar para 35 gatos y 40 coyotes y medimos su exposición al desarrollo urbano ("asociación urbana") como el porcentaje de cada rango de hogar compuesto por áreas desarrolladas o modificadas. Ambas especies ocuparon rangos de hogar naturales en su mayoría. Las hembras adultas de gatos silvestres mostraron niveles bajos de asociación urbana, significativamente menores que los coyotes, los machos adultos y las hembras jóvenes de gatos silvestres, lo cual sugiere que estas áreas dominadas por humanos fueron notablemente menos adecuadas que las áreas naturales. Los animales más estrechamente asociados con áreas no naturales, gatos adultos machos y coyotes, tienen niveles más altos de actividad nocturna y mayor probabilidad de ocupar áreas urbanizadas durante la noche que durante el día.*

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§email [seth\\_riley@nps.gov](mailto:seth_riley@nps.gov)

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*Las tasas de supervivencia fueron relativamente altas y no se relacionaban con la asociación urbana, al menos para animales >6-9 meses de edad. Las tasas de mortalidad por causas relacionadas con la población humana, tales como el atropellamiento por vehículos y el envenenamiento accidental también fueron independientes del desarrollo urbano. En esta región, los pocos animales que casi no incluían áreas urbanizadas en sus rangos de hogar, eran vulnerables a la mortalidad causada por humanos. La conservación de carnívoros en paisajes urbanos debe tomar en cuenta estas fuentes de mortalidad que afectan a todo el paisaje, incluyendo las reservas. Para la preservación de la viabilidad poblacional de gatos silvestres, hace falta conservar suficiente espacio abierto de calidad para hembras adultas. Es también de importancia crucial educar a los residentes locales sobre los carnívoros para conservar poblaciones en áreas urbanas.*

## Introduction

Conversion of natural habitat to human uses, including urban development, agriculture, and extractive industries such as mining and intensive forestry reduces the amount of intact natural habitat and fragments what remains (Saunders et al. 1991). Wide-ranging and low-density species such as mammalian carnivores are particularly vulnerable to the processes of habitat loss and fragmentation (Noss et al. 1996; Gittleman et al. 2001).

Some carnivores have adapted well to the presence of humans. Raccoons (*Procyon lotor*; Riley et al. 1998), skunks (*Mephitis mephitis*, Rosatte et al. 1990), and red foxes (*Vulpes vulpes*; Harris 1981) reach their highest densities in urban areas, and Crooks (2002) found that the relative abundance of gray foxes (*Urocyon cinereoargenteus*) and opossums (*Didelphis virginianus*) is highest in the smallest habitat fragments. Other species, however, are less able to coexist with humans. Large carnivores come into conflict with humans and their domestic animals, and more-specialized species may not benefit from human-associated foods such as ornamental fruit or garbage. Mammalian carnivores, although often controversial (Kellert et al. 1996), generate public interest and are often the focus of conservation. As top predators in many terrestrial ecosystems, carnivores may also affect other carnivores (Palomares & Caro 1999) and populations in lower trophic levels (Sovada et al. 1995; Crooks & Soulé 1999).

Bobcats (*Lynx rufus*) and coyotes (*Canis latrans*) are common predators throughout North America, yet little is known about how they respond to urban development and habitat fragmentation. A few studies have examined urban or suburban coyotes in southern California (Gill & Bonnett 1973), around Seattle, Washington, (Quinn 1997a; 1997b), in Tucson, Arizona (McClure et al. 1995; Bounds & Shaw 1997; Grinder & Krausman 2001a, 2001b), and in British Columbia (Atkinson & Shackleton 1991). Although interesting results have been obtained, particularly for urban coyote diets, the radiotracking components of these studies have all included <10 animals and have been of short duration, except for the study by Grinder and Krausman (2001a) which addressed largely younger animals (13 of 16). Harrison (1998) inter-

viewed residents in a rural residential area about bobcat sightings, and Riley (1999) studied bobcats and gray foxes in unfragmented habitats adjacent to urban areas in northern California. Studying bobcats and coyotes in an urban area allows an evaluation of how two relatively adaptable but also quite different carnivores are affected by urbanization. Although both bobcats and coyotes range across the entire continent and utilize a variety of habitats, coyotes are larger, more social, and more omnivorous than bobcats.

We studied the use of a fragmented urban landscape by bobcats and coyotes to better understand the conservation of carnivores in the face of urbanization. We estimated the level of exposure to development of these two carnivores by measuring the percentage of developed and altered area within their home range, or their "urban association." Our goals were to determine whether exposure to urban areas was related to species, age and sex class, homerange size, degree of nocturnal or diurnal activity, survival rates, and causes of mortality.

## Methods

### Study Area

Our study area was in the central Santa Monica Mountains and Simi Hills of southern California, west of the city of Los Angeles (Fig. 1). Natural vegetation varied and included mixed chaparral, coastal sage scrub, oak woodland and savanna, riparian areas, and introduced annual grasslands. Human land uses included commercial development, low- to high-density residential development, golf courses, landscaped areas in parks and adjacent to office buildings, agricultural land, and a 120-ha landfill. An 8- to 10-lane freeway (U.S. Route 101) and numerous secondary roads intersected the study area (Fig. 1).

### Animal Capture and Radiotelemetry

Bobcats and coyotes were captured with padded foothold traps and necksnare. Captured animals were fitted with radiocollars with activity/mortality sensors that indicated whether animals were active, inactive, or dead

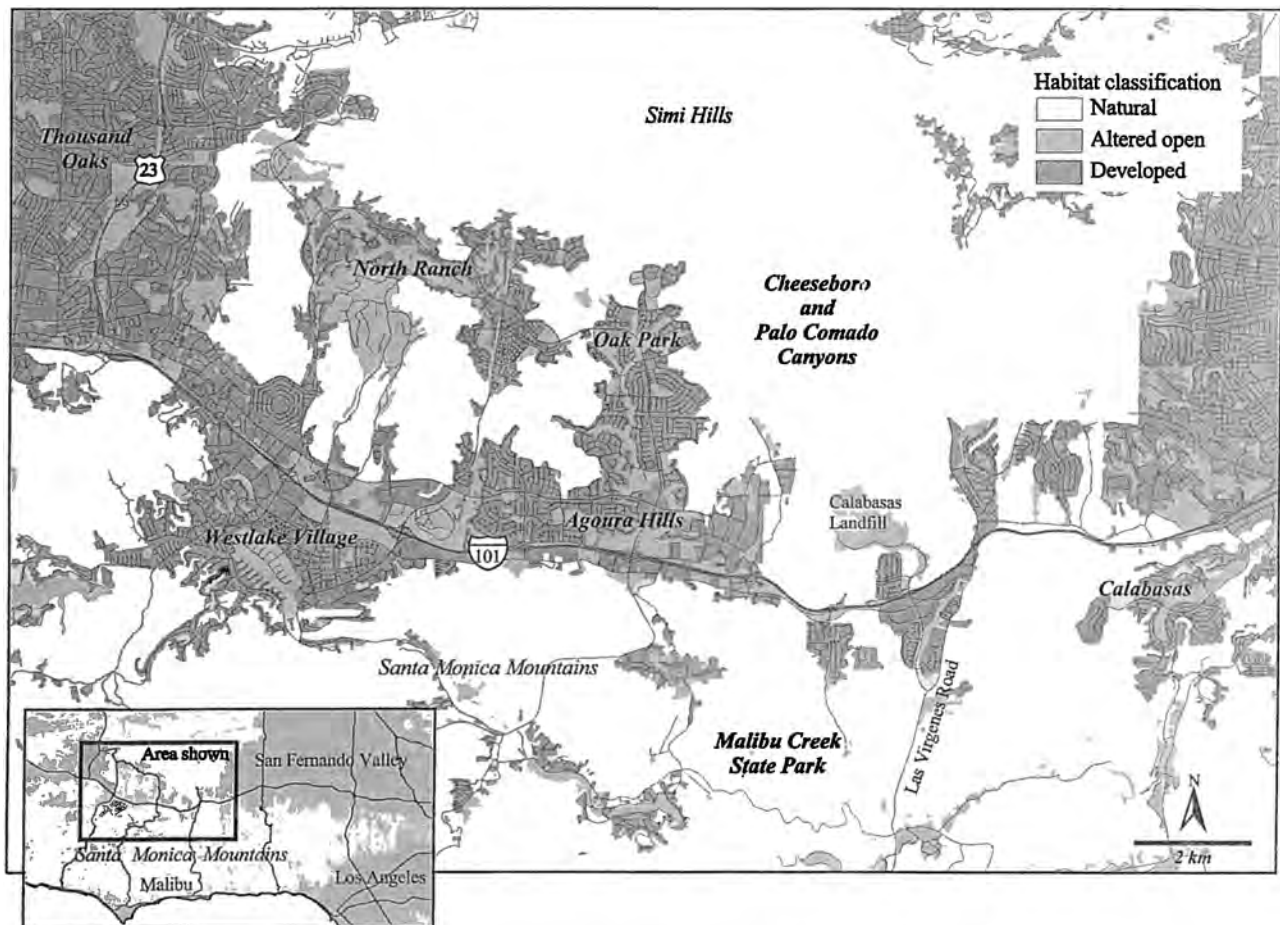


Figure 1. Land-use classification of bobcat and coyote study area in Los Angeles and Ventura Counties, California. The landscape within the study area was classified according to three land-use types: developed areas, altered open areas, and natural areas.

by variation in signal frequency (Advanced Telemetry Systems, Isanti, Minnesota, and Telemetry Solutions, Concord, California). We recorded sex, weight, morphological measurements, and age (juvenile, yearling, adult) for each animal. Juvenile animals were equipped with radiocollars with compressible polyurethane foam inserts to accommodate growth. “Young” animals included juveniles (0–1 year) and yearlings (1–2 years). To locate radiocollared animals by ground triangulation, observers recorded azimuths and their own location. We measured the accuracy of the radiotelemetry with test collars by comparing geographic positioning system locations of the collars to triangulated locations. Mean error distance was 42.4 m (SD = 50.2). This measure may underestimate the error of some locations, because test collars were generally close to the observers. However, we minimized the distance between observers and collared animals to acquire accurate locations, especially near land-use edges. We rechecked locations in or near the urban edge before conducting analyses, and we discarded those locations for which the observer was not

positioned along the urban edge because we could not know with certainty on which side of the edge the animal was located.

#### Estimates of Home Range

We used minimum convex polygon (MCP) home ranges (Hayne 1949) for our analyses because they more accurately characterized the landscape used by radiocollared animals in our study area. The highly fragmented nature of the landscape produced clumps of locations in disjunct areas, and kernel home ranges for these animals often included separate polygons with no utilized area in between, but these areas were potentially important. Our study area also had many linear boundaries, such as roads and freeways, across which many animals rarely or never moved, and kernel home ranges included areas on the far side of such boundaries, whereas MCPs did not. Home-range area-observation curves reached asymptotes around 20 locations, so we determined home ranges for each animal with  $\geq 20$  radiolocations. Over



our 4-year study, some animals made home-range shifts. If an animal completely shifted its area of use, we computed the home range based on the area that was used for the longest period. We estimated two different home ranges for one male bobcat that spent substantial time in two distant areas. We compared home-range size between species and age and sex groups with Mann-Whitney *U* tests.

### Urban Association

To classify land use in the study area, we generalized a digital land-use map (Southern California Association of Governments 1993) into three types of land use: natural areas, developed areas, and altered open areas (Fig. 1). "Natural areas" consisted of large, contiguous areas of natural vegetation. "Developed areas" included commercial and residential areas with at least one house per 0.40 ha (1 acre). "Altered open" areas included golf courses; the Calabasas Landfill; graded areas (e.g., future construction sites); landscaped lawns such as office parks, playing fields, and city parks; low-density residential areas (one house per 2 ha), and small patches or strips of natural vegetation within high-density residential development (e.g., stream corridors). These altered open areas were potentially more attractive to carnivores than developed areas.

We measured urban association as the percentage of each animal's home range consisting of these non-natural types of land use. Land-use association can also be measured by calculating the percentage of locations that occurred in the different types of land use (e.g., Mannan & Boal 2000), and contrasting the percentage of locations with the home range or the percentage of the home range with the study area could illuminate habitat selection (*sensu* Johnson 1980). However, we focused on the extent to which animals were exposed to urban areas, regardless of whether they "selected" them or not. We believe that the percentage of the home range is the best measure of this exposure.

With Arc-Info (Environmental Systems Research Institute, Redlands, California), we overlaid the 95% MCP home ranges for each animal onto the land-use classification map and measured the percentage of its home range consisting of development, altered open areas, or both. We refer to the combined developed and altered open areas as "non-natural areas." We also counted the number of animals that had no non-natural area within their home range as animals with no urban association. For logistic reasons there was probably some bias against developed areas in our trap locations, but we believe it unlikely that we missed any strictly urban bobcats or coyotes, or that this bias compromised our results.

We used Mann-Whitney *U* and Kruskal-Wallis tests to evaluate differences in degree of urban association between species and sexes, and Fisher exact tests to test

for differences in the number of animals with no urban association. We used Spearman rank correlations with two-sided tests of significance to determine the relationship between urban association and home-range size.

### Survival and Cause-Specific Mortality Rates

We monitored radiocollared animals at least weekly to assess survival. When a mortality signal was discovered, we attempted to determine cause of death in the field. If this was not possible, carcasses were sent to the California Department of Fish and Game Wildlife Investigations Laboratory. We used the program MICROMORT (Heisey & Fuller 1985) to calculate survival rates. For both sexes of each species we calculated survival and cause-specific mortality rates annually, during wet (November–April) and dry (May–October) seasons and over relevant life-history periods. If radio contact was lost and the animal's fate was unknown, the animal was excluded from the analysis.

We tested for differences in survival rates and cause-specific mortality rates with the chi-square methods of Sauer and Williams (1989) and the program CONTRAST (Hines & Sauer 1989). We examined the relationship between survival rate and urban association by classifying bobcats and coyotes into three groups based on breaks in the histogram of the percentage range non-natural. We then computed survival rates for the animals in those categories and tested for differences between groups with multiple comparisons and Bonferroni corrections. Because we computed urban association by using home ranges and we only computed home ranges for animals with >20 locations, many radiocollared animals were not included. Animals with few locations may have died sooner, potentially producing a bias toward high survival rates. To detect this bias, we used the percentage of locations in non-natural areas (because we did not compute home ranges for these animals) to determine urban association for the 26 coyotes and five bobcats with 5–19 locations. We tested survival rates based on these 66 coyotes and 40 bobcats for a relationship between urban association and survival rate and compared the results with those from the animals with  $\geq 20$  locations. We also used this larger group of animals to look for a relationship between cause-specific mortality rates and urban association, this time using the histogram of percentage points non-natural to split bobcats into three groups and coyotes into four groups for computing mortality rates based on urban association.

### Activity

When an animal was located, its activity level was recorded as active or inactive and time of day was classified as night (between 2200 and 0500 hours, the period during which human activity was significantly decreased)

or day (other hours). On the level of the individual animal, we used Spearman rank correlation to determine the relationship between urban association and the percentage of nocturnal locations that were active. To summarize the relationship between urban association, time of day, and activity across animals, for each animal we computed (separately for both active and inactive locations) the percentage of locations in the different types of land use that occurred at night or during the day. We then took the mean of these percentages across bobcats and coyotes, a procedure that uses individual animals as independent sampling units and avoids pseudoreplication.

We used an  $\alpha$  of 0.10 as the level of significance for all statistical tests because of our small sample sizes and the need to use nonparametric tests, both of which reduced statistical power. Statistical analyses were performed with the program SYSTAT.

## Results

We captured and radiocollared 50 bobcats (23 males; 27 females) and 86 coyotes (49 males; 37 females). We computed 95% MCP home ranges for 35 bobcats and 40 coyotes (Table 1) with  $\geq 20$  radiolocations (coyotes: mean = 48 locations, SD = 22, range = 20–177; bobcats: mean = 49 locations, SD = 30, range = 23–147). Males had significantly larger home ranges than females for both bobcats ( $U = 66.5, p = 0.005$ ) and coyotes ( $U = 119, p = 0.054$ ). These sex differences were also significant within age class for bobcats (adults:  $U = 40, p = 0.068$ ; young:  $U = 2, p = 0.041$ ) but not for coyotes (adults:  $U = 67, p = 0.262$ ; young:  $U = 8, p = 0.123$ ). Adult and

young home ranges were not different for bobcats ( $U = 141.5, p = 0.736$ ) or coyotes ( $U = 160, p = 0.951$ ).

## Urban Association

Male bobcats were significantly more urban-associated than female bobcats (Table 1; Fig. 2; range developed:  $U = 86, p = 0.027$ ; range non-natural:  $U = 68.5, p = 0.006$ ). This difference was most striking for adult males and females (range developed:  $U = 16, p = 0.001$ ; range non-natural:  $U = 17.5, p = 0.002$ ). Young females were not significantly more urban-associated than young males (range developed:  $U = 19, p = 0.149$ ; range non-natural:  $U = 12, p = 1.00$ ). However, adult males were more urban-associated than young males (range developed:  $U = 35, p = 0.036$ ; range non-natural:  $U = 34.5, p = 0.043$ ), and adult females were less urban-associated than young females (range developed:  $U = 15, p = 0.014$ ; range non-natural:  $U = 24, p = 0.098$ ). Only two bobcats, one adult female and one young male, had no urban association, so we did not test for sex or age differences in this measure. More adult females than adult males had no developed area in their home range (adult females, 6 of 11; adult males, 1 of 13; Fisher's test,  $p = 0.023$ ). However, the proportion of young females with no urban association did not differ from the proportion of adult females (Fisher's test,  $p = 0.147$ ) or the proportion of adult males (Fisher's test,  $p = 1.00$ ).

Male coyotes were more urban-associated than females by percentage range developed ( $U = 135, p = 0.085$ ), although not for percentage range non-natural ( $U = 142, p = 0.128$ ). Young animals were not significantly more urban-associated than adults (range developed:  $U = 115, p = 0.116$ ; range non-natural:  $U = 124, p = 0.194$ ).

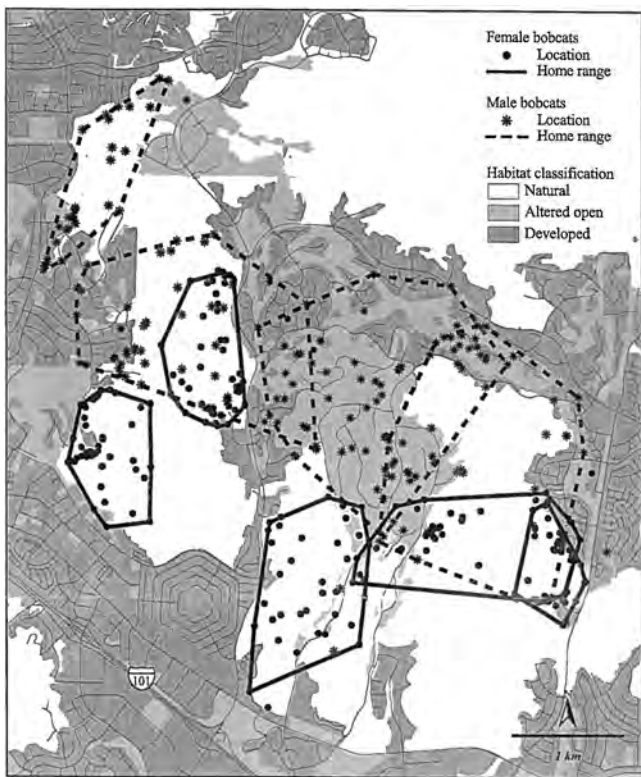
**Table 1.** Home range size and urban association<sup>a</sup> of bobcats and coyotes in the Santa Monica Mountains and Simi Hills.

Species	n	95% MCP <sup>b</sup> home range size (km <sup>2</sup> ) mean $\pm$ SD	Developed area in home range (%)	Altered open area in home range (%)	Natural area in home range (%)	Number of animals with	
						no developed area in home range	no non- natural <sup>c</sup> area in home range
Bobcats	35		7.6	11.5	80.9	10	2
males	16	3.21 $\pm$ 2.55	10.8	14.6	74.6	3	0
females	19	1.55 $\pm$ 1.44	4.8	8.9	86.3	7	0
adult males	13	3.03 $\pm$ 2.57	12.9	15.9	71.2	1	1
adult females	11	1.72 $\pm$ 1.80	1.4	9.5	89.2	6	0
young males	3	3.99 $\pm$ 2.83	2.0	8.9	89.1	2	1
young females	8	1.30 $\pm$ 0.76	9.6	8.1	82.3	1	0
Coyotes	40		17.6	9.1	73.3	9	4
males	22	6.17 $\pm$ 7.44	22.3	8.5	69.2	4	2
females	18	2.84 $\pm$ 2.81	11.8	9.8	78.4	5	2
adults	28	4.96 $\pm$ 6.91	15.6	7.9	76.6	9	4
young animals	12	4.18 $\pm$ 3.66	22.3	11.9	65.8	0	0

<sup>a</sup> Urban association is measured by the percentage of the home range that is made up of developed and altered open habitats.

<sup>b</sup> Minimum convex polygon (Hayne 1949).

<sup>c</sup> Non-natural area = developed area + altered open area.



**Figure 2.** Home ranges (95% minimum convex polygons) of male and female bobcats relative to land use in the Simi Hills region, Ventura County, California. Altered open areas include low-density residential areas, golf courses, and small vegetated patches or strips.

Sexes were not different within ages, and ages were not different within sexes.

Only 4 of 40 coyotes, all adults, had no non-natural area within their home range. There was no difference between males and females (Fisher's test,  $p = 0.705$ ) in the proportion of coyotes with no developed area in their home ranges.

To compare urban association among species, we separated adult male, adult female, and young female bobcats, excluded young male bobcats because of small sample size ( $n = 3$ ), and considered coyotes as one group. Kruskal-Wallis tests showed a significant effect of species-age-sex group on urban association (range developed:  $H = 11.415$ ,  $p = 0.010$ ; range non-natural:  $H = 8.105$ ,  $p = 0.044$ ). To specifically compare each bobcat group with coyotes, we carried out three contrasts with an overall  $\alpha$  of 0.075. Adult female bobcats were significantly less urban-associated than coyotes (at  $\alpha = 0.025$ , critical difference = 13.97, range developed difference = 23.24, range non-natural difference = 17.66), but adult male bobcats (critical difference = 13.10, range developed difference = 0.12; range non-natural difference = 4.26) and young female bobcats (critical difference = 15.88, range developed difference = 5.99, range non-natural difference = 7.36) were not.

More adult female bobcats than coyotes had no developed area in their home range (adult female bobcats: 6 of 11, coyotes: 9 of 40; Fisher's test,  $p = 0.061$ ), but neither adult male bobcats (Fisher's test,  $p = 0.419$ ) nor young female bobcats (Fisher's test,  $p = 1.00$ ) were different from coyotes in this measure.

### Urban Association and Home Range Size

For all bobcats, home range size was larger for animals with higher urban association, particularly for percent range non-natural ( $n = 35$ , range developed:  $r_s = 0.319$ ,  $0.10 > p > 0.05$ ; range non-natural:  $r_s = 0.681$ ,  $p < 0.001$ ). This positive relationship was significant for adult males ( $n = 13$ ;  $r_s = 0.484$ ,  $p = 0.10$ , for percent developed;  $r_s = 0.302$ ,  $0.50 > p > 0.20$ , for percent non-natural) and young females ( $n = 8$ ;  $r_s = 0.548$ ,  $0.20 > p > 0.10$ , for percent developed;  $r_s = 0.643$ ,  $p = 0.10$ , for percent non-natural). The relationship was not significantly negative for adult females ( $n = 11$ ;  $r_s = -0.484$ ,  $0.20 > p > 0.10$ , for percent developed;  $r_s = -0.368$ ,  $0.50 > p > 0.20$ , for percent non-natural). We could not compute a relationship for young males ( $n = 3$ ).

For all coyotes ( $n = 39$ ), home range size increased with percent range non-natural ( $r_s = 0.275$ ,  $0.10 > p > 0.05$ ) but not with percent range developed ( $r_s = 0.210$ ,  $p = 0.20$ ). For adult male coyotes ( $n = 15$ ; range developed:  $r_s = 0.481$ ,  $0.10 > p > 0.05$ ; range non-natural:  $r_s = 0.593$ ,  $0.05 > p > 0.02$ ) the relationship was stronger.

### Survival and Mortality Causes Relative to Urban Association

Average annual survival rates were similar between species (bobcats,  $n = 50$ , survival rate = 0.761, vs. coyotes,  $n = 86$ , survival rate = 0.742;  $\chi^2_1 = 0.093$ ,  $p = 0.760$ ) and between sexes within species (male bobcats,  $n = 21$ , survival rate = 0.822, vs. female bobcats,  $n = 29$ , survival rate = 0.745;  $\chi^2_1 = 0.910$ ,  $p = 0.340$ ; male coyotes,  $n = 49$ , survival rate = 0.770, vs. female coyotes,  $n = 37$ , survival rate = 0.730;  $\chi^2_1 = 0.392$ ,  $p = 0.531$ ). Survival rates were higher in the sample of animals for which we computed home ranges (those with  $>20$  locations; Table 2).

With the expanded sample of 66 coyotes and 40 bobcats with  $>5$  locations, survival rates did not vary with urban association (Table 3; bobcats:  $\chi^2_2 = 4.46$ ,  $p = 0.107$ ; coyotes:  $\chi^2_3 = 1.38$ ,  $p = 0.709$ ). Similarly, for those animals with  $>20$  locations (Table 2), average annual survival rates were not related to urban association for bobcats ( $\chi^2_2 = 3.91$ ,  $p = 0.142$ ) or coyotes ( $\chi^2_2 = 0.362$ ,  $p = 0.830$ ). Vehicles, other carnivores, and toxins—specifically anticoagulant rodenticides—were the principal causes of death for bobcats and coyotes (Table 3). For bobcats, the average annual vehicle mortality rate was related to urban association ( $\chi^2_2 = 6.20$ ,  $p = 0.045$ ), but

**Table 2.** Average annual survival rates of bobcats and coyotes in urban Southern California, 1996–2000, relative to urban association.<sup>a</sup>

	Urban association (%)	n	Average annual survival rate <sup>b</sup>	Total no. radio days	No. deaths
Bobcats					
group 1	0–9	13	0.825	8,874	6
group 2	10–21	14	0.829	8,755	3
group 3	>36	7	0.943	6,189	2
Coyotes					
group 1	0–14	16	0.873	12,952	6
group 2	22–40	14	0.828	9,842	6
group 3	>45	10	0.856	8,368	5

<sup>a</sup>Urban association is measured by the percentage of the home range that consists of developed and altered open areas.

<sup>b</sup>Survival rates based on the 34 bobcats and 40 coyotes with  $\geq 20$  locations.

Bonferroni-corrected pairwise comparisons were not significant, even between the groups with the most and least urban association (0.141 vs. 0.00;  $\chi^2_1 = 3.91$ ,  $p = 0.048$ ). The mortality rate from predation was not related to urban-association group ( $\chi^2_2 = 1.41$ ,  $p = 0.494$ ).

For coyotes, the vehicle mortality rate was not related to urban association ( $\chi^2_3 = 0.837$ ,  $p = 0.841$ ), but both the predation mortality rate ( $\chi^2_3 = 11.43$ ,  $p = 0.0096$ ) and the toxin mortality rate ( $\chi^2_3 = 11.39$ ,  $p = 0.010$ ) were. Although the group with the highest urban association had the highest average annual mortality rate from toxins (Table 3), there was no consistent relationship between urban association and toxin mortality, and corrected pairwise comparisons were not significant. The predation mortality rate in the animals with no urban association was higher than that in animals with some non-natural area in their home range ( $\chi^2_1 = 16.49$ ,  $p < 0.001$ ). Bobcats and coyotes did not differ in their average annual vehicle mortality rate ( $\chi^2_1 = 0.193$ ,  $p = 0.661$ ).

### Activity and Urban Association

Coyotes as a group were more active at night (66% of points active) than during the day (51% of points active).

For bobcats there was little difference between day and night in the percentage of points active (night, 64% active; day, 60% active).

Based on the analysis of all radiolocations for each species, both coyotes and bobcats shifted their use of altered open areas, and particularly of developed areas, to the night. Based on only bobcat locations recorded as active, 75% of developed-area locations, 47% of altered-open-area locations, and 27% of natural-area locations occurred at night (average percentages across 40 bobcats). For inactive locations, on average 77% of developed-area locations, 58% of altered-open-area locations, and 21% of natural-area locations occurred at night. On average overall, 25% of all locations, 28% of active locations, and 26% of inactive locations were recorded at night.

Coyotes exhibited the same pattern. Of coyote radiolocations recorded as active, on average 80% of developed-area locations, 60% of altered-open-area locations, and 29% of natural-area locations occurred at night (averages across 66 coyotes). For inactive locations, on average 66% of developed-area locations, 80% of altered-open-area locations, and 23% of natural-area locations occurred at night. On average overall, 25% of all locations, 32% of active locations, and 25% of inactive locations were recorded at night.

**Table 3.** Average annual cause-specific mortality rates for bobcats and coyotes in urban southern California relative to urban association,<sup>a</sup> 1996–2000.<sup>b</sup>

	Urban association (%)	Radio days	Survival rate	Vehicle mortality rate (no. deaths)	Predation mortality rate (no. deaths)	Toxin mortality rate (no. deaths) <sup>c</sup>	Gunsbot mortality rate (no. deaths) <sup>c</sup>	Unknown/miscellaneous mortality rate (no. deaths)
Bobcats								
group 1	0	4479	0.704	0.141 (3)	0.098 (2)	na	na	0.078 (2)
group 2	3–16	12104	0.825	0.042 (2)	0.024 (1)	na	na	0.024 (1)
group 3	>22	8890	0.904	0.000 (0)	0.023 (1)	na	na	0.059 (2)
Coyotes								
group 1	0	5013	0.744	0.027 (1)	0.232 (4)	0.053 (2)	0.000 (0)	0.000 (0)
group 2	1–19	13037	0.850	0.057 (3)	0.021 (1)	0.045 (3)	0.021 (1)	0.038 (2)
group 3	20–37	8712	0.823	0.061 (2)	0.027 (1)	0.000 (0)	0.000 (0)	0.066 (3)
group 4	>46	4515	0.836	0.046 (1)	0.000 (0)	0.135 (3)	0.000 (0)	0.000 (0)

<sup>a</sup>Urban association is based on the percentage of radiolocations in developed and altered open areas.

<sup>b</sup>Survival and mortality rates are for the 66 coyotes and 40 bobcats with fewer than five locations.

<sup>c</sup>The na indicates that no bobcats ever died of this cause, so we did not compute mortality rates for bobcats for these causes.

At the individual animal level there was a relationship between urban association and night activity. For adult female bobcats ( $n = 11$ ), level of night activity increased with percent range non-natural ( $r_s = 0.454$ ,  $0.10 > p > 0.05$ ) but not with percent range developed ( $r_s = 0.345$ ,  $0.25 > p > 0.10$ ). The percentage of night points active increased with urban association for adult male bobcats ( $n = 13$ ) for percent range non-natural ( $r_s = 0.643$ ,  $0.01 > p > 0.005$ ), although not for percent range developed ( $r_s = 0.308$ ,  $0.25 > p > 0.10$ ). For young female bobcats ( $n = 8$ ), neither relationship was significant, although both were positive.

For coyotes there were strong relationships between urban association and night activity. The relationship was significant for both urban-association measures for all coyotes ( $n = 39$ ) (range developed:  $r_s = 0.306$ ,  $0.05 > p > 0.025$ ; range non-natural:  $r_s = 0.286$ ,  $0.05 > p > 0.025$ ) and for adult male coyotes ( $n = 22$ ; range developed:  $r_s = 0.453$ ,  $0.05 > p > 0.025$ ; range non-natural:  $r_s = 0.444$ ,  $0.10 > p > 0.05$ ). For adult female coyotes ( $n = 17$ ) there was a significant relationship between percentage of night points active and percent range developed ( $r_s = 0.450$ ,  $0.10 > p > 0.05$ ) but not for percent range non-natural ( $r_s = 0.375$ ,  $0.25 > p > 0.10$ ).

## Discussion

Even though these carnivores utilized developed areas, all groups including coyotes and adult male bobcats were predominantly associated with natural areas (Table 1). Natural area was also the largest component of home ranges of coyotes in Tucson (Grinder & Krausman 2001a), and coyotes in Seattle preferred the least-disturbed habitats, even when they were scarce within the animal's home range (Quinn 1997a). Although coyotes are omnivorous and can take advantage of human-related food items, including ornamental fruit, garbage, pet food, and pets (McClure et al. 1995; Quinn 1997b; Fedriani et al. 2001), even in the most "humanized" part of their study area. Fedriani et al. (2001) found that at most 25% of the coyote diet consisted of anthropogenic food. Coyotes are opportunistic animals that find available resources in a disturbed landscape, but they still largely inhabit natural areas and subsist on natural foods.

For bobcats, age and sex affected sensitivity to urbanization. Similar sex differences were also found when individual bobcats were intensively monitored in the study area (Tigas et al. 2002). The low level of urban association of adult female bobcats may be related to the species' polygynous social system, in which females care for the young. Areas frequented or modified by humans may be perceived by female bobcats as unsafe for raising young. In Golden Gate National Recreation Area in northern California, female bobcats also appear to be more sensitive to urbanization because they maintain

home ranges only in the interior of the park, whereas males range out to the park edge (Riley 1999). Our findings that young female bobcats were more urban-associated than adult females whereas young male bobcats were less urban-associated than adult males, although currently based on a small sample of animals, is in accordance with bobcat social behavior. Female bobcats are generally territorial by prior rights land tenure (Bailey 1974; Anderson 1987), and in high-density populations young females searching for a territory may be willing to utilize marginal habitats. Dispersing Iberian lynx (*Lynx pardinus*) use lower-quality habitat than residents (Palomares et al. 2000). Adult male bobcats have larger home ranges that generally increase in size over time in order to encompass more females (Connor et al. 1999), and their greater willingness to move through developed areas may allow more mating opportunities.

For some predators such as red foxes (Harris 1981), raccoons (Riley et al. 1998), and Cooper's Hawks (*Accipiter cooperii*; Mannan & Boal 2000), density increases and home range size decreases in urban areas, presumably because of high-density food supplies and sufficient habitat requirements. Fedriani et al. (2001) suggest that coyote density may be enhanced by human-related food items in this study area, and, in comparison with other populations, the home ranges of bobcats and coyotes in our study were small. The high productivity of environments in coastal California may allow bobcats and coyotes to meet metabolic requirements with small home ranges, but the constraints of urban habitat fragmentation may also restrict home range size. Of the three bobcat studies that have reported home ranges of a similar size (Lembeck & Gould 1979; Miller & Speake 1979), one was also in an urban area (Riley 1999), and female home ranges were significantly smaller there than in a nearby rural area. Coyote home ranges can also be small in urban areas (Atkinson & Shackleton 1991; but see Bounds & Shaw 1997).

Although developed and altered open areas may offer increased food resources, we observed a positive relationship between home range size and urban association. This suggests that non-natural areas are less suitable than natural areas in some important aspect. Secure resting and denning locations may be more dispersed in developed areas, and although coyotes, adult male bobcats, and young female bobcats may forage in the neighborhoods, they may be less willing to rest there. For adult male bobcats, the significant relationship with percentage range developed but not with percentage range non-natural may indicate that the altered open areas are more equivalent to natural areas. In general, bobcats had consistently higher association with altered open areas than with developed areas (Table 1).

A decreased sense of security around humans would also explain the shift toward nocturnal use of more-developed areas in both bobcats and coyotes. Urban coyotes in Seattle

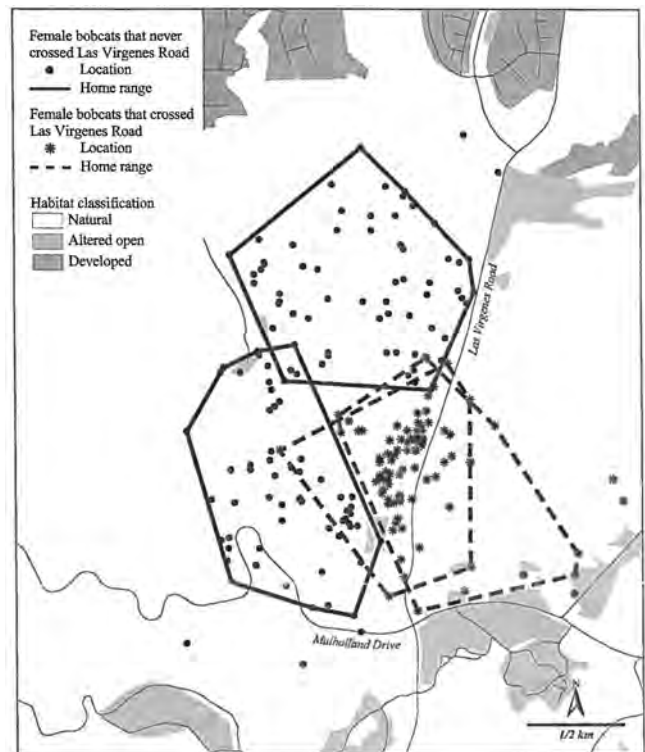


move through developed habitats more at night than during the day (Quinn 1997a), and coyotes in a suburban area in Wyoming have also shifted to less diurnal activity than animals in nearby Grand Teton National Park (McClennen et al. 2001). Coyotes in southeastern Colorado are more active during the day since population exploitation and harassment have ceased (Kitchen et al. 2000).

The survival rates for bobcats and coyotes in our study were similar to those reported in other unexploited populations (Gese et al. 1989; Fuller et al. 1995; Chamberlain et al. 1999; Grinder & Krausman 2001b) and higher than those in harvested populations (Davison 1980; Fuller et al. 1985; Windberg et al. 1985). Contrary to our expectations, there were no differences in survival rate relative to urban association. Although our sample of animals for which we could determine home ranges may have been biased toward higher survival, we found no more of a relationship between survival rate and urban association with animals found at  $\geq 5$  locations. We followed mostly full-grown animals that were at least 6–9 months old, so differences in survival rate could be more evident in young animals. Perhaps when bobcats and coyotes have negotiated their first few months in the urban landscape, the lack of human exploitation or larger carnivores produces high survivorship.

Still, if there were mortality sources associated with urbanization and fragmentation, such as vehicle collisions, nuisance animal trapping, or contaminant build-up, animals with more contact with developed areas should have lower survivorship. In Tucson, humans—specifically, their vehicles—accounted for most coyote mortality (Grinder & Krausman 2001b). In our study area almost every animal lives in a fragmented and urbanized landscape: only 4 of 40 coyotes and 2 of 35 bobcats had home ranges consisting entirely of natural area. Consequently, nearly every bobcat and coyote was potentially affected by human-associated mortality sources.

Similarly, mortality rates from human-related causes were not positively related to urban association. For bobcats, the vehicle death rate was highest in animals with the least urban association. In this landscape roads are omnipresent, and even if they are denser in urban zones, those traversing open space can be particularly dangerous, especially if used by many vehicles traveling at high speed. Animals most exposed to urban areas may also gain familiarity with roads and develop the ability to safely navigate them. Las Virgenes Road, a throughway between the 101 freeway and the town of Malibu, bisects significant natural area. Radiocollared animals in this area had low or no urban association, but a number of collared and uncollared animals were killed on this road. Four female bobcats were radiotracked in the vicinity of Las Virgenes road. Two that never crossed the road each survived for over 5 years. The two that were located on both sides of the road were each struck and killed by vehicles <15 months after capture (Fig. 3).



*Figure 3. Home ranges (95% minimum convex polygons) of four female bobcats along Las Virgenes Road, Los Angeles County. Risk of vehicle mortality was not related to urban association, as illustrated by these four female bobcats with low urban association (<4% for each). The two bobcats that crossed the road (dashed lines) were killed by vehicles, whereas the other two were not.*

The coyote mortality rate from anticoagulant poisoning was also not related to urban-association. Anticoagulant poisoning deaths were generally caused by brodifacoum, a chemical designed and designated as an indoor rodent poison (Hosea 2000). Although the highest mortality rate was among coyotes with the highest urban association, animals with the lowest urban association also died from anticoagulant poisoning. Although coyotes may have been exposed to poisons in residential areas or on golf courses, even animals in large natural zones may consume prey that have ingested poisons.

Woodroffe and Ginsburg (1998) suggest that minimizing carnivore mortality at the boundaries of nature reserves may be more important for conserving carnivores than the size of the reserve. Our results further indicate that in fragmented urban landscapes, human-caused mortality may affect all animals. Carnivore conservation efforts in these landscapes must account for the pervasive effects of humans and development, even within reserves.

Bobcats are more sensitive to urbanization than omnivorous canids such as coyotes and gray foxes (Riley 1999; Crooks 2002; Tigas et al. 2002; this study). The

higher sensitivity of adult female bobcats in particular is important for bobcat population viability because lands that are inhospitable to females cannot produce new animals. The most marginal areas used by bobcats may be a population sink (*sensu* Pulliam 1988) if dispersing bobcats reach these areas from nearby source populations but do not reproduce there. Source-sink dynamics can have critical implications for the long-term prospects of felid populations (Gaona et al. 1998). An important management issue then becomes the minimum requirements for adult female bobcats to survive and successfully reproduce. Adult female home ranges averaged 1.7 km<sup>2</sup>, and we know that fragments of 3.15 and 4.45 km<sup>2</sup> supported at least three female bobcats. The habitat quality of a particular patch is important, however, and intensive human alteration will limit its value. We do not know the reproductive success of bobcats in habitat fragments or how it compares with that in nearby wildlands. We also know from concurrent scat, track, and camera surveys (Tigas 2000) that bobcats utilize fragments as small as 0.4 km<sup>2</sup>. But whether only males use these smallest patches, whether and how bobcats move between these patches, and finally whether reproduction occurs in them are open questions.

Even the highly adaptable coyote utilizes natural areas more than developed areas, expands its home range in increasingly urbanized areas, shifts its use of developed areas to periods of decreased human presence, and is vulnerable to vehicle collisions and poison. Ultimately, we must not only learn the requirements of carnivore species in developing landscapes, we must also educate people to value carnivores and promote their conservation by preserving open space, using rodenticides sparingly and correctly, providing usable crossing points under freeways and major roads, driving slower where carnivores cross roads, and living with rabbits in the yard and in the park.

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## FAST-TRACK

# A southern California freeway is a physical and social barrier to gene flow in carnivores

SETH P. D. RILEY,\*†JOHN P. POLLINGER,\*RAYMOND M. SAUVAJOT,\*ERIC C. YORK,†CASSITY BROMLEY,†TODD K. FULLER‡ and ROBERT K. WAYNE\*

\*Department of Ecology and Evolutionary Biology, 621 Charles Young Dr. South, University of California, Los Angeles, CA 90095, USA, †Santa Monica Mountains National Recreation Area, National Park Service, 401 W. Hillcrest Dr., Thousand Oaks, CA 91360, USA, ‡Department of Natural Resources Conservation, Holdsworth Natural Resources Center, 160 Holdsworth Way, Amherst, MA 01003-9285, USA

## Abstract

Roads present formidable barriers to dispersal. We examine movements of two highly mobile carnivores across the Ventura Freeway near Los Angeles, one of the busiest highways in the United States. The two species, bobcats and coyotes, can disappear from habitats isolated and fragmented by roads, and their ability to disperse across the Ventura Freeway tests the limits of vertebrates to overcome anthropogenic obstacles. We combine radio-telemetry data and genetically based assignments to identify individuals that have crossed the freeway. Although the freeway is a significant barrier to dispersal, we find that carnivores can cross the freeway and that 5–32% of sampled carnivores crossed over a 7-year period. However, despite moderate levels of migration, populations on either side of the freeway are genetically differentiated, and coalescent modelling shows their genetic isolation is consistent with a migration fraction less than 0.5% per generation. These results imply that individuals that cross the freeway rarely reproduce. Highways and development impose artificial home range boundaries on territorial and reproductive individuals and hence decrease genetically effective migration. Further, territory pile-up at freeway boundaries may decrease reproductive opportunities for dispersing individuals that do manage to cross. Consequently, freeways are filters favouring dispersing individuals that add to the migration rate but little to gene flow. Our results demonstrate that freeways can restrict gene flow even in wide-ranging species and suggest that for territorial animals, migration levels across anthropogenic barriers need to be an order of magnitude larger than commonly assumed to counteract genetic differentiation.

*Keywords:* carnivores, conservation genetics, gene flow, habitat fragmentation, road and anthropogenic barriers, territoriality

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## Introduction

Roads are the primary threat to dispersal between habitat patches in urban landscapes (Forman & Alexander 1998) and, without dispersal, isolated populations may be doomed to extinction (Brown & Kodric-Brown 1977; Hanski *et al.* 1996). Roads can also isolate populations

previously in genetic communication, and the resulting genetic erosion may contribute to population decline (Saccheri *et al.* 1998; Westemeier *et al.* 1998). Empirical data on the frequency of dispersal across roads and its effect on genetic variation and population persistence are few and limited to small and relatively abundant species with low vagility (e.g. frogs, Reh & Seiz 1990; voles, Gerlach & Musolf 2000; beetles, Keller & Largiadér 2003). In contrast, the ability of large carnivores to disperse long distances could mitigate the effects of genetic isolation. However, for carnivores, population densities are low and home range

Correspondence: Seth P. D. Riley, Fax: 805-370-1850;

E-mail: seth\_riley@nps.gov

sizes and dispersal distances are large (Sunquist & Sunquist 2001), so their persistence should be strongly influenced by the isolating effects of roads and development. Additionally, carnivores are susceptible to the deleterious genetic effects of inbreeding in small populations (O'Brien *et al.* 1985; Roelke *et al.* 1993; Vila *et al.* 2003; Liberg *et al.* 2005). Although conservation biologists have focused on the importance of connectivity for carnivores, actual demonstrations of the genetic consequences of roads for such long-lived and mobile species have been lacking.

We studied dispersal and genetic differentiation in coyote (*Canis latrans*) and bobcat (*Lynx rufus*) populations separated by a wide and heavily travelled freeway in the highly urbanized landscape of southern California. To obtain a direct estimate of dispersal, we radio-tracked animals on both sides of the freeway over seven years, from 1996 to 2003. To obtain a genetic estimate of dispersal, we genotyped individuals using highly variable microsatellite loci and then used genetic assignment tests based on the composite genotypes to assign animals genetically to each side of the freeway. We then assessed levels of genetic differentiation between populations on the same and different sides of the freeway to measure the effect of the road on gene flow (genetically effective migration). Finally, we determined whether levels of observed migration were consistent with levels of gene flow estimated by a coalescent model based on the number of generations since the freeway was established. The use of both radio-tracking information and genetic data to monitor migration and gene flow allows an assessment of the long-term genetic consequences of roads and other anthropogenic barriers on genetic diversity and can lead to the development of plans to mitigate their effects.

## Materials and methods

We studied coyote and bobcat populations separated by the Ventura Freeway (US101), a congested 10–12 lane road in the San Fernando Valley 40 km from downtown Los Angeles. More than 150 000 vehicles use the road daily and the presence of a meridian fence largely restricts dispersal to underpasses and culverts (Fig. 1A) (Ng *et al.* 2004). The freeway was established in 1949 from a relatively undeveloped secondary road with minimal traffic (B. Marquez, personal communication), and there are no other natural barriers such as rivers or topographic features following the freeway that would have historically restricted gene flow. The study area consisted of 358 km<sup>2</sup> of chaparral, grassland, and oak woodland habitat (Table S1, Supplementary material) interspersed with secondary roads and housing developments. The 28.4-km length of the freeway connects the towns of Agoura Hills and Thousand Oaks that have a combined population of 200 000. The area is considered a critical habitat corridor connecting the Santa Monica Mountains with extensive natural habitat to the north (Penrod *et al.* 2001).

## Animal capture and radiotelemetry

Bobcats and coyotes were captured with padded foothold traps in 1996–1998 and with box traps (bobcats) and neck snares (coyotes) in 2000–2003. We also genotyped a population of bobcats from northern California where bobcats were captured with box traps from 1992 to 1995 (Riley *et al.* 2004). Captured animals were aged, sexed, weighed, measured, ear-tagged, radio-collared, and released at the capture site. Blood, hair, scat, and in some cases tissue samples were taken for genetic analyses.

Animals were radio-located by triangulation using three consecutive or two simultaneous compass directions obtained with a peak directional antenna. Locations were obtained throughout the 24-h daily cycle. We computed 95% minimum convex polygon home ranges for animals with at least 20 locations. Home range overlap was computed for animals that were radio-tracked concurrently. We computed overlap as the total percentage of the home range that intersected with any other animals of the same sex.

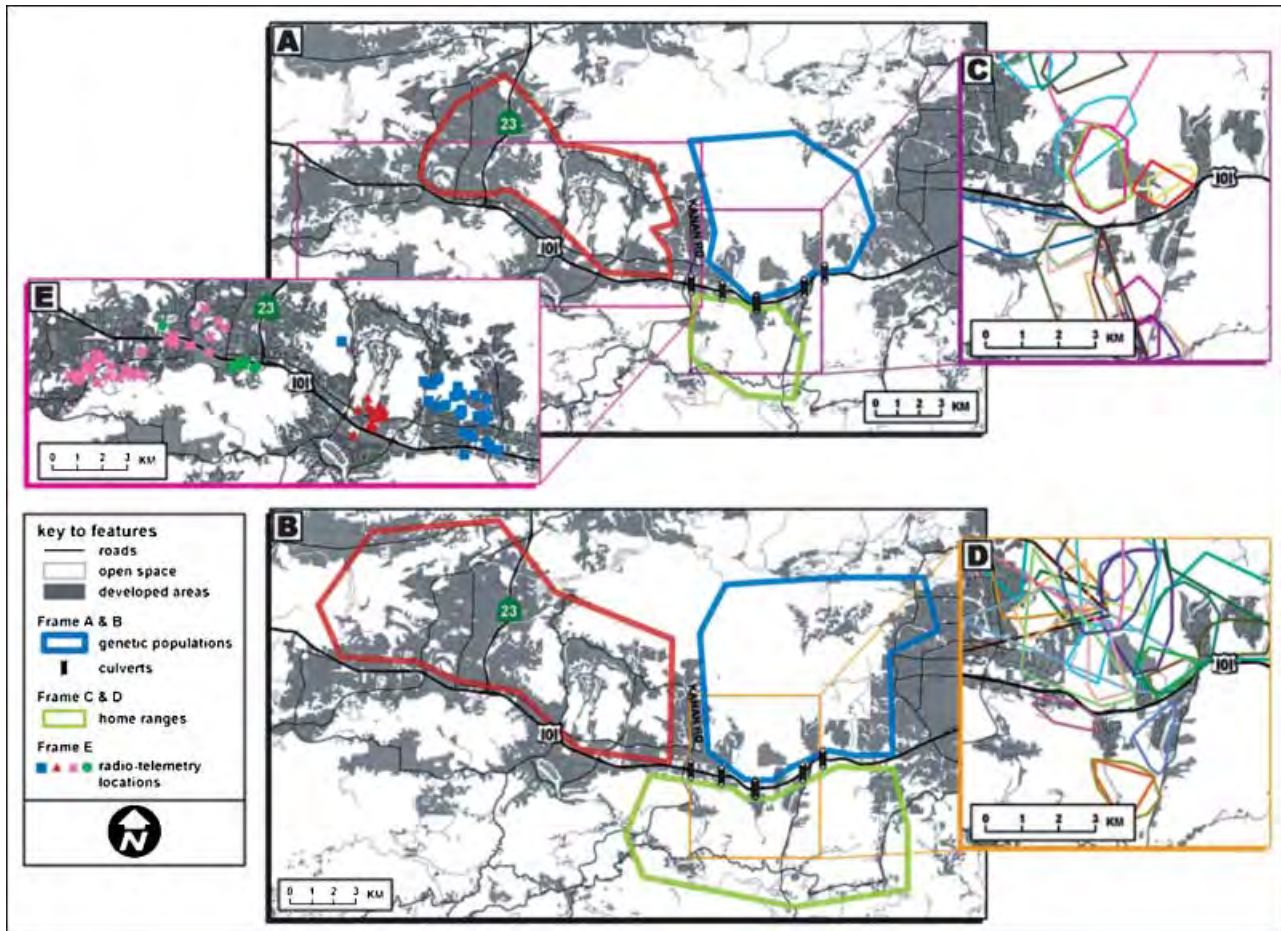
## Genetic sampling

All bobcat and coyote DNA samples were extracted from blood or tissue (ear punch) samples taken at time of capture. Standard phenol–chloroform extraction methods were utilized. Seven dinucleotide microsatellite loci developed for the domestic cat (Menotti-Raymond *et al.* 1999) and validated for polymorphism in the bobcat (Ernest *et al.* 2000) were used to genotype all bobcat specimens (FCA026, FCA043, FCA045, FCA077, FCA090, FCA096, and FCA132). Seven tetranucleotide microsatellite loci developed for the domestic dog (Breen *et al.* 2001) and validated as polymorphic for the coyote by the authors were used to type all coyote specimens (FH2001, FH2137, FH2422, FH2062, FH2226, FH2293, and PEZ19). Polymerase chain reactions (PCR) utilized either (i) a fluorescent dye-labelled forward primer, or (ii) a hybrid combination of forward primers consisting of the published forward primer with the M13F (–20) sequence (16 bp) added to the 5' end and a fluorescent dye labelled M13F (–20) primer. The unlabelled reverse primer was used in both cases. We used the PCR conditions for the hybrid combination primer (a two-step cycle) (Boutin-Ganache *et al.* 2001). Primer dye labelling utilized BeckmanCoulter dye D4 and PCR products were sized on the BeckmanCoulter CEQ2000XL DNA Analysis System.

## Genetic analysis

Observed and expected heterozygosities, allelic diversity, and deviation from Hardy–Weinberg equilibrium were assessed with GENEPOP (Raymond & Rousset 1995; Table S2, Supplementary material). Bonferroni corrections to significance levels were applied to account for multiple





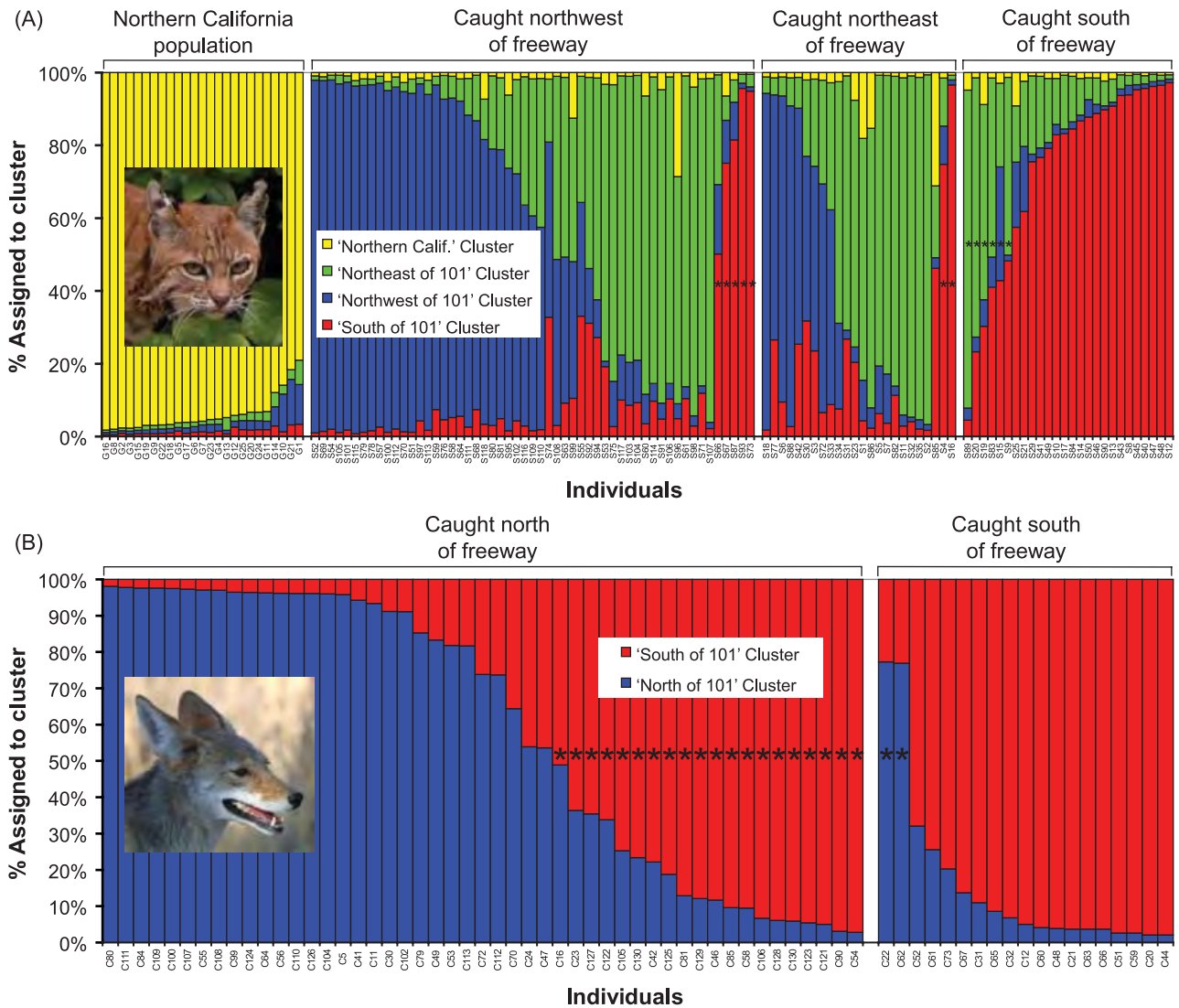
**Fig. 1** Study populations, home ranges and radio-locations of bobcats and coyotes near the Ventura Freeway in southern California. Bobcat (A) and coyote (B) study populations are located north and south of the Ventura Freeway. The north side populations are further divided by Kanan road into northeast and northwest populations. 95% minimum convex polygon (MCP) home ranges are shown for all radio-tracked bobcats (C) and coyotes (D) near the freeway between the south and northeast populations. In (E), radio-telemetry locations are shown for four bobcats with locations north and south of the freeway that were captured north of the freeway but assigned genetically to the population south of it (see Fig. 2).

tests in the determination of heterozygote deficiency/excess (Rice 1989). Coyote samples were grouped into two populations north and south of the freeway, whereas bobcats were divided into three populations, two north and one south of the freeway according to *STRUCTURE* results (see Results and discussion).

To obtain a genetic estimate of dispersal, we used assignment tests based on the composite microsatellite genotypes. Assignment tests identify the population of origin for each individual, and thus individuals assigned to a population other than the one in which they were caught can be considered migrants (Berry *et al.* 2004). We used the program *STRUCTURE* (Pritchard *et al.* 2000) to assign individuals to populations. *STRUCTURE* is a Bayesian clustering algorithm that uses multilocus genotypes to infer population structure and assign individuals to populations. All individuals were combined into one data set for analysis,

without any a priori population assignments. We utilized a burn-in of 50 000 iterations, followed by 500 000 iterations of the Gibbs sampler. Admixture was allowed. We evaluated  $K$  values, the number of assumed populations, from 1 to 6. Each value of  $K$  was run a minimum of three times to evaluate stability. For the highest likelihood  $K$  value, we then evaluated the cluster assignment results for each individual with respect to its capture location.

For potential migrants identified in the initial *STRUCTURE* analysis, we modified the *STRUCTURE* input data file to reassign them to their putative population of genetic origin based on the cluster assignment results. We then calculated the posterior probability of correct population assignment with this revised data set in *STRUCTURE* using the ancestry model with admixture, incorporating population information with the migration parameter set to  $v = 0.1$  (Table S5, Supplementary material).



**Fig. 2** Genetic assignment results from the program STRUCTURE for bobcat (top) and coyote (bottom) populations. Individuals are grouped according to capture location. Genetic population clusters are coded with different colours and the fraction of colour for each individual represents the probability of assignment to the cluster with that colour. Four clusters were found in bobcats, corresponding to a northern California group (yellow), two groups on the north side of the freeway (blue and green) and one group on the south side of the freeway (red). In coyotes, two clusters are supported by STRUCTURE, corresponding to a north (blue) and south (red) cluster. Asterisks denote misassigned individuals (individuals with greater than 50% assignment to a cluster different from the capture location) that are potential migrants.

We measured population differentiation by calculating population pairwise  $F_{ST}$  values and significance ( $g$ -test) using the program FSTAT (Goudet 2002). We estimated gene flow as the number of genetic migrants ( $Nm$ ) between populations from  $F_{ST}$  values [ $F_{ST} \approx 1/(1 + 4Nm)$ ; Wright 1921]. Population membership was based on the capture location north or south of the Ventura Freeway. The northern population was additionally split into northwest and northeast populations to measure differentiation between populations on the same side of the freeway. Computing  $F_{ST}$  between these two populations north of the

freeway allows us to compare the amount of genetic differentiation across the freeway with that over the same or greater distance without the barrier. The east and west populations were divided by Kanan Road, a secondary road, and surrounding development (Fig. 1A,B).

We also computed the pairwise relatedness coefficient,  $R$  between individuals, (Queller & Goodnight 1989) using the program KINSHIP (Goodnight 2005). We identified pairs of individuals significantly related ( $\alpha = 0.05$ ) at the  $R \geq 0.25$  level by first performing a simulation in KINSHIP using the complete population data set at  $R = 0.25$ , followed

by log-likelihood calculations for all possible pairs. Based on the three defined populations, two north and one south of the freeway, for both bobcats and coyotes, we then determined the percentage of number of close relatives ( $R \geq 0.25$ ) across the freeway, across a similar distance on the same side of the freeway, and within each population (Fig. S1, Supplementary material).

We used coalescent simulation to generate predicted levels of genetic differentiation based on a population isolation event with the program SIMCOAL (version 1.0) (Excoffier 2004). SIMCOAL is a computer program for the simulation of molecular genetic diversity in an arbitrary number of diploid populations based on a retrospective coalescent approach. SIMCOAL was utilized to estimate expected population pairwise  $F_{ST}$  values for both bobcat and coyote microsatellite results, based on the time since the freeway was built. A sensitivity analysis was performed on the parameter space of inference for the simulations by varying population effective sizes, sample sizes, migration rates, number of generations since a historical event (population separation), and microsatellite mutation rate. The microsatellite mutation rate was varied from  $10^{-3}$  to  $10^{-2}$  based on observed mutation rates for dinucleotide and tetranucleotide microsatellites for the domestic dog (Francisco *et al.* 1996). Effective population sizes ( $N_e$ ) were estimated as the number of territorial adults in the study area based on telemetry observations. This calculation assumes that all territorial individuals reproduce equivalently; however, sensitivity analysis showed that results were not sensitive to small changes in  $N_e$  or sample size. One thousand analysis iterations were performed for each combination of input parameters. SIMCOAL output results were then analysed using ARLEQUIN (Schneider *et al.* 2000) for pairwise population  $F_{ST}$  estimation.  $F_{ST}$  values were determined by averaging the  $F_{ST}$  values of all 1000 iterations. Because sensitivity analysis showed that population effective size and sample size had minimal effect on  $F_{ST}$  within the range of our study values, they were held constant at 200/50 (population effective size/sample size) for bobcats and 75/25 for coyotes. The number of generations since separation was varied from 25 to 100, and migration rate was varied from 0 to 10% of source population. We assume a 2-year generation time for coyotes and bobcats (Knick *et al.* 1985; Bekoff & Wells 1986).

## Results and discussion

We captured bobcats and coyotes on the north and south sides of the freeway and placed radio-telemetry collars on 110 (92 north side, 18 south side) coyotes and 87 (64 north side, 23 south side) bobcats. Using radio-telemetry, from 1996 to 2003 five (4.5%) radio-collared coyotes and 10 (11.5%) radio-collared bobcats were observed to cross the

freeway, whereas 58 (52%) coyotes and 40 (45%) bobcats crossed major secondary roads. Because a principal study objective was to understand the effects of roads, and in particular the freeway, on carnivore movement, all radio-collared animals were captured within dispersal distance, and many within an average home range diameter, of both the freeway and secondary roads. However, only 213 (2.3%) of 9311 bobcat locations and 19 (0.4%) of 4565 coyote locations were on the opposite side of the freeway from the capture location of the individual.

Home range perimeters followed but did not cross roads such as the freeway, implying that they functioned as artificial territorial boundaries (Fig. 1C, D). For both male and female bobcats, home ranges that bordered on hard boundaries such as the freeway or development were significantly smaller than those that did not (males:  $t = -1.919$ , one-sided  $P = 0.033$ ; females:  $t = -2.186$ , one-sided  $P = 0.018$ ). Also, for adult female bobcats, the age class most important for reproduction, home range overlap was three times higher among individuals with home ranges adjacent to development and the freeway than in those with nonadjacent home ranges (38.8% vs. 12.4% overlap;  $t = -1.77$ , one-sided  $P = 0.045$ ). For coyotes, we did not radio-track a sufficient proportion of territorial individuals throughout the study area to reliably measure territory overlap. Overall, the freeway was a significant barrier to movement as only about 5–10% of individuals crossed in the 7 years of observation, and home range boundaries, overlap, and size were affected by its proximity.

We genotyped 68 (49 north side, 19 south side) coyotes and 108 (82 north side, 26 south side) bobcats for variation in seven microsatellite loci. Microsatellite loci were highly polymorphic for both species (Table S2, Supplementary material). We also typed a population of 25 bobcats from Golden Gate National Recreation Area in the San Francisco Bay Area, a geographically remote and genetically distinct population (Riley *et al.* 2004). For bobcats, the STRUCTURE assignment test results determined that four populations best fit the data (Table S3, Supplementary material), with the northern California population clearly separated from those in southern California and two populations located north and one south of the freeway (Fig. 2A). All bobcats from northern California were assigned correctly to that population. However, seven bobcats caught north of the freeway, five to the west and two to the east, were assigned genetically to the south side population with assignment probabilities and posterior probabilities of greater than 50% (Fig. 2A; Table S5, Supplementary material). We had radio-telemetry observations on six of these seven bobcats, and four of the six were located south of the freeway at least once (Fig. 1E), corroborating their status as migrants. Six bobcats assigned north of the freeway were captured to the south (Fig. 2A). None of these bobcats were found north of the freeway based on

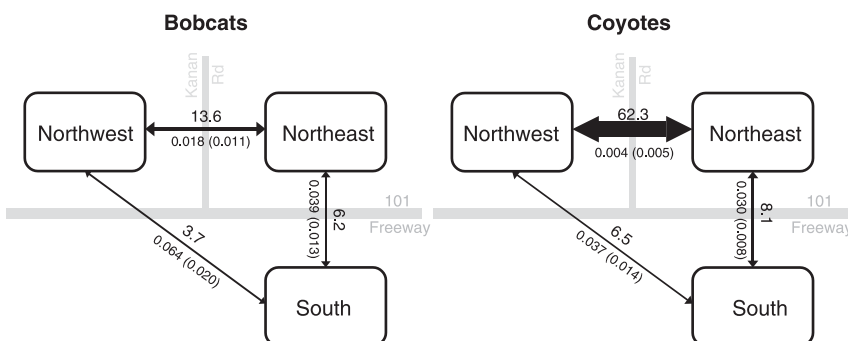


radio-telemetry observations, although three were located within 500 m of it, and two within 100 m. Therefore, based on genetic assignment and in part supported by telemetry observations, 9% (7 of 80) of the bobcats sampled from the north side of the freeway and 23% (6 of 26) of the bobcats sampled from the south side are putative migrants (see Fig. 2A). Considering the limited sampling of activity provided by radio-telemetry, the genetically derived estimate of migration (13 of 106 individuals or 12.3%) and that based on telemetry (10 of 87 individuals or 11.5%) are remarkably similar and suggest that about 12% of the sampled bobcat population crossed the freeway over the 7-year study period, or 3.4% per generation.

For coyotes, the assignment test determined that two populations best fit the observed data, one north and one south of the freeway (Fig. 2B; Table S3, Supplementary material). Two of 19 individuals (11%) captured south of the freeway were assigned to the north side population with assignment probabilities and posterior probabilities of greater than 50% (Fig. 2B; Table S5). Radio-telemetry observations were available for one of these two coyotes, and none of the 107 locations were north of the freeway, although six of the first seven locations were within 1.5 km of it, indicating that this coyote may have dispersed from the north. Twenty of the 49 coyotes (41%) captured on the north side of the freeway were assigned to the south side. We had radio-telemetry observation on 18 of these coyotes, and none showed evidence of crossing the freeway, although 11 of 18 were observed within 1 km of it. Consequently, the genetic results suggest that 10% of the South side population and as much as 41% of the north side population may be migrants. This implied migration fraction of 32% (22 of 68 individuals) or 9.1% per generation is much larger than the value of 4.5% or 1.3% per generation based on telemetry observations. Considering higher assignment thresholds of 80% and 90%, 21% (14 of 68) or 5.9% per generation and 10% (7 of 68) or 2.9% per generation, respectively, are still misassigned and likely to be migrants. The discrepancy between genetic- and telemetry-based estimates may reflect the unlikely probability of observing dispersal with limited radio-telemetry

observations or the difficulty of classifying migrants in genetically similar populations. The use of assignment tests to measure dispersal requires a modest degree of genetic differentiation between populations, otherwise historical gene flow will confound the assessment of recent dispersal events (Berry *et al.* 2004). However, two observations argue for a higher dispersal rate than suggested by telemetry observations. First, coyotes generally disperse farther than bobcats (Van Vuren 1998), which had higher observed and implied rates of migration (see above). Second, of the 22 coyotes that were genetically misclassified, 14, or 64%, were juveniles or yearlings, the ages when coyotes typically disperse (Gese *et al.* 1989). This compares to 39% juveniles or yearlings in the population of coyotes that were not misclassified.

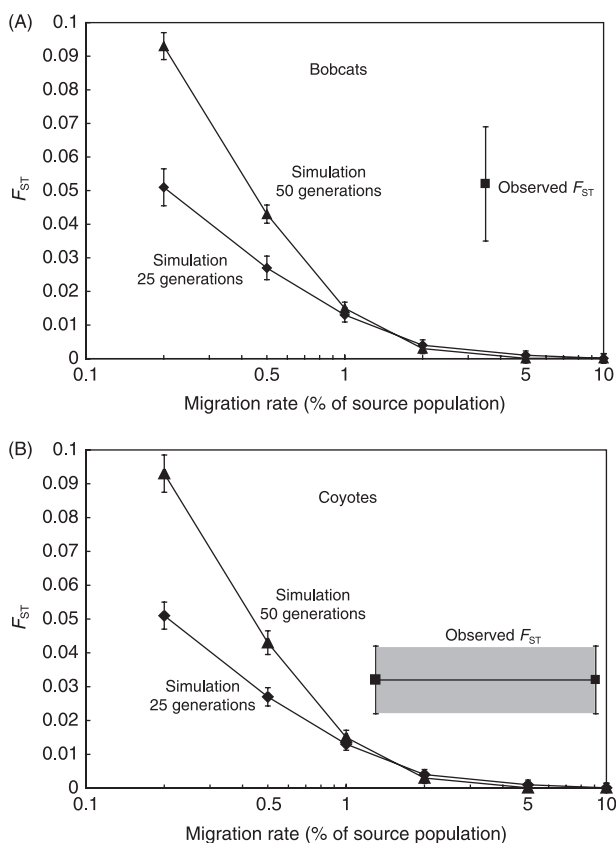
Although the freeway is a barrier to movement, rates of migration of 3.4% per generation for bobcats and from 1.3% to 9.1% per generation for coyotes as suggested by telemetry or genetic data imply high rates of gene flow sufficient to counteract drift (Mills & Allendorf 1996; Vucetich & Waite 2000). To assess levels of differentiation, we measured  $F_{ST}$ , the fixation index, for the seven microsatellite loci. For both species, we found that  $F_{ST}$  values between populations on different sides of the freeway were two to nine times larger (and  $Nm$  2–9 times smaller) than those between populations on the same side, although the latter populations were separated by greater distances (Figs 1A, B and 3). Additionally, 39.2% of alleles for coyotes and 23.6% of alleles for bobcats were unique to one side of the freeway (Table S4, Supplementary material). For coyotes, both pairwise  $F_{ST}$  values across the freeway ( $F_{ST} = 0.030$  northwest-south,  $F_{ST} = 0.037$  northeast-south) were significantly different from zero ( $P < 0.003$ ), whereas the  $F_{ST}$  values between the two subpopulations on the same side of the freeway (0.004, northwest-northeast) was not ( $P = 0.134$ ). For bobcats all three pairwise  $F_{ST}$  values were significantly different from zero ( $F_{ST} = 0.064$  northwest-south,  $F_{ST} = 0.039$  northeast-south,  $F_{ST} = 0.018$  northwest-northeast) ( $P < 0.003$ ), suggesting that Kanan Road, a busy secondary road, and the wide development corridor flanking it, may also be a significant barrier to gene flow for bobcats



**Fig. 3** The number of genetic migrants ( $Nm$ , above line) and levels of genetic differentiation ( $F_{ST}$ , below line, standard error in parentheses) between populations across the freeway (northwest vs. south and northeast vs. south) and on the same side of the freeway (northeast vs. northwest) for bobcats and coyotes. Arrow widths are proportional to  $Nm$  values.

(Fig. 3). Relatedness values also indicated substantially more closely related pairs of animals ( $R \geq 0.25$ ) between populations on the same side of the freeway (northeast vs. northwest) than across it (northeast vs. south) (Fig. S1, Supplementary material). Overall, these results clearly show that the Ventura Freeway is an imposing barrier to gene flow for both species.

To assess if these levels of genetic differentiation were consistent with population history and the observed and implied migration rates, we used coalescent simulation modelling to estimate north side–south side pairwise  $F_{ST}$  indices resulting from the division of a single population by the creation of the freeway in 1949. The simulation results (Fig. 4) showed that a genetically effective migration rate of approximately 0.5% per generation or less is required to explain the observed level of population differentiation for both carnivore species. Consequently, given



**Fig. 4** Comparison of predicted genetic divergence ( $F_{ST}$ ) using coalescence simulations (Y-axis) with observed  $F_{ST}$  values as a function of migration rate (X-axis) between bobcat (A) and coyote (B) populations north and south of the freeway. Migration rates for observed  $F_{ST}$  values are based on radio-tracking observations and genetic assignment tests (see text). Error bars for  $F_{ST}$  values represent one standard error. Observed genetic differentiation is consistent with a migration rate of 0.5% or less for both species given 25 or 50 generations since isolation.

that our observations span a period of about three generations (Knick *et al.* 1985; Bekoff & Wells 1986), the genetically effective migration rates estimated by the coalescent simulation are approximately 3–18 times lower than migration rates between populations separated by the freeway based on direct observation or genetic population assignment.

The disparity between observed migration rates and inferred gene flow likely reflects the lack of reproductive success of migrants. For example, 6 of the 10 bobcats that were found on both sides of the freeway were located across it less than four times, and of the four that stayed across, the two females were known not to have produced kittens the following spring. Of the five coyotes radio-tracked across the freeway, four did not reproduce since they were located six or fewer times across the road and over only a short period of time outside the reproductive season. Further, of the potential migrants observed by telemetry and implied by genetic results, 54% were classified as less than 2 years old. In undisturbed populations, young dispersers enter a matrix of occupied and unoccupied territories, reflecting natural mortality of territorial adults. However, in our study area, home ranges follow the freeway boundary (Fig. 1C, D) and consequently, territorial and reproductive individuals contribute genes to the population on one side of the freeway only. Additionally, in our urban study area, mortality from hunting and trapping is low or nonexistent, and carnivore survival rates were high (Riley *et al.* 2003). High survival rates, small home ranges, high home range overlap, and the barrier effect of roads and development all resulted in territory packing along hard boundaries such as the freeway. This territory pile-up likely produced a formidable social and behavioural barrier to genetically effective dispersal because dispersers are unlikely to obtain and hold territories near the freeway. This unique genetic-isolating effect of roads and other artificial boundaries likely applies to other territorial species.

Conceivably, genetic differences may also correspond to changes in habitat composition across the freeway. For example, continent-wide climate and habitat changes have been associated with genetic structure in grey wolves (*Canis lupus*; Geffen *et al.* 2004), and regional-scale biome changes, e.g. between mountainous regions and flat valley expanses, were associated with genetic structure in coyotes (Sacks *et al.* 2004). However, both the geographic scale and diversity in habitats sampled by these studies far exceed the habitat differences observed throughout the area that we studied. Both sides of the freeway consist of a similar mix of the three dominant types of vegetation in the Santa Monica Mountains and Simi Hills including mixed scrub (64–85%), grassland (8–26%) and riparian and oak woodland (2–11%; Table S1, Supplementary material). There is variation in the amounts of specific



types of scrub communities (e.g. coastal sage scrub, dominated by *Salvia* spp. and *Artemisia californica*, and chaparral, dominated by *Adenostoma fasciculatum* or *Ceanothus* spp.) across the entire study area, but coyotes and bobcats on both sides of the freeway used both of these scrub communities, indicating a lack of ecological specialization. Coyotes and bobcats are generalist carnivores, and we feel such small-scale ecological differences are an unlikely explanation of our results. Unfortunately, there are too few historical specimens from our study area in museum collections to directly assess genetic differentiation prior to the construction of the freeway.

Roads are a primary threat to the persistence of animal populations in urban landscapes. This threat is caused directly through vehicle mortality or indirectly by increasing the probability that isolated populations will become extinct through random demographic processes (Forman 2003). Our results show that the genetic effects of roads can also be substantial even for large, highly mobile species. Levels of differentiation between coyote and bobcat populations isolated for about 50 years are as large as those between coyote populations separated by several hundred kilometres (Roy *et al.* 1994). These levels of differentiation were found even between high-density populations of bobcats and coyotes. The isolating effects of roads would likely be even more severe for very small populations and rare species (Spielman *et al.* 2004). An additional insidious factor is the effect of roads in decreasing gene flow well below that expected from migration rates or existing between similarly spaced populations on the same side of the freeway. We suggest this decrease may be caused by: (i) roads acting as home range boundaries for terrestrial and reproductive individuals, and thus decreasing the migration rate of genes, and (ii) home range pile-up near roads that make it less likely that dispersing individuals can find territories. To counteract such genetic isolation, corridors across freeways could conceivably include more natural habitat so that home ranges could extend across the freeway and rates of genetic exchange might be increased. Five of the six potential crossing points in our study (Fig. 1A, B) were unvegetated culverts or paved underpasses. Finally, our results imply that observed migration rates across anthropogenic barriers may be poor surrogates for gene flow, and that molecular genetic studies of even recently isolated populations may provide new insights for conservation.

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### Supplementary material

The supplementary material is available from <http://www.blackwellpublishing.com/products/journals/suppmat/MEC/MEC2907/MEC2907sm.htm>

**Table S1** Percentage of different habitat types in the sampled areas, determined by overlaying the polygons for each population (Fig. 1) on a vegetation map of the Santa Monica Mountains and Simi Hills (Franklin 1997). Chaparral consists of scrub habitat dominated by chamise (*Adenostoma fasciculatum*) and ceanothus (*Ceanothus* spp.); coastal sage scrub consists of scrub habitat dominated by sage (*Salvia* spp.) and California sagebrush (*Artemisia tridentata*); grassland is mostly introduced annual grasses; woodland consists of oak and riparian woodlands and some walnut woodlands.

**Table S2** Observed and expected heterozygosities, allelic diversity and deviations from Hardy–Weinberg equilibrium (significant deviations indicated by  $\pm$ ).

**Table S3** Likelihood values for inferred number of genetic clusters ( $K$ ) from STRUCTURE (3 iterations per value of  $K$ ).

**Table S4** Private alleles as percentage of total alleles per locus in each population.

**Table S5** Cluster assignment and posterior probability of correct genetic population assignment of potential migrants.

**Fig. S1** Comparison of the percentage bobcat and coyote pairs that were closely related genetically, as defined by having an  $R$  value of 0.25 or greater between populations across the freeway (south vs. northwest and northeast) and on the same side of the freeway (across Kanan road, northwest vs. northeast). Bar widths are proportional to percentage values.

**Fig. S2** Sensitivity of the SIMCOAL simulation algorithm for  $F_{ST}$  as a function of microsatellite mutation rate ( $\mu$ ), migration rate, and number of generations since population separation (since construction of the freeway).

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Seth Riley conducts research about habitat fragmentation and urban encroachment effects on wildlife for the National Park Service at Santa Monica Mountains National Recreation Area. John Pollinger studies conservation genetics of carnivores and birds and directs UCLA's Conservation Genetics Resource Center. Ray Sauvajot directs science and planning for the National Park Service at Santa Monica Mountains National Recreation Area and serves as a National Park Service senior science advisor. Eric York and Cassidy Bromley are wildlife biologists with specialties in mammalian carnivore ecology and conservation. Todd Fuller studies the natural history and population ecology of mammalian carnivores and herbivores. Robert Wayne applies molecular genetic techniques to study questions in ecology, behavior and evolution of animals.

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# Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California

SETH P. D. RILEY,<sup>1</sup> *National Park Service, Santa Monica Mountains National Recreation Area, 401 W. Hillcrest Drive, Thousand Oaks, CA 91360, USA*

CASSITY BROMLEY,<sup>2</sup> *National Park Service, Santa Monica Mountains National Recreation Area, 401 W. Hillcrest Drive, Thousand Oaks, CA 91360, USA*

ROBERT H. POPPENG, *Toxicology Laboratory, California Animal Health and Food Safety Laboratory, School of Veterinary Medicine, University of California, One Shields Avenue, Davis, CA 95616, USA*

FRANCISCO A. UZAL, *California Animal Health and Food Safety Laboratory, San Bernardino Branch, 105 W. Central Avenue, San Bernardino, CA 92408, USA*

LYNN WHITED, *California Wildlife Center, P.O. Box 2022, Malibu, CA 90265, USA*

RAYMOND M. SAUVAJOT, *National Park Service, Santa Monica Mountains National Recreation Area, 401 W. Hillcrest Drive, Thousand Oaks, CA 91360, USA*

**ABSTRACT** Humans introduce many toxicants into the environment, the long-term and indirect effects of which are generally unknown. We investigated exposure to anticoagulant rodenticides and evaluated the association between notoedric mange, an ectoparasitic disease, and anticoagulant exposure in bobcats (*Lynx rufus*) and mountain lions (*Puma concolor*) in a fragmented urban landscape in southern California, USA. Beginning in 2002, an epizootic of notoedric mange, a disease previously reported only as isolated cases in wild felids, in 2 years reduced the annual survival rate of bobcats from 0.77 (5-yr average) to 0.28. Anticoagulants were present in 35 of 39 (90%) bobcats we tested, multiple compounds were present in 27 of these 35 (77%), and total toxicant load was positively associated with the use of developed areas by radiocollared animals. Mange-associated mortality in bobcats showed a strong association with anticoagulant exposure, as 19 of 19 (100%) bobcats that died with severe mange were also exposed to the toxicants, and for bobcats with anticoagulant residues >0.05 ppm, the association with mange was highly significant ( $\chi^2 = 10.36, P = 0.001$ ). We speculate that concomitant elevated levels of rodenticide exposure may have increased the susceptibility of bobcats to advanced mange disease. Bobcats were locally extirpated from some isolated habitat patches and have been slow to recover. In 2004, 2 adult mountain lions died directly from anticoagulant toxicity, and both animals also had infestations of notoedric mange, although not as advanced as in the emaciated bobcats that died with severe disease. Two other mountain lions that died in intraspecific fights also exhibited exposure to 2–4 different anticoagulants. These results show that the effects of secondary poisoning on predators can be widespread, reach even the highest-level carnivores, and have both direct and possibly indirect effects on mortality. Further research is needed to investigate the lethal and sub-lethal effects of anticoagulants and other toxicants on wildlife in terrestrial environments. (JOURNAL OF WILDLIFE MANAGEMENT 71(6):1874–1884; 2007)

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The conversion of land for urban or agricultural uses has obvious impacts on natural populations by eliminating, fragmenting, and altering habitat. However, human activity, including the introduction of toxicants into the environment, can have other unintended and more cryptic consequences for wildlife populations. Determining the nature and extent of these effects can be difficult, particularly if multiple stressors are involved. In recent years, laboratory and artificial pond experiments on aquatic amphibians have revealed that anthropogenic stressors can interact with natural ones to have a much greater influence on survival, growth, and population persistence than either factor in isolation (Kiesecker et al. 2001, Kiesecker 2002, Relyea 2003). However, there have been few similar demonstrations in terrestrial systems or in more natural field situations (e.g., Gervais and Anthony 2003).

Anticoagulant rodenticides are widely used in both urban and agricultural settings to control rodent populations.

There are 6 anticoagulant rodenticides registered by the Environmental Protection Agency for control of rats and mice in and around buildings. They are often formulated as grain-based food baits, typically pellets, although other formulations are used, and all are sold over-the-counter and are therefore available to the general public. Warfarin, chlorophacinone, and diphacinone were developed earlier and are referred to as first-generation anticoagulants. They generally require multiple feeding by the target species and are less toxic to birds. They are also more readily metabolized and are much less persistent in the body. The other 3 anticoagulants, brodifacoum, bromadiolone, and difethialone, are commonly referred to as second-generation anticoagulants. They exhibit very high toxicity to birds and mammals, can provide a lethal dose in a single feeding, and can remain in body tissues for long periods (months) because they are highly persistent and are not readily metabolized (Eason et al. 2002, Erickson and Urban 2004, Berny et al. 2006).

Secondary anticoagulant poisoning of nontarget animals has been well-documented in a wide range of birds and mammals (Eason and Spurr 1995; Stone et al. 1999, 2002;

<sup>1</sup> E-mail: seth\_riley@nps.gov

<sup>2</sup> Present address: Big Horn Canyon National Recreation Area, 20 Highway 14A East, Lovell, WY 82431, USA

Hosea 2000; Eason et al. 2002) including owls (Mendenhall and Pank 1980), buzzards (Berny et al. 1997), coyotes (*Canis latrans*; Riley et al. 2003), feral cats (*Felis catus*; Alterio 1996), mountain lions (*Puma concolor*; Littrell 1988), otters (*Lutra lutra*), endangered European mink (*Mustela lutreola*), and polecats (*Mustela putorius*; Fournier-Chambrillon et al. 2004). However, the vast majority of this poisoning undoubtedly remains undetected for several reasons. Most importantly, testing for the presence of anticoagulants requires necropsy and analysis of liver tissue (using high-performance liquid chromatography [HPLC]). Unless an animal is being tracked through radiotelemetry, finding deceased animals in a nondecomposed state is rarely possible in the field (Wobeser 2006). Another problem is that many animals do not exhibit any outward signs of poisoning, so toxicants go undetected without specific testing (e.g., McDonald et al. 1998).

When testing is done, anticoagulant occurrence is often high. Shore et al. (1996) found that 31% of polecats tested in Britain had anticoagulants present, Hosea (2000) found that 70% of the mammals (including coyotes and bobcats [*Lynx rufus*]) tested in California, USA, had been exposed to anticoagulants, and anticoagulants were detected in 49% of the raptors tested in New York, USA, from 1998 to 2001, including in 81% of the great horned owls (*Bubo virginianus*; Stone et al. 2002). Although some predators die directly from anticoagulant toxicity, many others do not. For example, 86% of the raptors exposed to anticoagulants in New York did not show evidence of death from direct toxicity. However, according to Stone et al. (2002:37), “the impact of anticoagulant exposure must extend well beyond those cases in which acute lethal hemorrhage is the proximal cause of death.” Little is known about what constitutes a lethal dose for wildlife species, what the sub-lethal, chronic effects may be, or what kinds of interactions may occur between anticoagulants and other factors.

We investigated the association between anticoagulants and the natural stressor of disease, specifically notoedric mange. Mange is not an uncommon disease in carnivore populations, but most reports of population-level effects are from sarcoptic mange infestation, often in canids (Pence and Ueckermann 2002). Notoedric mange has generally only been reported as isolated cases in wild felids (e.g., Pence et al. 1995, Ryser-Degiorgis et al. 2002) including both bobcats (Penner and Parke 1953, Pence et al. 1982) and captive Florida panthers (*Puma concolor coryi*; Maehr et al. 1995), although there are reports of epizootics in coatis (*Nasua narica*; Valenzuela et al. 2000) and in a feral cat population in Florida, USA (Foley 1991). The mite, *Notoedres cati*, occurs as a treatable ear parasite in domestic cats and may be more common in veterinary practices in Southern California (Brooks 2000), although it occurs in urban areas throughout the United States (K. Kwochka, DVM Pharmaceuticals, personal communication). Mange cases may become severe and result in dehydration, emaciation, and eventually death (Pence and Ueckermann 2002). However, by itself, the occurrence of mange mites,

including *Sarcoptes*, on a healthy animal would not be considered fatal but can develop into lethal disease when other factors are also present (Samuel 1981). Consequently, the prevalence of mange increases in times of increased environmental stress such as drought or winter or in animals under social or nutritional stress (Pence and Ueckermann 2002).

Following results from previous research about the occurrence of anticoagulant toxicity in coyotes (Riley et al. 2003) and more recent observations of mange-associated mortality in bobcats, we began investigating anticoagulant exposure and the potential for interactive effects of this exposure in bobcats and mountain lions. Specifically, we measured the frequency and amount of anticoagulant exposure and notoedric mange incidence in both species, and we assessed the potential association between anticoagulant exposure and susceptibility to severe mange infestation. We also evaluated the degree to which anticoagulant exposure was related to the use of development by radiocollared bobcats and the impact of the mange epizootic on the local bobcat population.

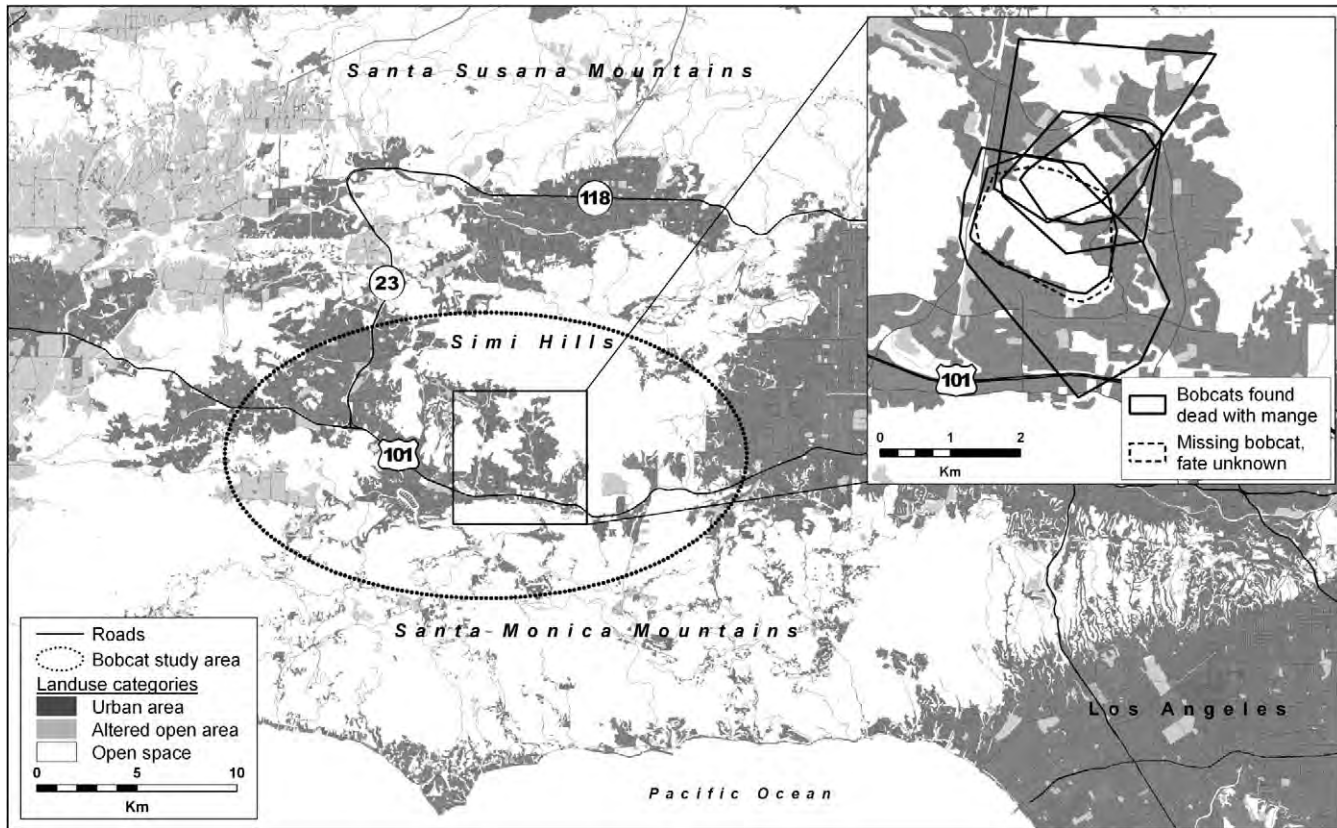
## STUDY AREA

Our study was conducted in the coastal mountain ranges north and west of the city of Los Angeles in southern California, including the Santa Monica Mountains, Simi Hills, and Santa Susana Mountains (Fig. 1). The area had a Mediterranean climate with cool, wet winters and hot, dry summers. Predominant habitat types included mixed chaparral, coastal sage scrub, oak woodland and savanna, riparian areas, and introduced annual grasslands. Human land-uses included commercial development, low- to high-density residential development, golf courses, landscaped areas in parks and adjacent to office buildings, agricultural land, and a 120-ha landfill. An 8–10-lane freeway (United States Route 101), 2 4–6-lane freeways (State Routes 23 and 118), and numerous secondary roads intersected our study area (Fig. 1). For bobcats, we focused on the southern Simi Hills area, including habitat fragments, and the portions of the Santa Monica Mountains immediately across the 101 freeway (see bobcat study area, Fig. 1). For mountain lions, our study area included all of the Santa Monica Mountains, Simi Hills, and Santa Susana Mountains.

## METHODS

### Bobcat and Mountain Lion Capture and Radiotracking

We captured bobcats using foothold traps and snares (1996–1998) and cage traps (2000–2004) and captured mountain lions using foot-snares, cage-traps, and hound-capture. We chemically immobilized all animals with ketamine hydrochloride and xylazine hydrochloride in a 5:1 ratio, and then weighed, measured, and marked them with ear-tags. We fitted adult bobcats with very high frequency (VHF) radiotransmitters (Telonics Inc., Mesa, AZ; Telemetry Solutions, Concord, CA; Advanced Telemetry Systems, Isanti, MN). We fitted mountain lions with combination VHF and Global Positioning System (GPS) collars (Tele-



**Figure 1.** Study area for bobcats and mountain lions near Los Angeles, California, USA, 1996–2006. Inset: home ranges (95% min. convex polygons) of 6 bobcats in an isolated habitat patch in Westlake Village, California. Five of 6 radiocollared bobcats in this patch died of mange between March 2002 and March 2003, and contact was lost with the sixth animal. Based on trapping and scat surveys, little or no evidence of bobcat activity has been seen in this patch since.

vilt, Lindesberg, Sweden). All radiocollars were equipped with mortality sensors. We obtained the necessary permits for animal capture and handling.

We located bobcats by ground telemetry using triangulation (3 compass azimuths obtained within 15 min) 2–5 times per week throughout the 24-hour cycle. Locations used for home range analysis were separated by >12 hours. We tested radiotelemetry accuracy using test collars (see Riley et al. 2003) and it averaged 42.4 m (SD = 50.2). We calculated 95% minimum convex polygon home ranges using the home range extension in the program ArcView. We calculated bobcat survival rates with the techniques of Heisey and Fuller (1985) using the program MICRO-MORT.

We calculated the urban association (the relative amt of potential interaction with human development) of bobcats by determining the percentage of developed land and the percentage of altered land (areas that are not natural habitat, but are potentially more conducive to wildlife use than developed areas) present in the home range (see also Riley et al. 2003). Developed land included commercial areas and residential areas with  $\geq 1$  house per 0.4 ha. Altered land included golf courses, landscaped areas such as office or city parks, a landfill, small strips or patches of habitat, and low-density ( $\leq 1$  house/2 ha) residential areas. We define unnatural area as developed areas plus altered areas.

We radiotracked mountain lions 2–3 times per week by VHF ground telemetry, and we obtained 100–150 GPS collar locations each month by remote download. Potential mountain lion prey kill-sites were identified by examining each month's GPS locations for clusters of locations (Anderson and Lindzey 2003) encompassing a period of 24 hours or more. Potential kill sites were investigated and prey remains were identified to species, age, and sex, when possible.

#### **Bobcat Distribution and Relative Abundance**

We collected scat on established transects each month. Over multiple years, changes in the numbers of scat collected over time allowed us to monitor changes in bobcat distribution and relative abundance. Transects were cleared in March 2001, and then all bobcat scat was collected each month through December 2004, except for 3 months in 2002. We identified bobcat scat by size and shape (Murie 1954). Verification of species identification of bobcat scat in the same region using faecal genotyping revealed approximately 90% accuracy using field characteristics (Kohn et al. 1999, Fedriani et al. 2000), although for examining trends over time, consistency of technique is most important.

#### **Necropsy and Diagnostic Analysis**

When we detected mortality signals, we immediately located the carcasses of radiocollared animals. We determined cause



of death by necropsy and, when possible, by using associated ancillary tests including routine histology, bacteriology, virus isolation, and toxicology. We transported the first 4 bobcats that showed indications of mange to the California Animal Health and Food Safety Laboratory (CAHFS) San Bernardino Branch, where full necropsies were performed. We treated skin scrapings from these animals with 10% potassium hydroxide and examined them microscopically for mites, and we examined mites as whole mounts in glycerin. We identified future cases of mange in bobcats by visual examination and by the distinctive pattern of disease progress for notoedric mange. We performed a field necropsy on the first mountain lion that died, an adult female. We transferred her liver, head, and pelt and the complete carcasses of the other 3 mountain lions, an adult male, an adult female, and a yearling female, to CAHFS for examination. We also obtained skin scrapings and mites from the 2 mange-infested mountain lions, which we processed as described for the bobcats.

### Anticoagulant Testing

We collected liver samples from radiocollared bobcats that died and were recovered intact. We also collected livers from unmarked bobcat carcasses encountered in the field and from 2 bobcats collected by the City of Los Angeles. We froze all liver samples at  $-20^{\circ}\text{C}$  and shipped them to the CAHFS laboratory (Davis Branch), where they were tested for the presence of 7 anticoagulants: warfarin, bromadiolone, coumachlor, brodifacoum, diphacinone, chlorophacinone, and difethialone. We also collected blood samples from 3 bobcats that were afflicted with mange when live-captured. For 2 of these animals, we measured prothrombin time of blood samples to determine anticoagulant presence. These samples were analyzed by Idexx Veterinary Services (San Bernardino, CA). Normal prothrombin time was considered to be 7.0–12.7 seconds, based on values for domestic cats. The third animal was B108, a female bobcat that also had an early stage case of mange and was kept at the California Wildlife Center for rehabilitation (see Results). Partial thromboplastin time was determined for this bobcat (Idexx Veterinary Services). Between 10 seconds and 28 seconds was considered normal partial thromboplastin time, again based on values for domestic cats.

We analyzed liver samples using a previously published method for the analysis of anticoagulant rodenticides in serum (Palazoglu et al. 1998) modified for tissue analysis. We acidified 5-g liver samples with acetic acid and homogenized them with 5% ethanol in ethyl acetate. We cleaned up the samples using gel-permeation chromatography (GPC). We then exchanged the GPC eluent to methanol and reduced the volume of methanol to 0.5 mL. We analyzed the methanol extracts by HPLC using diode-array and fluorescence detectors in series. Identification was by comparison with diode-array and fluorescence spectra from known standards. In cases in which diode-array and fluorescence spectra were ambiguous, we performed qualitative confirmation analysis using liquid chromatography–mass spectrometry. We performed quantification by com-

parison of analyte response in samples with that of known standards. Minimum detectable levels were 0.05 ppm for warfarin, bromadiolone, and coumachlor, 0.01 ppm for brodifacoum, and 0.25 ppm for diphacinone, chlorophacinone, and difethialone.

### Statistical Analyses

We measured the association between severe notoedric mange and anticoagulant exposure using a chi-square test. We assessed the relationship between mange and urban association of radiocollared bobcats with nonparametric Mann–Whitney  $U$  tests, measured the relationship between the total concentration of anticoagulants (ppm) and urban association with simple linear regression, and compared the total concentration of anticoagulants between mange-infected and uninfected bobcats with a 2-sample  $t$ -test. We report statistical results with a  $P$ -value of  $\leq 0.10$ . We performed statistical tests with the program SYSTAT (SPSS Inc., Chicago, IL).

## RESULTS

We tested the livers from 39 bobcats, including animals with and without mange and that died both before and after the mange epizootic. Anticoagulant toxicants were present in 35 of 39 (90%) bobcat livers, and 27 of these 35 (77%) revealed exposure to  $\geq 2$  compounds. We detected brodifacoum in 31 of the liver samples at levels ranging up to 0.56 ppm, bromadiolone in 25 livers at levels up to 0.82 ppm, diphacinone in 12 livers up to 0.58 ppm, and difethialone in 10 livers at trace levels ( $< 0.25$  ppm; Table 1). Prothrombin times for the 2 bobcats whose blood we tested were 17.3 seconds and  $> 100$  seconds (normal time: 7.0–12.7 sec). The livers of all 4 mountain lions we tested indicated high levels of the 2 compounds most common in bobcats, and one mountain lion also had significant levels of difethialone and trace levels of diphacinone. In the 2 mountain lions that died of anticoagulant toxicity (see below), we detected bromadiolone at 1.27 ppm and brodifacoum at 0.57 ppm in the liver of the male (P3) and bromadiolone at 0.51 ppm and brodifacoum at 0.31 ppm in the female (P4). Two other mountain lions were killed in August 2005 (ad F P2) and June 2006 (yearling F P7) by an adult male lion. We detected bromadiolone at 0.37 ppm and brodifacoum at 0.32 ppm in the liver of P2 and bromadiolone at 0.66 ppm, brodifacoum at 0.32 ppm, difethialone at 0.66 ppm, and diphacinone at trace levels in P7.

Mange-afflicted bobcats and mountain lions exhibited severe mite encrustation on the head and shoulders (Fig. 2) in the form of proliferative dermatitis with hyperkeratosis, epidermal scaling and multiple mites, identified as *Notoedres cati*, on the surface in keratin tunnels (see also Uzal et al. 2007). In the bobcats the mange often extended over much of the body, including the hind legs. The bobcats became emaciated and increasingly diurnal in many cases, and eventually succumbed to the disease. With one exception, bobcats that died of mange did not show evidence upon necropsy of direct anticoagulant toxicity as a cause of mortality. Specifically, we did not find evidence of a

**Table 1.** Anticoagulant exposure of bobcats in the Santa Monica Mountains and Simi Hills, Ventura and Los Angeles Counties, California, USA, 1997–2003. Values indicate residues from liver samples (ppm). We captured and radiocollared all bobcats with identification (ID) numbers except for B050, which had an identification collar without a radiotransmitter. All bobcats with ID letters were recovered by other means, such as being recovered on a road, submitted to an animal control agency, or seen and reported by a homeowner. We also conducted tests for warfarin, coumachlor, and chlorophacinone, but we detected no residues except for a trace of warfarin (mdl = 0.05) in Bobcat 114.

Bobcat ID	Sex	Age	Bromadiolone mdl = 0.05 <sup>a</sup>	Brodifacoum mdl = 0.01 <sup>a</sup>	Diphacinone mdl = 0.25 <sup>a</sup>	Difethialone mdl = 0.25 <sup>a</sup>	Total <sup>a</sup>	Mange?	Yr	Cause
30	F	ad	nd	0.05	nd	nd	0.05	n	1997	anticoagulant toxicity
H	F	ad	nd	0.03	nd	nd	0.03	n	1988	roadkill
E	M	ad	nd	nd	nd	nd	nd	n	1988	unknown
25	F	ad	nd	nd	nd	nd	nd	n	1988	unknown
I	F	ad	nd	0.02	nd	nd	0.02	n	1988	roadkill
50	F	ad	tr	0.02	nd	nd	0.02	n	1999	unknown
G	M	ad	nd	0.01	nd	tr	0.01	n	1999	unknown
52	M	ad	0.11	0.07	nd	nd	0.18	n	1999	unknown
11	F	ad	nd	nd	nd	tr	tr	n	1999	predation
79	F	ad	0.48	0.22	nd	nd	0.70	y	2002	mange
54	F	ad	nd	nd	nd	nd	nd	n	2002	roadkill
98	F	juv	tr	0.02	0.58	nd	0.60	n	2002	roadkill
F	F	ad	nd	nd	nd	nd	nd	n	2002	roadkill
65	M	ad	0.36	0.37	nd	nd	0.73	y	2002	mange
66	M	ad	nd	0.09	0.30	nd	0.39	y	2002	mange
67	F	ad	tr	0.07	nd	nd	0.07	y	2002	mange
72	F	juv	nd	tr	nd	nd	tr	y	2002	mange
91	M	ad	0.50	0.14	tr	tr	0.89	y	2002	mange
92	F	ad	0.13	0.11	tr	tr	0.64	y	2002	mange
114	M	ad	0.08	0.44	nd	tr	0.52	n	2003	unknown
115	M	ad	0.09	0.31	tr	nd	0.40	n	2003	fence
A	M	ad	nd	0.03	nd	nd	0.03	y	2003	mange
B	M	ad	0.82	nd	nd	nd	0.82	n	2003	roadkill
C	F	ad	tr	nd	nd	nd	tr	n	2003	roadkill
95	M	juv	tr	nd	tr	nd	tr	n	2003	roadkill
116	M	juv	0.05	0.24	nd	nd	0.29	n	2003	roadkill
118	M	ad	0.10	0.02	nd	nd	0.12	n	2003	roadkill
D	M	ad	nd	0.11	0.29	tr	0.40	n	2003	unknown
7	M	ad	0.18	0.34	tr	tr	0.52	y	2003	mange
22	M	ad	0.10	0.17	nd	nd	0.27	y	2003	mange
70	M	juv	0.09	0.25	tr	nd	0.34	y	2003	mange
71	F	ad	0.14	0.36	tr	tr	0.50	y	2003	mange
76	M	ad	0.21	0.29	tr	tr	0.50	y	2003	mange
84	M	ad	0.11	0.05	nd	nd	0.16	y	2003	mange
88	F	ad	0.05	0.03	nd	nd	0.08	y	2003	mange
106	F	juv	0.16	0.24	nd	nd	0.40	y	2003	mange
112	F	ad	0.07	0.11	nd	nd	0.18	y	2003	mange
113	F	ad	tr	0.07	0.27	nd	0.34	y	2003	mange
121	M	juv	0.15	0.56	nd	tr	0.71	y	2003	mange

<sup>a</sup> tr = positive, but amt < min. detectable limit (mdl) for that compound; nd = not detected.

coagulopathy (manifested by extensive internal hemorrhaging), indications that were seen previously in >8 coyotes and 1 bobcat that were determined to have died directly from anticoagulant toxicity (Hosea 2000, Riley et al. 2003). On the other hand, both mountain lions died directly from anticoagulant toxicity as demonstrated by the high levels of anticoagulants detected in the liver, multiple extensive hemorrhages on serosal surfaces and within body cavities, and the lack of evidence of trauma or other lesions to justify the bleeding. In addition, we obtained negative results from all the other ancillary tests performed.

Severe mange and anticoagulant exposure were highly associated as 19 of 19 bobcats with advanced mange had anticoagulant compounds in their liver, 18 at more than trace levels (Table 1). Including the 2 mountain lions, 21 of 21 wild felids (100%) with mange also had anticoagulant

toxicants present. The anticoagulant levels were also generally high in bobcats with mange, and for bobcats with anticoagulant residues >0.05 ppm, the association with mange was very high (Table 2;  $\chi^2 = 10.36$ ,  $P = 0.001$ ). By contrast, just 8 of 20 bobcats (40%) that died of other causes exhibited a similar level of anticoagulant exposure. Overall, the total anticoagulant level in bobcats that died with severe mange ( $\bar{x} = 0.39$ ) was higher than in bobcats that died of other causes ( $\bar{x} = 0.17$ ;  $t = 2.67$ ,  $P = 0.011$ ). There did not appear to be a specific, or threshold, level of anticoagulants in bobcats with mange because 3 of the bobcats that died with mange had 0.03 ppm, 0.07 ppm, and trace levels of anticoagulants, although it is impossible to know the level of toxicant present when the mange infestation began.

In November of 2003, we captured an adult female bobcat (B108) in the early stages of mange development that also



**Figure 2.** Bobcat with severe mange, Simi Hills, Ventura County, California, USA, 2002.

had a prolonged partial thromboplastin time (PTT) of 50.6 seconds indicative of anticoagulant exposure (normal time: 10–28 sec). She was held captive at a wildlife rehabilitation center (California Wildlife Center, Calabasas, CA) and treated with vitamin K<sub>1</sub> for anticoagulant intoxication and 2 doses of ivermectin for mange. After 2 weeks, her PTT was still elevated (>100 sec), but after 4 weeks it was normal (21.0 sec) and she had no signs of mange. We released her at the capture site in December 2003, and she subsequently produced a large litter of 4 healthy kittens in the spring of 2004. However, she was apparently exposed again to mange, and she and her surviving kitten both died with severe mange infestations in the autumn of 2004.

Beginning in 2002, when the mange epizootic began, the bobcat survival rate fell from a high of 0.847 in 1999 and a 5-year average of 0.770 to 0.280 in 2003 (Table 3). Simultaneous scat surveys also showed a significant decrease in bobcat activity starting in the autumn of 2002 (Fig. 3). Finally, local extirpations of bobcats have occurred in some of the habitat fragments in the area, both large and small. In one larger patch that is surrounded by roads and development, we were radiotracking 6 bobcats (3 F, 3 M) at the beginning of 2002 (Fig. 1, inset). All 3 males and 2 of the females died with severe mange, and we lost contact with the third female's radiocollar. Scat surveys and intensive trapping for bobcats in 2004–2006 found little evidence of bobcat activity. In 2005, 2 radiocollared male bobcats occasionally visited this patch.

For bobcats in this fragmented landscape, use of developed areas was not significantly greater for bobcats with mange (% of the home range consisting of unnatural area: Mann–Whitney  $U = 234$ ,  $P = 0.351$ ). Although neither mange nor the presence of anticoagulants were associated with human development, the total concentration (ppm) of all anti-

**Table 2.** Relationship between notoedric mange and anticoagulant exposure of >0.05 ppm in bobcats in the Santa Monica Mountains and Simi Hills, Ventura and Los Angeles Counties, California, USA, 1997–2003. Two mountain lions also had both notoedric mange and high levels of anticoagulant exposure.

Mange	Anticoagulants >0.05 ppm	
	Yes	No
Yes	17	2
No	8	12

coagulants in the livers of radiocollared bobcats was related to their use of developed areas. Total concentration was positively related to the percentage of the home range made up of developed area ( $r^2 = 0.255$ ,  $F_{1,20} = 6.85$ ,  $P = 0.017$ ) or unnatural area ( $r^2 = 0.163$ ,  $F_{1,20} = 3.91$ ,  $P = 0.062$ ) and to the percentage of radiolocations in developed areas ( $r^2 = 0.310$ ,  $F_{1,20} = 8.97$ ,  $P = 0.007$ ) or unnatural areas (Fig. 4;  $r^2 = 0.249$ ,  $F_{1,20} = 6.64$ ,  $P = 0.018$ ).

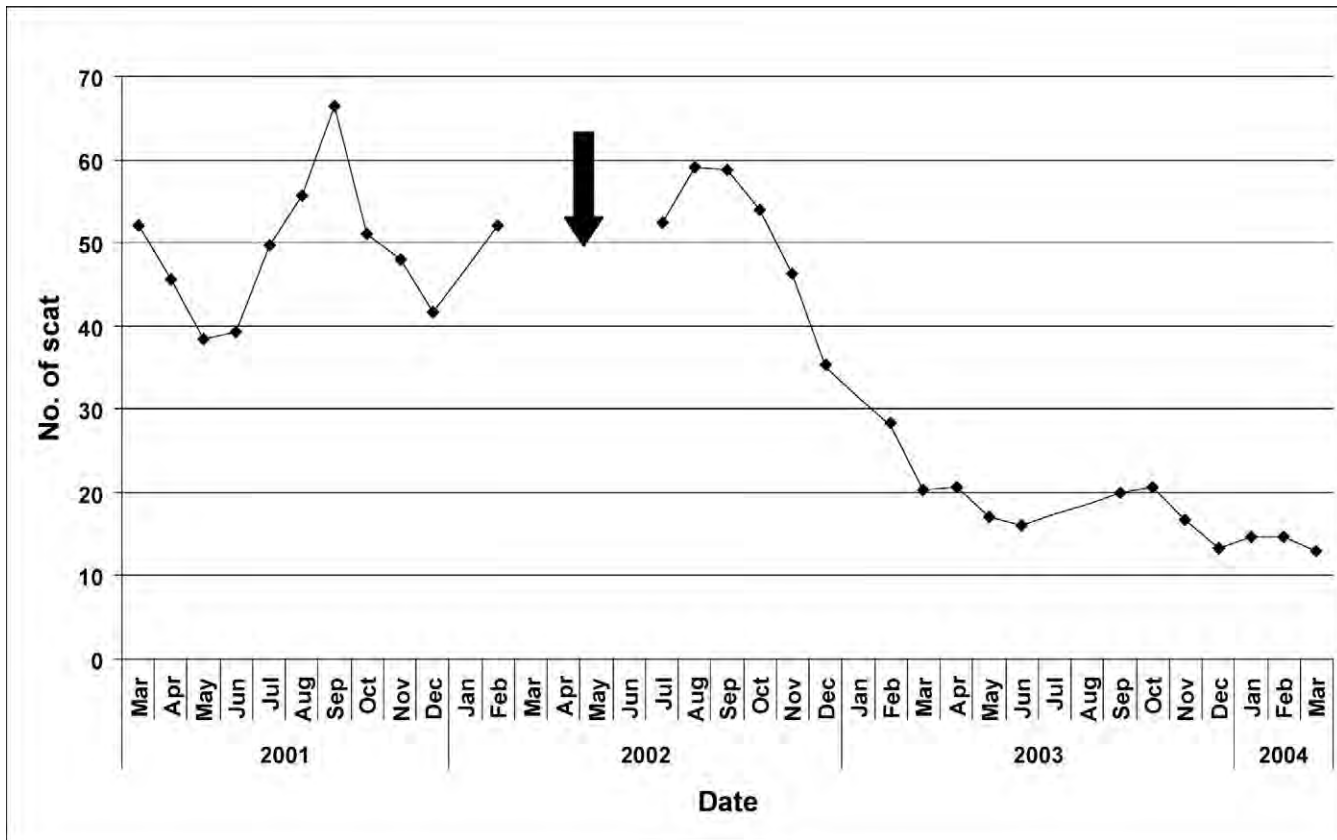
The radiocollared mountain lions were generally less urban-associated than the bobcats, but both mountain lions (P3 and P4) diagnosed with anticoagulant intoxication died after spending the bulk of their last month in the most developed parts of their home ranges. For example, just prior to his death, there were multiple locations for the male mountain lion (P3) in the same habitat fragments used by many of the bobcats, only the third month in 16 that he utilized these patches (southern part of Simi Hills, see Fig. 1). The female mountain lion (P4) lived almost exclusively in the Santa Susana Mountains (Fig. 1), a large contiguous block of open space, and only used the more developed Simi Hills area during the month before she died. The other 2 lions (P2 and P7) that were killed in intraspecific fights lived exclusively south of the 101 Freeway in the less-developed Santa Monica Mountains (Fig. 1).

## DISCUSSION

We frequently detected anticoagulant rodenticides in the wild felids in this landscape; including the 4 mountain lions, 91% of the cats we tested were positive for  $\geq 1$  compound. Bobcats are strict carnivores and the cases were widespread geographically and temporally, so we expect that most if not all exposure is secondary, from bobcats consuming poisoned prey. The presence of multiple compounds in 27 of 35

**Table 3.** Survival rate of radiocollared bobcats in the Santa Monica Mountains and Simi Hills, Ventura and Los Angeles Counties, California, USA, from 1997 to 2003, showing decrease in survival rate caused by mange.

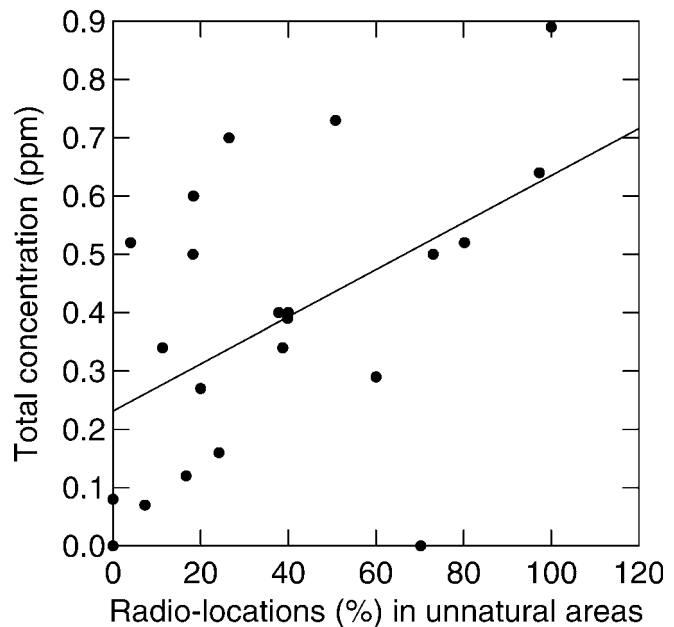
Yr	No. of bobcats	No. of deaths	No. of mange deaths	Survival rate
1997	22	3	0	0.836
1998	33	7	0	0.707
1999	19	3	0	0.847
2000	20	3	0	0.796
2001	34	8	1	0.685
2002	31	15	8	0.516
2003	25	15	10	0.280



**Figure 3.** Three-month running average of the number of bobcat scat collected on standardized scat transects from 2001 to 2004 in the Santa Monica Mountains and Simi Hills, Ventura and Los Angeles Counties, California, USA. The arrow indicates the beginning of the mange epizootic.

exposed bobcats and all 4 mountain lions tested also points to secondary exposure and to the potential for accumulation of toxicity as a result of multiple exposure events. Anticoagulants are highly persistent in tissue (Eason et al. 2002, Erickson and Urban 2004, Wobeser 2006), with liver retention times of up to 256 days for brodifalone, and >250 days for brodifacoum (see Eason et al. 2002, table 6 for review, references). Target rodents may also ingest a much larger than lethal dose in the days between initial bait ingestion and eventual death (Erickson and Urban 2004), in part because of the delayed onset of toxic effects (often 3–5 d) following ingestion (Murphy and Talcott 2006), thereby increasing the amount of toxicant available to a carnivore. The lack of a significant relationship between either mange or anticoagulant exposure and urban association suggests that even bobcats with low levels of development within their home ranges were close enough to developed or altered areas to be exposed to anticoagulants. Of particular concern is the finding that toxicant concentrations increased in bobcats that more frequently utilized developed areas. This is consistent with repeated exposures, and it also suggests that as development continues to encroach upon remaining habitat, anticoagulant exposure among carnivores may increase.

The compounds that we detected, brodifacoum, bromadiolone, diphacinone, and difethialone, are widely available as household and landscape rodenticides. In our study area, those known to have used anticoagulants to target rodents



**Figure 4.** Linear regression of total concentration of all anticoagulants (ppm) found in the livers of radiocollared bobcats and the percentage of radiolocations for those bobcats in unnatural areas (developed + altered areas), in the Santa Monica Mountains and Simi Hills, Ventura and Los Angeles Counties, California, USA, 1997–2003.

include private homeowners, golf courses, office parks, schools, water utilities, apartment complexes, and park agencies. Brodifacoum, bromadiolone, and difethialone, which represent 67 of the 79 anticoagulant detections, are registered specifically for use in or adjacent to buildings to control commensal rodent pests, specifically Norway rats (*Rattus norvegicus*) and house mice (*Mus musculus*). They are not designated for the control of species such as rabbits (*Sylvilagus audubonii*), woodrats (*Neotoma* spp.), pocket gophers (*Thomomys bottae*), and ground squirrels (*Spermophilus beecheyi*) that make up the dominant prey of bobcats in this area (Fedriani et al. 2000; C. S. Schoonmaker, National Park Service [NPS], unpublished data). The high prevalence of these compounds in wild carnivores suggests widespread exposure of native, free-ranging, nontarget (at least according to the regulations) species.

The deaths of 2 mountain lions as a direct result of anticoagulant toxicity (see also Uzal et al. 2007) and the exposure of all 4 lions tested indicate the pervasiveness of these toxicants across the landscape and that they are reaching the highest levels of the food chain (see also Littrell 1988). Rodents commonly constitute a significant component of bobcat diets (Anderson and Lovallo 2003), but mountain lions specialize on ungulate prey, and 157 (95.2%) of 165 known lion kills in our study (through 2004) were mule deer (*Odocoileus hemionus*). Anticoagulant residues have not been widely reported in ungulates (but see Stone et al. 1999, Eason et al. 2002), but we only recovered kills requiring  $\geq 1$  day to eat, so we would generally not detect smaller prey items. We did find coyotes killed by radiocollared lions, and coyotes made up 15% and 7% of the kills for the 2 lions that died of anticoagulant intoxication but only 4% of kills overall. Anticoagulant toxicity was previously documented as a leading cause of death for coyotes in this area (Riley et al. 2003), and if coyotes are retaining anticoagulants, a lion eating a coyote could ingest a large quantity of toxicant at once. Both mountain lions consumed coyotes during the last month before they died.

The association between anticoagulants and mange suggests that synergistic interactions between natural and anthropogenic stressors can occur in terrestrial ecosystems. In particular, bobcats that have been exposed to anticoagulant rodenticides appear highly susceptible to succumbing to severe mange infestations, although not all anticoagulant-exposed bobcats necessarily contract mange, presumably because not all bobcats encounter *Notoedres* mites. There has been much recent discussion in the ecological literature about the enhanced effects of multiple stressors and, in particular, of natural and human-caused stressors (e.g., Sih et al. 2004). However, the empirical work has generally been in aquatic systems and in laboratory or artificial pond settings (e.g., Mills and Semlitsch 2004, Rohr et al. 2004). Here, we have documented what appear to be significant population effects in the field.

The interaction between mange and anticoagulant rodenticides also appears to be critical because each stressor by

itself would likely not have the same impact based on available evidence and previous studies. Notoedric mange has been rarely reported in wild felids, never at epizootic levels, and never in free-ranging adult mountain lions (Uzal et al. 2007). In domestic cats, young animals and those debilitated by retroviral disease are more susceptible to mange (Sparger 1990, Guaguère 1999), suggesting that complicating factors are important in disease development. Pence et al. (1982) report cases in an adult male bobcat and a litter of kittens. Wassmer et al. (1988) found that 4 of 17 captured bobcats (24%) showed evidence of mange, one of which died of the disease. However, the other 3 bobcats had only bare patches “suggesting a current or former mild mange infestation” (Wassmer et al. 1988:176). This population was also experiencing a concurrent epizootic of feline panleukopenia virus, so this disease may have contributed to the mange incidence. Despite 5 deaths from mange (notoedric and sarcoptic) in an endangered lynx (*Lynx lynx*) population in Switzerland, Ryser-Degiorgis et al. (2002) conclude that an epidemic is unlikely because of the less social nature of felids. In our study, the appearance of severe, widespread mange in adult animals prompted us to look at other factors, including anticoagulants.

Anticoagulant poisoning alone also appears to be less of a direct threat to bobcats. Although it was the most common source of mortality in coyotes, we documented one case of potential anticoagulant poisoning in bobcats in the first 5 years of our project (Riley et al. 2003). Laboratory research on anticoagulants has determined that felids have up to 100 times greater resistance than canids to certain compounds, including brodifacoum (Roder 2001, Morgan et al. 2003, Erickson and Urban 2004). There is also previous evidence of the interactive effects of anticoagulants and other stressors in mammals. In laboratory experiments with rabbits, anticoagulant levels that produced zero mortality alone resulted in 40%–70% mortality when combined with other stressors (e.g., frostbite), and similar results were obtained with rats (Jacques 1959). In a more recent study of free-ranging merino sheep (*Ovis aries*; Robinson et al. 2005), anticoagulants had a greater effect than in a similar study of sedentary sheep, and stress (specifically shearing) in combination with anticoagulant exposure caused more mortality than anticoagulant exposure alone. Bobcats and mountain lions are certainly susceptible to direct mortality from anticoagulant toxicity as demonstrated by the deaths of 1 bobcat and 2 lions.

Although we have demonstrated a strong association between anticoagulant exposure and notoedric mange, this is not the same as establishing cause and effect. Experimental evidence would be ideal, but this kind of manipulative experiment would be logistically and ethically very difficult, if not impossible, to pursue with wild felids. Wobeser (1994), reviewing Susser (1973), discusses 5 criteria or guidelines for inferring causal relationships related to disease in wild animals: strength of association, specificity of association (one cause produces one effect), time sequence, consistency (similar results in other populations), and



coherence with current knowledge about the disease. In medicine and epidemiology, these five are sometimes broadened to nine, including biological gradient (a dose response), biological plausibility (similar to coherence), experimental evidence, and analogy (Hill 1965).

Many of these criteria will not be met even in cases where a cause does produce an effect (e.g., specificity: 1 cause can produce >1 effect, and vice versa), and they are often difficult to evaluate in wildlife populations. However, the criteria can be useful in evaluating the potential for a causal relationship, in this case whether exposure to anticoagulants causes increased susceptibility to advanced mange disease (not necessarily increased exposure to *Notoedres cati*). We believe that the strength and the specificity of the association are clear in this case, as every felid with mange was also exposed to anticoagulants, and there is a highly significant association between the two. There is also evidence of a biological gradient, as bobcats with mange had significantly higher levels of exposure to anticoagulants. We have less information for the other criteria, and there are potential alternative explanations for our results. We address both of these issues below. Further research is certainly needed to more fully resolve this question. However, we believe that the available evidence points to anticoagulant exposure contributing to advanced and fatal mange disease.

In the case of each bobcat, we do not know that the anticoagulant exposure preceded the infestation, or specifically the manifestation, of notoedric mange. It is possible that the bobcats contracted mange, the mange infestation became advanced, and the bobcats were then more likely to prey on animals contaminated with anticoagulants. Several factors argue against this alternative. If anticoagulant exposure was the result of animals with mange eating prey exposed to anticoagulants, we would not expect to find anticoagulant exposure in bobcats prior to the beginning of the mange epizootic. However, on the contrary, 7 of 9 tested bobcats that died before 2002 were positive for anticoagulant exposure (Table 1). Under this alternative, we would also not expect to find bobcats with significant anticoagulant levels that did not have mange. In fact 6 animals that died after the beginning of the mange epizootic, but had no evidence of mange, had high levels of anticoagulants. Finally, this alternative presumes that bobcats weakened by mange would eat prey weakened by anticoagulants but that healthy bobcats would not. There is no reason to believe that healthy bobcats would pass up potential prey animals, including ones that were less able to escape.

It is also possible that the mange and anticoagulant exposure were simply coincident. This alternative is also related to the consistency criterion: why has this interaction not been documented in the past? Given the paucity of studies of carnivores in urban areas, and specifically of bobcats, this is not surprising. Although other studies are underway, to date we know of 2 published studies of radiocollared bobcats in urban areas, one in the San Francisco Bay area (Riley et al. 2004, Riley 2006) and this

project. The northern California study also documented a case of mortality caused by anticoagulant poisoning (Riley 1999, Hosea 2000), although not any cases of mange. However, our study is the only long-term study of bobcats in urban areas and is, to our knowledge, the longest continuous radiotracking study of bobcats ever undertaken (E. M. Anderson, University of Wisconsin—Steven's Point, personal communication). Without intensive and long-term study, periodic changes in disease prevalence or interactions between a disease and toxicants would be very difficult to document. Moreover, although anticoagulants have been in use for a long time, the second-generation anticoagulants implicated here came into widespread use more recently (e.g., brodifacoum in the 1990s; Eason et al. 2002).

Another potential alternative is that the severe mange is related to exposure to other diseases. Advanced mange, both notoedric and sarcoptic, is generally associated with debilitation by some other factor (Samuel 1981, Pence and Ueckermann 2002), including disease. There was no evidence of other disease in the 4 bobcats upon which full necropsies (with ancillary tests, see Methods) were performed, although the general poor condition as a result of the advanced mange may have masked signs of other conditions. We have tested bobcats serologically for a number of viral diseases including feline panleukopenia virus, feline infectious peritonitis, feline herpes virus, and feline calicivirus (J. E. Foley, NPS, unpublished data), and there is no indication that animals that died of mange had greater evidence of exposure to these diseases.

Although we have not been able to investigate specific mechanisms that could be responsible for the potential interaction between mange and anticoagulants, it is certainly conceivable that anticoagulant exposure could increase the likelihood of severe mange infestation (the coherence and biological plausibility criteria). Anticoagulant poisoning causes a broad spectrum of clinical signs resulting from hypovolemia from hemorrhage, organ dysfunction, or bleeding into cavities (Searcy 2001). A sub-lethal, chronic anemia, in turn, may lead to increased susceptibility to disease and leave the animals more vulnerable to mange or other stressors. Other studies have also found sub-lethal effects of anticoagulants. For example, female sheep (*Ovis aries*) exposed to anticoagulants had more aborted or stillborn lambs (up to 50%), male sheep had lower sperm motility (Robinson et al. 2005), and barn owls (*Tyto alba*) fed difenacoum-killed rats exhibited sub-lethal hemorrhaging (Mendenhall and Pank 1980). Other chronic, sub-lethal effects have included decreased food intake in sheep (Oliver and Wheeler 1978), liver damage in brushtail possums (*Trichosurus vulpecula*; Jolly et al. 1994, Littin et al. 2002), and a decrease in body weight in brushtail possums (Littin et al. 2002). Decreases in feeding and weight in particular could affect overall condition and thereby disease resistance. Sub-lethal effects may also be more likely in a species such as bobcats that is less susceptible to direct, lethal coagulopathy than, for example, coyotes.

## MANAGEMENT IMPLICATIONS

At present, anticoagulant rodenticides are seen as an effective and inexpensive method of killing rodents. However, anticoagulant applicators, including homeowners, landscape professionals, pest control operators, and land and resource managers, should consider that these chemicals can have significant impacts on nontarget wildlife. Especially in areas of high anticoagulant use such as urban areas, exposure of nontarget carnivores to anticoagulant rodenticides may be extensive and can result in direct mortality and possibly sublethal effects, potentially including complex interactions with other factors such as our data suggest. Increased awareness and the use of alternative pest control methods should reduce risks to nontarget wildlife, including carnivores. Where species of conservation concern may be exposed, further regulation of the use of anticoagulant rodenticides may be warranted. Managers should also be aware that the effects of anticoagulant rodenticides may be difficult to document without intensive study, but that a range of species may be affected. Finally, our results indicate that severe notoedric mange in bobcats, previously undocumented as an epizootic, can have population-level effects, and that those effects may be particularly significant in fragmented landscapes where local extirpations can occur.

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# Individual Behaviors Dominate the Dynamics of an Urban Mountain Lion Population Isolated by Roads

Seth P.D. Riley,<sup>1,2,\*</sup> Laurel E.K. Serieys,<sup>2</sup> John P. Pollinger,<sup>2</sup> Jeffrey A. Sikich,<sup>1</sup> Lisa Dalbeck,<sup>3</sup> Robert K. Wayne,<sup>2</sup> and Holly B. Ernest<sup>3</sup>

<sup>1</sup>Santa Monica Mountains National Recreation Area, National Park Service, 401 West Hillcrest Drive, Thousand Oaks, CA 91360, USA

<sup>2</sup>Department of Ecology and Evolutionary Biology, University of California, Los Angeles, 621 Charles E. Young Drive South, Los Angeles, CA 90095, USA

<sup>3</sup>Wildlife and Ecology Unit, Veterinary Genetics Laboratory and Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, 1089 Veterinary Medicine Drive, Davis, CA 95616, USA

## Summary

Large carnivores can be particularly sensitive to the effects of habitat fragmentation on genetic diversity [1, 2]. The Santa Monica Mountains (SMMs), a large natural area within Greater Los Angeles, is completely isolated by urban development and the 101 freeway to the north. Yet the SMMs support a population of mountain lions (*Puma concolor*), a very rare example of a large carnivore persisting within the boundaries of a megacity. GPS locations of radio-collared lions indicate that freeways are a near-absolute barrier to movement. We genotyped 42 lions using 54 microsatellite loci and found that genetic diversity in SMM lions, prior to 2009, was lower than that for any population in North America except in southern Florida, where inbreeding depression led to reproductive failure [3–5]. We document multiple instances of father-daughter inbreeding and high levels of intraspecific strife, including the unexpected behavior of a male killing two of his offspring and a mate and his son killing two of his brothers. Overall, no individuals from the SMMs have successfully dispersed. Gene flow is critical for this population, and we show that a single male immigrated in 2009, successfully mated, and substantially enhanced genetic diversity. Our results imply that individual behaviors, most likely caused by limited area and reduced opportunities to disperse, may dominate the fate of small, isolated populations of large carnivores. Consequently, comprehensive behavioral monitoring can suggest novel solutions for the persistence of small populations, such as the transfer of individuals across dispersal barriers.

## Results

### Movements, Mortality, and Dispersal in an Urban Landscape

We captured, genotyped, and radio-tracked 26 mountain lions in the Santa Monica Mountains (SMMs;  $n = 21$ ) and Santa Susana Mountains (including the Simi Hills;  $n = 5$ ) from July 2002 through July 2012 (Figure 1). We also genotyped 17 other mountain lions from opportunistically collected samples,

including from Angeles National Forest and the Verdugo Hills. Large freeways, including the 101 freeway (Figure 2A), the 5 freeway (Figure 2B), and the 405 freeway (Figure 2A), were significant barriers to movement (i.e., were almost never crossed by mountain lions) and often acted as home-range boundaries. One smaller freeway, the 118 freeway between the Simi Hills and the Santa Susana Mountains (Figure 1), was crossed at least 23 times by two radio-collared mountain lions in an area with a large tunnel and natural habitat on both sides [6]. In February 2009, subadult male P12 crossed the 101 freeway into the SMMs, the only time that a radio-collared mountain lion crossed 101, which separates the SMMs from all areas to the north.

Fourteen radio-collared lions died during the study period: six from intraspecific strife, two from vehicles, two of anticoagulant toxicosis from ingesting rodenticides, one from poaching, one from starvation as a young kitten, and two from unknown causes. Overall, 50% of mortalities of known cause were from intraspecific strife. An uncollared young male was also killed by another lion, for a total of seven instances of intraspecific killing. In five of these cases we were able to identify the surviving individual, and in all five we found that an adult male killed his offspring, his brother, or a previous mate (Table S1 available online).

We tracked the fate of young mountain lions, especially males, to assess dispersal. In the SMMs, we radio-tracked ten subadult male mountain lions and sampled five others that originated there (Table S1). Not one of these 15 young males was known to disperse from the SMMs to a home range with mating opportunities. Of the 12 young males from the SMMs whose ultimate fates are known, 11 died before or during dispersal from intraspecific strife ( $n = 5$ ), vehicle strikes ( $n = 4$ ), control action by police ( $n = 1$ ), and unknown causes ( $n = 1$ ). The only young male to successfully disperse from the SMMs, P22, settled in Griffith Park, requiring the crossing of two freeways (405 and 101; Figure 1). For more than 2 years, this male inhabited a home range of 26 km<sup>2</sup>, as compared to 500 km<sup>2</sup> for adult male P1 (Figure 1). P22's home range was entirely bounded by freeways and urbanization, and he was its sole occupant.

North of 101, we radio-tracked three subadult males and sampled three others that were killed on roads (Table S1). All three collared animals successfully crossed roads and established home ranges as adults. P3 moved regularly between the Simi Hills and the Santa Susana Mountains across the 118 freeway. P12 crossed 101 and subsequently established himself as a dominant male in the SMMs. Perhaps most instructive, young male P16, who shared the eastern Santa Susana Mountains with his father, P21, dispersed north across highway 126 and established a home range (Figure 1). Among radio-collared animals of known fate, the least biased sample for mortality and dispersal, none of the seven subadult males from the SMMs successfully dispersed and established viable home ranges, while all three from the Santa Susana Mountains did.

### Population Genetics of a Small, Isolated Population

We found very low genetic diversity compared to large, contiguous populations in California and in other parts of the west

\*Correspondence: [seth\\_riley@nps.gov](mailto:seth_riley@nps.gov)





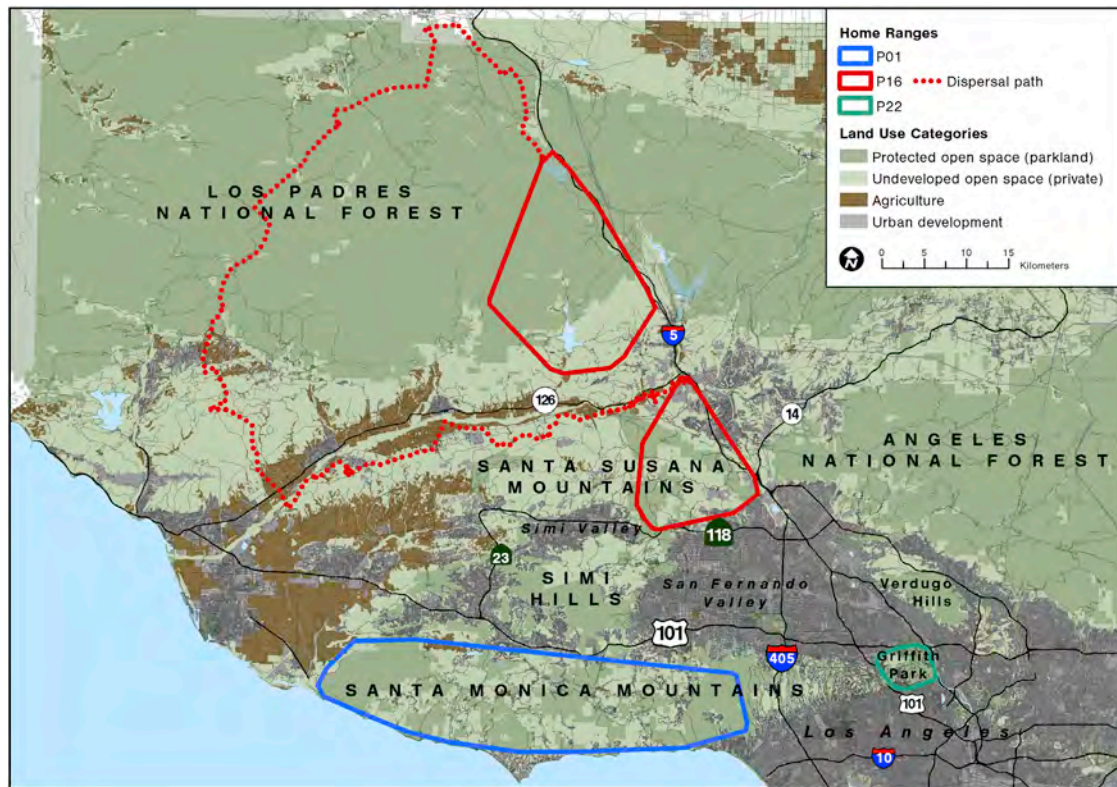


Figure 1. Study Area for Mountain Lion Movements and Population Genetics in and around Santa Monica Mountains National Recreation Area Northwest of Los Angeles

Large natural areas and major freeways are labeled. Home ranges are 100% minimum convex polygons for male P22 in Griffith Park, male P01 in the SMMs, and male P16 that dispersed from the eastern Santa Susana Mountains, across highway 126 to Los Padres National Forest. See also [Table S1](#).

([Tables 1](#) and [S2](#)). Genetic diversity was particularly low in the SMMs south of the 101 freeway, which is the largest and busiest road to the north (175,000 vehicles/day versus 115,000 for the 118 freeway and 22,000 for highway 126; [7]). This population is also farthest away from the putative source populations in Los Padres and Angeles National Forests. The expected heterozygosity ( $H_E$ ), total number of alleles ( $N_A$ ), and number of effective alleles ( $N_E$ ) were all significantly lower in the SMMs than north of the 101 freeway ([Table 1](#)). For private alleles (defined here as those present only in one study population), 67 of 172 discovered alleles were absent from the SMM population, and 78% of loci (42 of 54) had at least one private allele north of 101.

Genetic differences between local populations were also apparent from Bayesian cluster analyses ([Figure 3A](#)). Despite the small sample sizes, the program STRUCTURE [8] indicated strong clustering into three groups ( $K = 3$  by the Evanno  $\Delta K$  method [9]; [Figure S1](#)). The  $F_{ST}$  value between populations north and south of the 101 freeway was 0.12 ( $p < 0.05$ ), three times larger than that previously found for other carnivores in the area [10]. The SMM mountain lion population showed evidence of having experienced a genetic bottleneck based both on significant heterozygote excess (program Bottleneck [11]; single-step mutation probabilities of 90%,  $p = 0.00044$  and 78%,  $p = 0.00004$ ) and Garza and Williamson's  $M$  ratio test ([12]; average  $M = 0.75$ ; for single-step mutation proportion, 90%,  $p < 0.0001$ ). The current effective population size,  $N_E$ , for mountain lions south of 101 was just six individuals.

### The Influence of Specific Behavioral Events on Population Demography and Genetics

Our analysis of a genetically based pedigree showed that specific behavioral events greatly affected population dynamics and genetic composition ([Figure 3B](#)). For example, the migration into the SMMs of P12, who was genetically assigned to the population north of 101 ([Figure 3A](#), blue cluster) and had private northern alleles at 33% of microsatellite loci, demonstrated that the 101 freeway can be traversed. Critically, P12 then survived in the SMMs and bred with resident females, including female P13 twice and his daughter, P19 ([Figure 3B](#)). This was the second instance of father-daughter mating, as P13 was the result of male P01 mating with his daughter, female P06 ([Figure 3B](#)) [13].

The immigration and subsequent matings of male P12 increased the genetic diversity and decreased the internal relatedness (IR) of the SMM population ([Table 1](#)) and thus is an example of a genetic rescue. P12 possessed 20 private alleles from north of the freeway, 19 of which he passed on to his offspring, such that private alleles absent from the SMMs decreased from 67 to 47, loci with private alleles to the north decreased from 42 to 32, and monomorphic loci in the SMMs decreased from 13 to 9. Bayesian clustering analysis also clearly showed the impact of P12's immigration ([Figure 3A](#)). Ninety-seven percent of P12's genome was assigned to the Santa Susanna Mountain population, and he fathered eight offspring based on our pedigree ([Figure 3B](#)). Six of these, including the five with P13 (99% assigned to the SMMs) exhibited a near equal mix of the



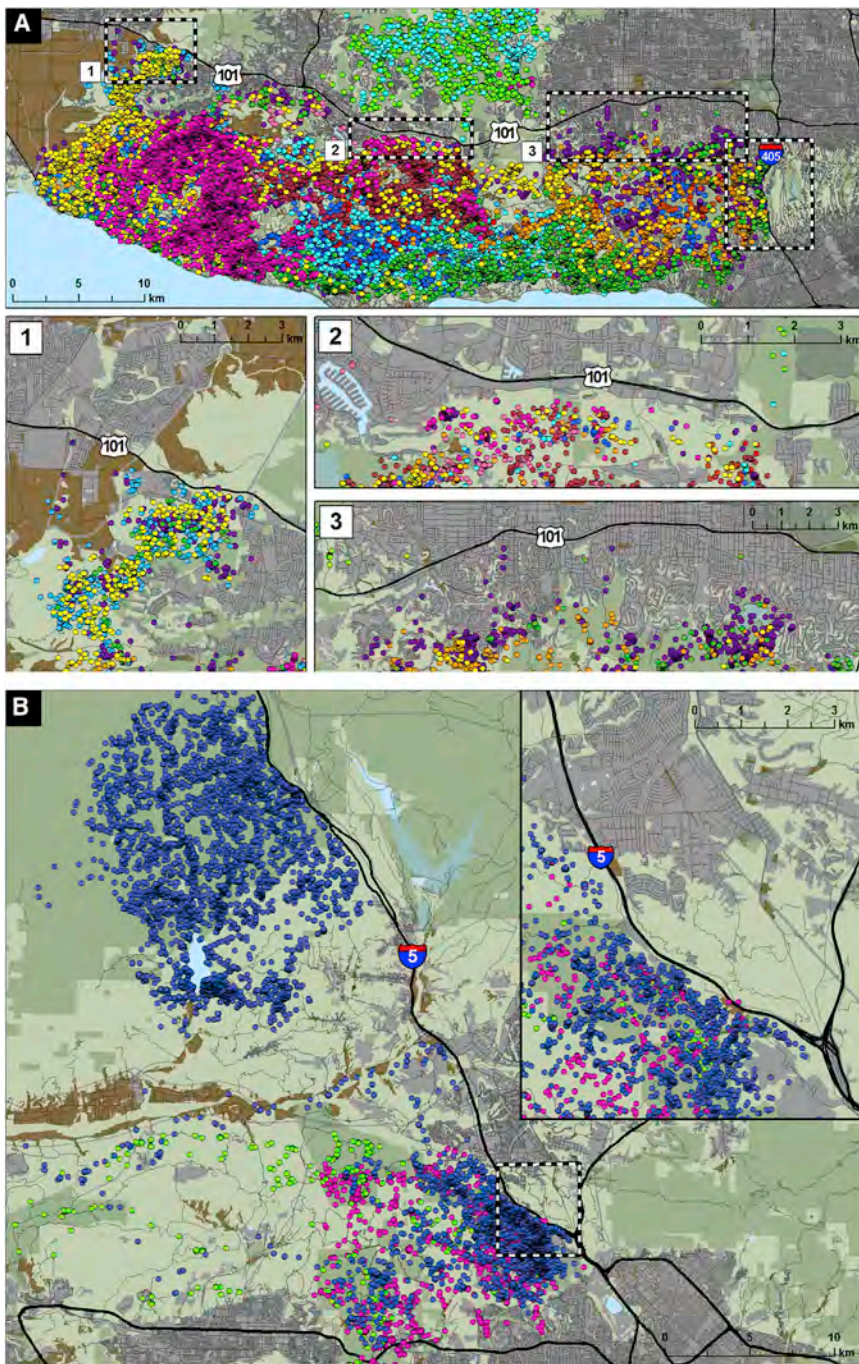


Figure 2. Locations of Mountain Lions along Freeways in Southern California from GPS Radio Collars, 2002–2012

(A) Locations near the 101 freeway, which runs east-west north of the Santa Monica Mountains. Because there is urban development along most of this freeway, in many areas (insets 2 and 3) animals do not approach the freeway. Toward the east end of the SMMs, the 405 freeway passes north-south through the mountains. This freeway is also a major barrier to mountain lion movement.

(B) Locations north of 101 in the Santa Susana Mountains and Los Padres National Forest near the 5 freeway, which runs north-south through the region.

the SMMs, and then rose again in 2013 after P12 bred with his daughter. Similarly, gene diversity showed the opposite pattern, decreasing after the first close inbreeding event, rising in 2010 after P12 bred, and then decreasing with the second inbreeding event (Table S3). The dramatic shifting values of these coefficients over short time periods demonstrate how important individual matings are to the levels of inbreeding and relatedness in the population (Figure S2).

Finally, the IR, a measure that has the potential to provide novel insight about inbreeding and genetic health [15], reflected both the initial bottleneck and the effects of the inbreeding and genetic rescue events. The mean IR for SMM animals dropped from 0.09 (SE = 0.014) to 0.03 (SE = 0.036) when P12 and his offspring were included, as IR values for the initial offspring of the genetic rescue event were low and averaged  $-0.16$  (range  $-0.10$  to  $-0.35$ ). For P23 and P24, the incestuous offspring of P12 and his daughter, IR values rose again to 0.10 and 0.09, indicating that one close inbreeding event may have reversed much of the value of the genetic rescue.

Our results from this small, isolated population also indicate how individual male mountain lions can monopolize breeding opportunities and

SMM (green) and Santa Susanna Mountain (blue) clusters (Figure 3A). Interestingly, P23 and P24, the offspring of P12 and his daughter, P19, each had about three-quarter assignment to the Santa Susana Mountains, as expected (Figures 3A and 3B).

The effects of individual mating events on population genetic measures were also evident as quantified with our pedigree by gene-drop analysis (program PMx [14]) applied for the first time to a wild population. Both the mean inbreeding coefficient (F) and mean kinship increased in 2007 after male P1 bred with his daughter, decreased in 2010 after migrant P12 began to produce offspring in

genetically dominate future generations. Two males, first P01 and later P12, had very high reproductive success based on the pedigree (Figure 3B). Specifically, P01 fathered  $\geq 15$  offspring, P12 fathered  $\geq 8$  offspring, and no individual in the SMM population was fathered by any other male. The pedigree and PMx analyses indicated that P01 had 22 descendants, including six of the seven animals known in the population in 2013, and that P12 had eight descendants, including four of the seven current animals; 33.9% of the copies of the genome in the current population are derived from P01 and 35.7% from P12 (see Table S4).

Table 1. Genetic Diversity Based on 54 Microsatellite Loci for Mountain Lions in and around the Santa Monica Mountains, California, 2002–2012

Population	N <sub>A</sub>	N <sub>E</sub>	Poly (%)	H <sub>E</sub>	H <sub>O</sub>	IR
Santa Monica Mountains only, south of the 101 freeway before P12 crossing (n = 17)	1.9 ± 0.2	1.6 ± 0.1	76%	0.31 ± 0.03	0.38 ± 0.04	0.09 ± 0.04
North and east of the Santa Monica Mountains, north of the 101 freeway (n = 15)	3.1 ± 0.1	2.1 ± 0.1	100%	0.48 ± 0.02	0.42 ± 0.02	0.17 ± 0.05
Santa Monica Mountains only, south of the 101 freeway after P12 crossing (n = 26)	2.3 ± 0.1	1.8 ± 0.1	83%	0.36 ± 0.03	0.36 ± 0.03	0.03 ± 0.04

Populations are from the SMMs before the genetic rescue event (the dispersal of subadult male P12 from north to south), from north of 101 in the Santa Susana Mountains and San Gabriel Mountains, and from in the SMMs after the genetic rescue event. N<sub>A</sub> is the total number of alleles, N<sub>E</sub> is the number of effective alleles, poly (%) is the percentage of loci that are polymorphic, H<sub>E</sub> is expected heterozygosity, H<sub>O</sub> is observed heterozygosity, and IR is individual heterozygosity or internal relatedness (see the [Supplemental Experimental Procedures](#) for details). N<sub>A</sub>, N<sub>E</sub>, and H<sub>E</sub> are significantly lower (nonoverlapping 95% confidence intervals) for the SMMs before P12 crossed than for north of the 101 freeway. Mean ± SE is shown. See also [Table S2](#).

## Discussion

### Individual Effects on Population Dynamics and Genetic Diversity

Urban environments are generally inhospitable for large carnivores. Therefore, it is remarkable that a population of a large carnivore extends into the metropolitan area of Los Angeles, one of 30 world megacities (metropolitan areas of >10,000,000 people). However, the challenges for the long-term persistence of this population are substantial. Freeways in the area are almost complete barriers to mountain lion movement ([Figure 2](#)). This severe isolation most likely caused a striking assignment of lions to a single genetic cluster in the SMMs ([Figure 3A](#)). SMM lions were also clearly differentiated from those east of the 5 freeway (red cluster in [Figure 3A](#)), which separates the Angeles National Forest from the Santa Susana Mountains and Los Padres National Forest ([Figure 1](#)). The F<sub>ST</sub> value of 0.12 across the 101 freeway is high given its relatively recent age (1949) and given that other studies of *Puma concolor* microsatellite loci have found F<sub>ST</sub> < 0.10 among 15 subpopulations across the state of Idaho (distances of ≥500 km; [16]) and an average F<sub>ST</sub> of 0.041 among 20 subpopulations from four southwestern states (700 by 700 km; [17]).

Genetic diversity in SMM mountain lions also is very low relative to populations north of the 101 freeway and elsewhere in California and the western US ([Table S2](#)). A measure that is less affected by sample size, the expected heterozygosity, is 0.31 for the SMMs before the immigration event, a value that is the lowest ever reported for western mountain lions, with the exception of another isolated population in the Santa Ana Mountains of Southern California that has comparable variability (H.B.E., unpublished data). The average number of alleles per locus (N<sub>A</sub>) was also lower in the SMMs than north of 101 and was one-half to two-thirds of the average value from other populations across the western range ([Table S2](#)). The sole population with lower genetic diversity than the SMM population across all of these measures is the Florida panther, *Puma concolor coryi*, a federally endangered subspecies that suffered from substantial inbreeding depression and had been isolated for more than a century before lions from Texas were introduced to alleviate inbreeding depression ([Table S2](#)) [4, 5].

In the small, isolated SMM population, individual behavioral events can have a significant impact on population dynamics and genetics. We documented only one movement across the 101 freeway, by subadult male P12. But after his establishment as a dominant breeding male, new alleles entered the

population, and, particularly for his mixed offspring, genetic diversity increased and measures of inbreeding decreased. However, first-order inbreeding events (father-daughter matings) by males P1 and P12 had the opposite effect, increasing inbreeding and reducing diversity. This kind of close inbreeding has only rarely been documented in mountain lions, specifically in the small and isolated southern Florida population [3, 4].

We also found significant effects of individual behavior on two other critical aspects of population dynamics, dispersal and mortality. Although typically every young male and half of young females disperse out of their natal range [18], not a single subadult mountain lion has successfully dispersed out of the SMMs. Instead, young males have died, principally from intraspecific strife and vehicles. In the one dramatic case, male P22 dispersed from the SMMs into the Hollywood Hills and has lived for 2 years in a home range of 26 km<sup>2</sup>, the smallest annual range ever reported for an adult male. In this range, P22 was surrounded by roads and development ([Figure 1](#)) and had no opportunity to mate. Male mountain lion home ranges are typically an order of magnitude larger, at 300–400 km<sup>2</sup> or more [18, 19], and overlap with those of multiple females. By contrast, all three of the young males that we radio-tracked in the Santa Susanna Mountains successfully dispersed and established home ranges.

Intraspecific strife, the most common cause of mortality, can also be important in other populations, particularly those that are not hunted [20, 21]. However, in the SMMs, we documented repeated cases of males killing their offspring, their brothers, and previous mates. Little has been reported about paternity or kin recognition in mountain lions [18, 22], but clearly this is rarely a sound evolutionary strategy as the survivorship of offspring or siblings is traded against the probability of future reproduction [23]. It is particularly hard to imagine an advantage from killing potential mates or female offspring ([Table S1](#)). In fact, in the Santa Susanna Mountains, we observed the opposite pattern. Male P21 was the father of subadult males P12 and P16 ([Figure 3B](#)), both of which successfully emigrated and established long-term home ranges: P12 south into the SMMs and P16 north across highway 126 ([Figure 1](#)). None of the young males originating in the SMMs, dominated by adult males P1 and P12, have lived beyond age 2, so with respect to male mountain lions, the SMMs are a population sink. In other aspects of ecology and behavior, including home-range size (males, 300–500 km<sup>2</sup>; females, 100–200 km<sup>2</sup>), diet (≥90% deer), annual adult survival (≥75%), and litter size (two to four) [6], the SMM lion population is similar to those throughout the southwest [20].



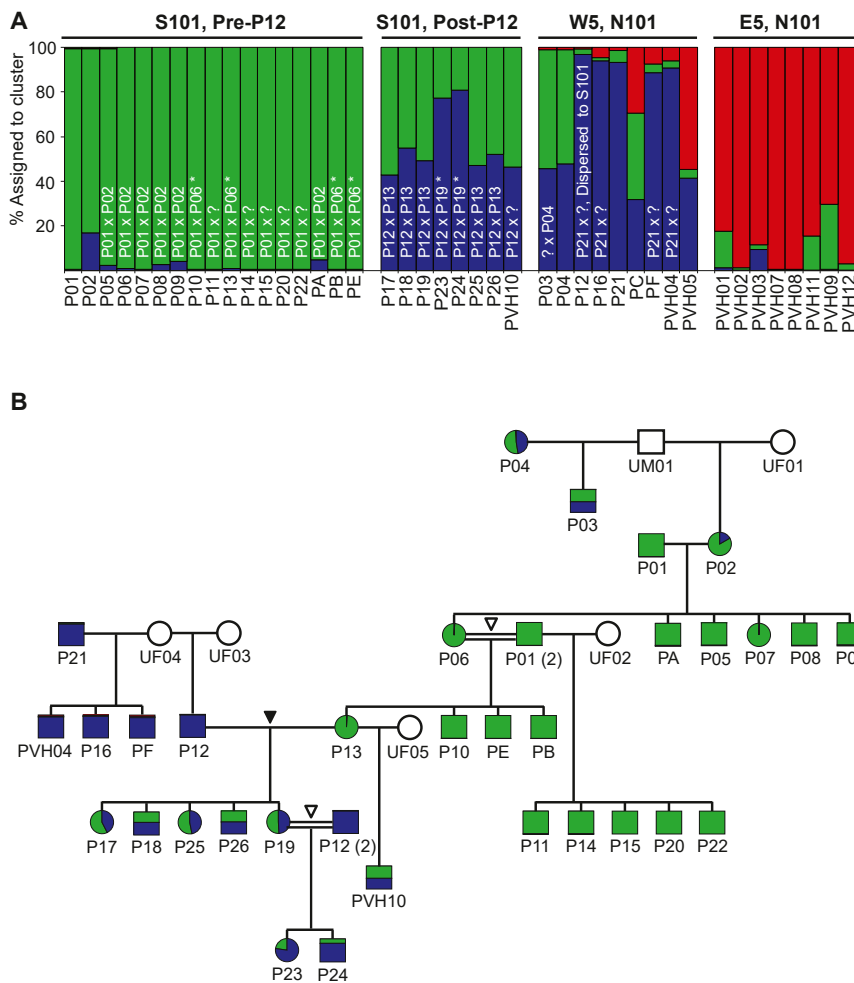


Figure 3. Genetic-Based Cluster Assignments and Recreated Pedigree Based on 54 Microsatellite Loci

(A) Results of program STRUCTURE for 42 mountain lions in the SMM region in Southern California, 2002–2012. The “S101, pre-P12” group is mountain lions from the SMMs, south of the 101 freeway (see Figure 1), before male P12 crossed the 101 freeway from the Simi Hills to the SMMs. The “S101, post-P12” group includes animals sampled in the SMMs that are the offspring of male P12 after he crossed the 101 freeway. “W5, N101” includes animals from the Simi Hills and Santa Susana Mountains, north of the 101 freeway. “E5, N101” includes mountain lions east of the 5 freeway in the San Gabriel Mountains and Verdugo Hills. White lettering for the first three groups indicates the known parentage based on the recreated pedigree. See also Figure S1.

(B) Pedigree for mountain lions in and around the SMMs, 2002–2012. The pedigree was constructed using the programs CERVUS and Colony (see the Supplemental Experimental Procedures). Colors for individual animals correspond to the genetic cluster assignments determined using STRUCTURE: green is the SMM cluster, and blue is the “W5, N101” or Santa Susana Mountains cluster. Symbols with two colors indicate animals with assignment to both clusters. Animals that were not sampled but whose presence is presumed are labeled “UF” for unknown females or “UM” for unknown males. Double lines and open triangles between animals indicate close inbreeding events, specifically father–daughter mating. The black triangle indicates the outbreeding event when P12, from north of the 101 freeway, bred with P13, from the SMMs. See also Figure S2 and Tables S3 and S4.

Very small populations are subject to Allee effects in which low growth rates result from low density, often caused by social disruption as individuals are too sparse to form social groups or find mates [24]. In the SMMs, the inverse has occurred as a small mountain lion population is at high density but lives in a spatially constrained area, resulting in social disruption through negative interactions between close relatives that normally would be rare or nonexistent. The result is reduced population health as indicated by low genetic diversity and increased inbreeding. Such “inverse Allee effects” leading to social disruption could be an important but largely unrecognized problem in isolated and densely packed urban environments.

#### Implications for Management and Conservation of Large Carnivores in Urban Landscapes

The importance of specific behavioral events such as dispersal, inbreeding, and killing of close relatives in this small, isolated mountain lion population has implications for conservation in fragmented landscapes. First, detailed behavioral and genetic monitoring may be critical for understanding the factors that threaten population persistence. Only through the collection of extensive demographic and behavioral data on most of the population were we able to identify the most important behaviors affecting population dynamics and genetic diversity.

Second, the maintenance and restoration of habitat connectivity is vital for small populations of large carnivores. Migration events between populations may not have to be frequent to maintain genetic diversity [25], and we have observed that one successful migrant can have a significant impact, especially in mountain lions, where individual males can have high reproductive success. However, the skewed reproduction in small mountain lion populations [26] can result in dominance of the gene pool by individual males, especially when close inbreeding is also occurring, which may be detrimental to population persistence. In the wolves at Isle Royale National Park, although a single male wolf immigrated into the population and increased genetic diversity, the effects were reversed by reproductive dominance of this individual and associated inbreeding [27, 28]. Connectivity is also important because stochastic effects, such as the loss of one dominant male through a vehicle collision, are more extreme and can result in extinction. Previous research on mountain lions in the Santa Ana Mountains suggested that an area of less than 1,100 km<sup>2</sup> was unlikely to support mountain lions without some immigration [29], and the SMMs are only about 660 km<sup>2</sup>. In highly developed areas, the conservation of natural habitat on both sides of freeways and effective corridors across them [30] or translocations may be necessary if large carnivores are to persist in proximity to the megacities of the future.

## Supplemental Information

Supplemental Information includes Supplemental Experimental Procedures, two figures, and four tables and can be found with this article online at <http://dx.doi.org/10.1016/j.cub.2014.07.029>.

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# **Assessment of Wildlife Crossing Sites for the Interstate 15 and Highway 101 Freeways in Southern California**

March 2018

Prepared by (in alphabetical order):

Seth P. D. Riley, Ph.D., National Park Service

Trish Smith, The Nature Conservancy

T. Winston Vickers, Ph.D., UC Davis Wildlife Health Center



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## EXECUTIVE SUMMARY

Roads can cause significant mortality for wildlife, but large roads like freeways can also form major barriers to wildlife movement and gene flow. Freeways are ubiquitous in southern California, and two freeways, Interstate 15 and U.S. 101, have been found to be barriers to wildlife passage and gene exchange, especially for mountain lions, between the Santa Ana Mountains and the Palomar Mountains and other mountains to the east (separated by Interstate 15), and between the Santa Monica Mountains and the Simi Hills, Santa Susana Mountains, and others to the north (separated by the 101 Freeway). We used two sources of information with the goal of bridging the gap between connectivity science and conservation practice. In early 2015 we engaged an independent panel of connectivity experts to evaluate possible locations and concepts for wildlife crossings along stretches of both freeways. We also developed and implemented an evaluation tool based on landscape characteristics and wildlife data to help prioritize locations for wildlife crossing infrastructure. The experts were asked to evaluate stretches of each freeway where wildlife studies have indicated that some connectivity potential remains due to the presence of natural habitat on both sides of the road, but where new or enhanced structures are likely required to restore lost connectivity. Multiple specific sites were examined along these stretches of each freeway. For I-15, both the Landscape and Expert scoring indicated that retention and enhancement of function under the Temecula Creek Bridge, and construction of a new under or overpass south of the bridge, were both likely needed for long term connectivity. For the 101 Freeway, the Landscape and Expert scoring both strongly concluded that West Liberty Canyon is the best location for a new wildlife crossing structure, with several other locations being sites where enhancements or new construction could serve the role of providing secondary crossings. The experts indicated that an overpass, over both 101 and the parallel Agoura Rd, was the best option here to provide connectivity for a range of species. The experts agreed that accompanying measures, such as effective wildlife fencing to funnel animals to crossing points and appropriate vegetative cover on and near structures were also important. They also recommended that, over the long term, more than one crossing structure should be enhanced or created for each linkage to assure sufficient movement of wildlife to accomplish gene exchange between populations in entire mountain ranges. Increasing connectivity across both freeways is critical for the long-term viability of local wildlife populations, especially for wide-ranging species such as mountain lions, and this analysis provides a concrete way forward.

## 1. INTRODUCTION

The protection of habitat connectivity is arguably one of the most salient global conservation problems of our day – how to keep from fragmenting intact natural landscapes with areas of intense human land use, and how to halt and reverse the cascading impacts of habitat fragmentation resulting from past land use decisions.

The threat of habitat fragmentation to biodiversity is well recognized in southern California. Here, coastal, montane, and desert ecosystems intersect to create an area renowned for its unique and diverse biota (Myers et al. 2000). It also is an area of intense human development with a growing population of nearly 24 million that threatens the persistence of the region’s natural habitats and species (State of California, Dept. of Finance 2017). Despite large expenditures of funds and effort to preserve biodiversity and conserve threatened or endangered species in the region, substantial challenges remain for persistence of some species.

The Santa Ana Mountains and Santa Monica Mountains are two of several large southern California landscapes (Figure 1) that, despite conservation investments in the hundreds of millions of dollars, remain at risk of isolation and fragmentation by roads and urban development (Riley et al. 2014, Ernest et al. 2014). Wildlife research studies have identified that major highways and associated development have severed connectivity between these coastal ranges and larger inland protected lands that are considered critical to protecting plant and animal species against climate change and other threats. Specifically, Interstate 15 (hereafter referred to as “I-15”) in western Riverside County has seriously reduced connectivity between the Santa Ana Mountains and the inland eastern Peninsular Ranges (with the Palomar Mountains being the most proximate portion of the Peninsular Ranges to I-15), and US Highway 101 (hereafter referred to as the “101 Freeway”) in northern Los Angeles County and Ventura County has seriously reduced connectivity between the Santa Monica Mountains and inland Santa Susanna and Sierra Madre Mountains to the north (Riley et al. 2014, Ernest et al. 2014). These concerns have been amplified by the findings of recent genetic analyses relating to both the Santa Ana Mountains’ and Santa Monica Mountains’ mountain lion (*Puma concolor*) populations, indicating significant genetic restriction and minimal evidence of migration into these populations in recent years. These studies indicate that genetic diversity for Santa Ana and Santa Monica mountain lions is very low (Riley et al. 2014, Ernest et al. 2014), lower than has been measured anywhere else in the west. Only in endangered Florida panthers, where severe genetic defects were present throughout the population before a genetic introgression program, has lower genetic diversity been found (Gustafson et al. 2017).

Both linkages have been prioritized for protection by the South Coast Missing Linkages Project, an effort to identify important landscape linkages throughout the State of California (Penrod et al. 2001). Subsequently, detailed linkage designs, including recommendations for highway crossing structures for the 101 and I-15 freeways, were developed (Penrod et al. 2006, South Coast Wildlands 2008). Both linkages were also identified as important in the California Essential Habitat Connectivity Project (2010), commissioned by Caltrans and the California Department of Fish and Wildlife.

Significant research and planning efforts have been conducted for both linkages to help address connectivity needs, which range from strategic land acquisition for conservation to the identification of locations and concepts for wildlife crossing structures for both freeways. Because of the rate and extent of past urbanization throughout southern California, opportunities for securing connectivity across

major freeways in both linkages are limited. Each of these areas presents unique challenges to accomplishing improved connectivity, with many improvements that have been proposed likely requiring significant financial investment, for both wildlife crossing structures and land protection, and significant political and public support.

As stated in the Wildlife Crossing Structure Handbook (2011): "There is currently an urgent need to provide transportation and other stakeholder agencies with technical guidance and best management practices on the planning and design of wildlife crossing mitigation measures. The siting of wildlife crossing structures is equally as important as their design. Identifying the proper location of crossing structures is critical for designing effective mitigation of the barrier effect caused by roads."

Given the challenges and level of financial investment required to secure connectivity for the Santa Ana to Palomar Mountains Linkage (Figure 2), and the Santa Monica to Sierra Madre Mountains Linkage (Figure 3), the National Park Service, The Nature Conservancy, and the UC Davis Karen C. Drayer Wildlife Health Center felt that both linkages would benefit from a collaborative effort to help bridge the gap between science and practice by: 1) engaging an independent panel of connectivity experts to evaluate possible wildlife crossing site locations and concepts for the I-15 and 101 Freeways; and 2) developing and implementing an evaluation tool based on landscape characteristics and wildlife knowledge to help prioritize locations for the siting of wildlife crossing infrastructure.

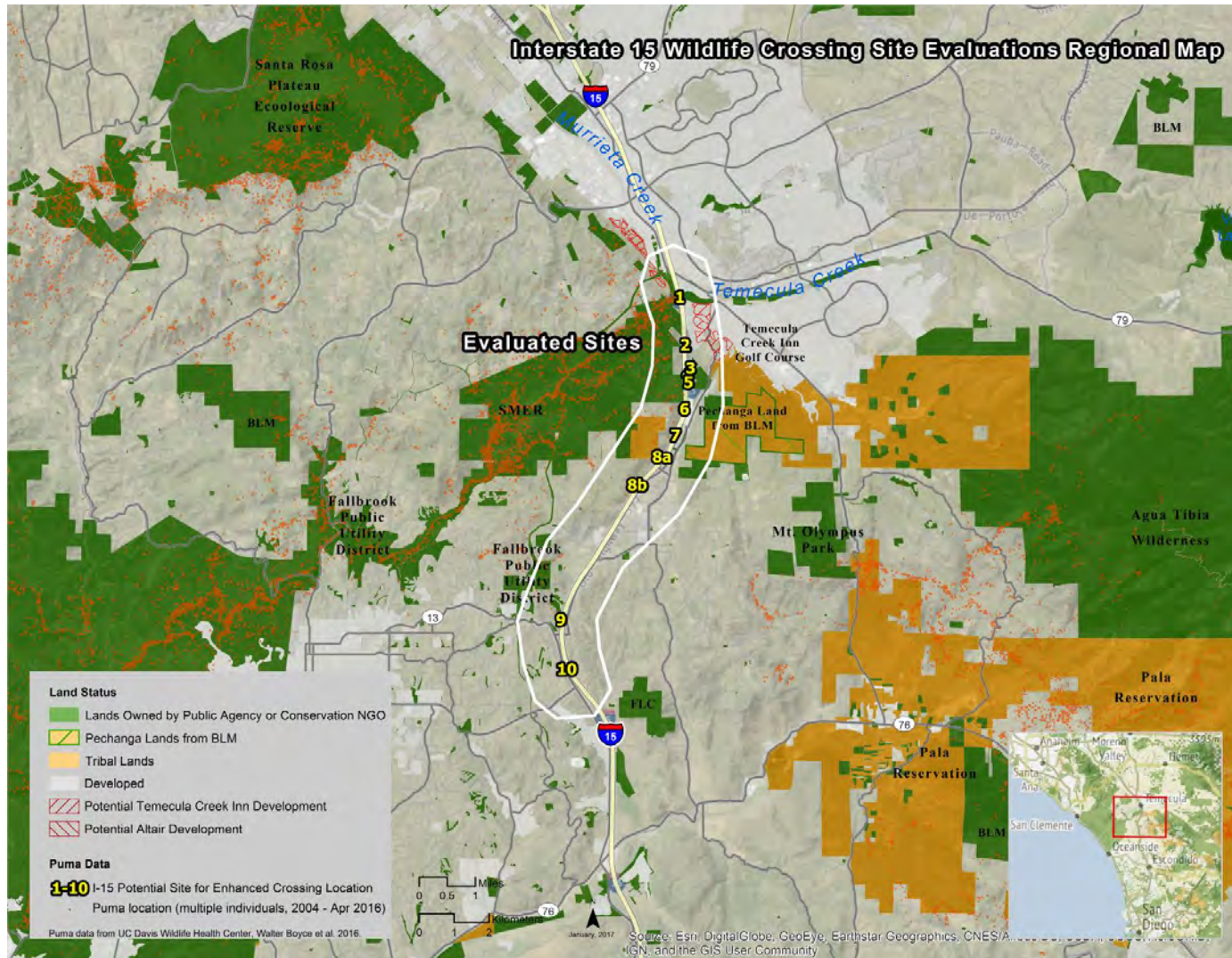


**Figure 1.** Regional map of the Santa Ana to Palomar Mountains Linkage and Santa Monica to Sierra Madre Linkage and other priority linkages in Southern California



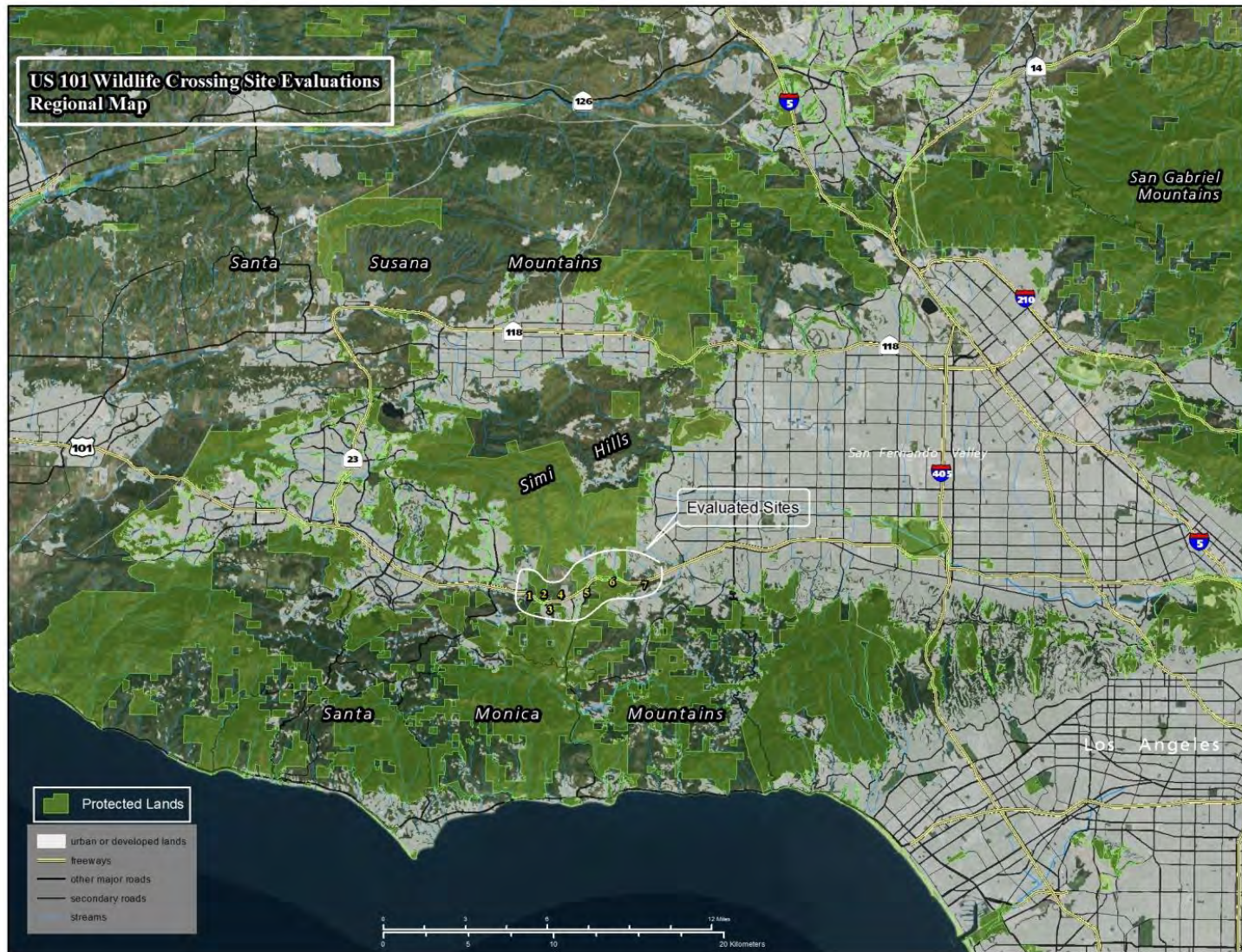


Figure 2. Location map of Santa Ana to Palomar Mountains Linkage, including the area along I-15 evaluated for wildlife crossings.





**Figure 3.** Location map of Santa Monica Mountains to Sierra Madre Mountains Linkage, including the area along 101 evaluated for wildlife crossings, and the intervening natural areas of the Simi Hills and Santa Susana Mountains.



**Project Objective:** The overall objective of this effort was to provide critical information to stakeholders involved in the development of new or improved wildlife crossing structures across the I-15 and 101 Freeways. Stakeholders that are expected to use this information include conservation agencies and organizations (governmental and non-governmental), highway agencies, local jurisdictions involved with land use decisions, wildlife agencies, and others in the region in their efforts to increase connectivity for wildlife.

Given the likelihood that these freeways negatively impact or block free exchange of genes for many wildlife species (documented for the 101 and I-15 Freeways for mountain lions, and for the 101 Freeway for bobcats, coyotes [Riley et al. 2006], and smaller vertebrates [Delaney et al. 2010]) and full use of available habitat by other wild species, assessment of potential crossing locations included the goal of providing potential movement pathways for large and medium-sized carnivores, mule deer, reptiles, amphibians, small mammals, and fish.

In relation to mountain lions specifically, the aim of crossing structure modification or new construction is to enhance the likelihood that juvenile mountain lions can move out of larger populations to the east of the Santa Ana Mountains and to the north of the Santa Monica Mountains, into the coastal mountain ranges. Without this in-migration of dispersing animals, including territory establishment and breeding, genetic diversity in these populations will continue to decline. Out-migration of animals from the Santa Ana Mountains and Santa Monica Mountains would also assure that overall genetic exchange between these populations was adequate for the health of both populations. In the Santa Monica Mountains, there have been repeated instances of close inbreeding between fathers and daughters, as well as extensive mortality from intraspecific fighting (Riley et al. 2014), both of which could likely be reduced by increasing migration out of the Santa Monicas.

This report presents background on both linkages, methods on how wildlife crossing points for each freeway were evaluated and scored through an expert review process and landscape evaluation, and summary results for each crossing point that was evaluated.

## 2. METHODS

The general areas of evaluation for the potential placement of wildlife crossing infrastructure for the I-15 and 101 Freeways were based on the local landscape configuration and detailed linkage assessments completed by South Coast Wildlands (Penrod et al. 2006, South Coast Wildlands 2008), and were further informed by wildlife movement studies and modelling efforts (Gibbons 2008, Tracey and Crooks 2011, Zeller et al 2015, Zeller et al. 2017a, Zeller et al. 2017b, Huber unpublished data).

Specific sites that were evaluated for the placement of wildlife crossing infrastructure along both freeways were identified using several parameters that indicate likely or at least potential use by wildlife if adequate crossing structures were present.

Parameters utilized for initial identification of potential crossing points for evaluation were:

1. Current presence of suitable habitat or pathways that could be restored to wild habitat on both sides of the potential crossing;
2. Evidence from GPS or radio tracking, camera traps, or other methods, of close approaches of mountain lions or other carnivores (e.g., bobcats and coyotes) to the freeway at that location;

3. Indication in movement or corridor models that mountain lions and other wildlife are likely to approach or cross the roadway at that point;
4. Documented crossing by mountain lions or other wildlife at that location previously (either through existing structures or at grade);
5. Occurrence of mountain lion mortalities from roadkill at that location.

Scoring of each location for ranking purposes was accomplished by use of two methods, with equal weight in final rankings assigned to each method.

## Method 1: Expert Opinion

The following connectivity experts were assembled in January 2015 for a three-day workshop aimed at discussing, evaluating, and ranking locations and designs for infrastructure to improve connectivity (undercrossings, overcrossings, fencing, etc.) for the I-15 and 101 Freeways.

- Dr. Paul Beier, with Northern Arizona University, is a professor of wildlife biology who is widely recognized as one of the nation's leading experts on habitat connectivity and the design of wildlife corridors. He has studied the movements of mountain lions in southern California, has published numerous journal articles on designing, conserving, and managing functional corridors in urbanizing areas, and is the founder of CorridorDesign.org.
- Dr. Anthony Clevenger is a senior research scientist at the Western Transportation Institute, Montana State University who has been studying road effects on wildlife populations in Banff and the surrounding national and provincial parks in the Canadian Rocky Mountains since 1996. During his 20+ years of research, Dr. Clevenger's interests have been broad and ecologically based, but have been weighted towards the ecological effects of roads and the conservation of small remnant populations of carnivores.
- Dr. Patricia Cramer is a Research Assistant Professor at Utah State University. Her research focuses on transportation ecology, wildlife connectivity, and carnivore and ungulate movement. She is nationally renowned advocate for wildlife crossings, and has conducted extensive evaluation of wildlife crossing structures throughout North America and developed recommendations for their construction.
- Julia Kintsch is an ecologist specializing in conservation planning, road ecology, large landscape conservation, and collaborative problem-solving. She is recognized across North America as an expert in wildlife crossing siting and design, offering a unique understanding of the features that influence successful passage for species ranging from salamanders to deer to the elusive Canada lynx. Following an active career working for non-profit organizations such as the Nature Conservancy, Southern Rockies Ecosystem Project, and Freedom to Roam, she launched ECO-resolutions LLC in 2008.
- Dr. Patrick Huber is a Project Scientist with the Information Center for the Environment at the University of California, Davis. He earned a Ph.D. in geography at UC Davis and wrote his dissertation on spatial scale and conservation planning. His work focuses on conservation planning, landscape connectivity, and reserve design primarily in California.
- Kathy Zeller earned a PhD in Environmental Conservation at the University of Massachusetts. Her research is focused on designing wildlife corridors, modeled across a resistance-to-movement surface where the landscape is quantified in terms of the difficulty different landscape features pose to a moving organism. Her work includes methodological comparisons



for estimating resistance to movement and modeling corridors, using data from mountain lions in southern California and black bears in northern Idaho.

- Kelsey Stricker earned her Master's degree studying road impacts on wildlife along I-15 by utilizing remote camera arrays. She lives in the area and is the lead biologist for the Pechanga Tribe, a major landowner in the vicinity of the Santa Ana to Palomar Mountains Linkage.

The panel of experts was provided with available information relating to both linkage areas (aerial photos, maps, adjacent land conservation status, existing locations of culverts and bridges, data on crossing point use, modeling results, wildlife movement data) and participated in day-long field tours of each linkage area to evaluate various sites for the potential placement of connectivity structures. Field tours were then followed on the third day by an all-day workshop to discuss and rank sites and options for connectivity structures for each linkage. At this workshop, the experts were joined by transportation planners, wildlife agency representatives, and various local connectivity experts who have been involved in past assessments of wildlife connectivity status and options at these locations.

During the all-day workshop, the invited experts were asked to rank the crossing point locations, and in many cases expressed their opinions relating to the likely best types of structures that could be utilized at those locations. These expert opinions are noted in the report, however determining the most feasible or best type of structure that could be utilized at any crossing point was beyond the level of engineering expertise that was present at the workshop. Thus, this report is primarily focused on relating the ranking of crossing point locations and the type of structure, with specific structure feasibility assessments to occur in the future.

Rankings were converted into a point system that assigned a point score of 3 to each expert's first choice, a score of 2 to their second choice, and a score of 1 to their third choice. For the Santa Ana to Palomar Mountains I-15 Linkage crossing point assessments, some experts ranked more than one crossing point identically. In that case, both crossing points were given the same point score. Expert scores were then rescaled to a maximum score of 5 before combination with the Landscape scores (also scaled to 5).

## **Method 2: Assessment of Landscape Characteristics and Wildlife Use**

In this method, points were assigned to each wildlife crossing location based on important characteristics that were scored categorically (Table 1). Possible points for each characteristic ranged from 0-1 based on the strength of that characteristic at the site. In some instances, fractional scores were given to reflect partial satisfaction of the listed condition (e.g., for Landscape pattern - broad scale, if connectivity was present in 3 of 4 directions, this would generate a score of 0.75). The maximum number of points attainable by any individual site was 5. Rankings from each method were then added together for a composite total score (maximum score of 10) which were used to determine overall rankings.

Table 1. Attributes used for Landscape scoring of crossing points in both linkage areas.

Attribute	Score Guide
<b>1. Evidence of mountain lion use</b>	
Confirmed crossing or roadkill, or close approach both sides	1
Approach within 100 meters (close approach) - either side	0.66
Approach within 500 meters (medium approach) - either side	0.33
No known approaches	0
<b>2. Landscape pattern - broad scale</b> <i>What is the overall landscape connectivity like, i.e., can animals effectively reach the vicinity of the crossing point?</i>	
Both sides have good connectivity	1
One side has good connectivity	0.50
Neither side has good connectivity	0
<b>3. Landscape pattern - fine scale</b> <i>Is the landscape in the immediate vicinity of the crossing conducive to wildlife movement - all the way to the crossing structure or freeway edge itself?</i>	
Both sides conducive to animals getting to and through the crossing	1
One side conducive to animals getting to and through the crossing	0.50
Neither side conducive	0
<b>4. Land securement - broad scale</b> <i>Is land generally continuously protected in larger blocks within 1 km of site?</i>	
Both sides protected	1
One side protected	0.50
Neither side protected	0
<b>5. Land securement - fine scale</b> <i>Is land protected leading to the crossing point from larger blocks of habitat, and at the crossing?</i>	
Both sides protected	1
One side protected	0.50
Neither side protected	0

### 3. RESULTS

Results are presented separately for each linkage. Background information on each linkage is followed by assessments of each crossing point, briefly in this section and then in more detail in the Appendices (Appendix A for Santa Ana to Palomar Mountains Interstate 15 Linkage, and Appendix B for Santa Monica to Sierra Madre Mountains 101 Freeway Linkage). Assessments for each crossing point include a summary of existing conditions related to habitat, conservation status, documented wildlife use, threats, and existing crossing structures. Assessments are then followed by a summary of the overall results based on the combination of the Expert and Landscape scores.

Note: Statements in this report regarding the potential for constructing various types of structures at each site are based on previous publications and discussions with wildlife agency personnel, other stakeholders and experts, and, in the case of the 101 Freeway crossings, preliminary engineering studies. To the authors' knowledge, no detailed engineering studies have been conducted relating to the I-15 sites to ascertain viability or costs of any options mentioned.

There are some general characteristics of successful wildlife crossings (Clevenger and Huijser, 2011; Vickers unpublished data) that have helped to inform the recommendations in this report:

1. Undercrossings that are intended to accommodate mule deer movement are generally larger than those required for most other wild species. Frequently crossings intended or with the potential for wildlife use may be judged on their "openness," which refers to the size of the opening relative to the length of the crossing, and specifically by the "openness ratio", arrived at by multiplying width times height in meters, and dividing by length in meters  $[(\text{Height} \times \text{Width}) / \text{Length}]$ . For ungulates in general, and mule deer specifically, the shorter and wider the structure the more likely mule deer are to use it. Although there is certainly variability between sites, between species, and even within species, previous research has indicated that an openness ratio of 0.6 m or greater is preferred; however, landscape character, adaptations to the highway, width relative to height, and other factors may be more important (Kitsch and Cramer 2011). This generally requires a bridge-type structure to carry the highway above the crossing, or a large arch culvert. Mule deer have been documented using arch-type culverts with lower openness ratios (0.25 – 0.3m) in situations where the terrain favors extensive deer use of the approaches to the structure (Vickers unpublished data), thus terrain modification near the crossing end points might allow for a somewhat smaller structure. In a study of 15 freeway crossings in the Santa Monica Mountains area (Ng et al. 2004), the two crossings with significant deer use were wide bridges with openness ratios of 5.2 (15 crossings) and 4.1 (9 crossings); one tunnel with a ratio of 0.37 but good natural vegetation on both sides had two crossings.

Some proposals for enhancing connectivity have proposed a 4m round "jack and bore" culvert as the solution for the need for new crossings. For the 101 Freeway, tunnel length would likely be close to 100m, resulting in an openness ratio of 0.13m for a 4m diameter opening, less than 1/4 of the recommended value, making it not suitable for mule deer. Tunnel length for I-15 would vary depending on the site.

2. As in almost all effective wildlife crossing structures, animals must be able to see through the structure to the opposite end and the habitat cover at both ends needs to promote wildlife movement by the full range of species expected to use the structure. Arch culverts also allow for

the placement of internal structural components such as rocks, shelves, or water features that can effectively promote the movement of small rodents, reptiles, amphibians, etc. through the structure.

3. Mountain lions and other wildlife have been documented using round culvert structures that are smaller (~4 meters in diameter) than that required by mule deer (Clevenger and Waltho 2005, Kintsch and Cramer 2011, W. Vickers unpublished data). Thus, discussions of undercrossing designs and costs need to take these two different parameters into account, and the determination should be made early in the process whether connectivity for mule deer and other smaller species with more specific needs should be assured for any new or modified crossing structure to be judged successful.
4. In general, overcrossings for wildlife have several characteristics that are expected to enhance their use by a wider range of species than culverts. They are typically wide (50m or more), contain vegetation and natural substrates, have vegetation structure that accommodates the movement tendencies of multiple species, have structural elements that block sound and light from the roadway below, and incorporate modifications to the landscape and vegetation on the approaches that assist in funneling wildlife to the structure entrances.
5. In addition, high fencing (preferably 3- to 3.7-meter (10 – 12 ft.) high chain-link, buried to prevent animals digging underneath, and with barbed-wire outriggers) should be installed for long distances (up to a mile or more) in both directions along both sides of the roadway to funnel wildlife to any new or improved crossing structure (Huijser et al. 2016). This design is expected to minimize the likelihood of mountain lions, mule deer, and most of the smaller carnivores entering the roadway. Fencing of different designs and as low as 2.4 meter (8 ft.), such as "webwire" fencing without outriggers or burial, would be expected to restrict mule deer entrance to the highway but not mountain lions, smaller carnivores, or other wildlife.

## **Santa Ana to Palomar Mountains Linkage: Assessments of Interstate 15 Crossing Points**

The Santa Ana to Palomar Mountains Linkage connects the Santa Ana Mountains and adjoining coastal lowlands with the Palomar Mountains and other inland portions of the Peninsular ranges primarily in San Diego County. The Santa Ana Mountains include over 120,000 hectares of protected chaparral, coastal sage scrub, grasslands, vernal pools, and oak and riparian woodlands. Lands that are protected as wildlife habitat are owned or managed by various public agencies including the National Forest Service, Department of Defense, California State Parks, the Counties of Orange, Riverside, and San Diego, San Diego State University, California Department of Fish and Wildlife, and a variety of water districts, non-profit entities, and others. The linkage has been studied by wildlife biologists for over 25 years and is widely recognized as critical for maintaining biodiversity in the Santa Ana Mountains, as it is the last option for securing connectivity between this coastal range and larger intact natural lands to the east (Figure 2). The linkage is necessary to maintain ecological processes and genetic diversity in the Santa Ana Mountains as they become more degraded and fragmented by development.

In practical terms, urban, rural, and agricultural development have limited the potential I-15 crossing area to an approximately 10-kilometer-long (6-mile) stretch of I-15 south of Temecula where wildlands and agricultural lands are present on both sides of the freeway (Figure 2; Luke et al 2004). The only

exception to this generalization is that, further south, the bridge over the San Luis Rey River provides safe passage for wildlife under I-15, but for mountain lions, an east to west crossing at that location requires that they follow the San Luis Rey River west through the cities of Fallbrook, Bonsall, San Luis Rey, Oceanside, and developed portions of Marine Base Camp Pendleton before reaching wild areas of the Santa Ana Mountains to the north of Oceanside. Thus, this pathway is not one that is expected to support regular movement of mountain lions in and out of the Santa Ana Mountains.

Urban and rural development remain a threat to what remains of the linkage, and I-15 and associated development, as well as secondary roads, have formed an apparent partial or complete barrier to east-west movement for wildlife and plants. One secondary road of concern is Rainbow Canyon Rd (Old Hwy 395), which runs parallel to the I-15 Freeway and is a lesser but likely significant barrier to wildlife movement that needs to be addressed as part of linkage planning.

Two extensive mountain lion studies have been conducted in the region, both of which included multiple radio-collared and GPS-collared animals circulating in the Santa Ana to Palomar Mountains Linkage (Beier and Barrett 1993, Vickers et al. 2015). Mountain lion GPS points from the Vickers et al. (2015) study are depicted in Figure 2. In the Beier and Barrett study period, only two mountain lions were documented to have crossed I-15 (both west to east). In the Vickers, et al. (2015) study, only one GPS-collared animal was documented to have crossed the freeway (west to east. Based on that genetic analysis (Ernest et al. 2014), that animal (M86) did reproduce, potentially enhancing the gene pool in the Santa Ana Mountains lion population; however, few of his probable offspring have survived as of late 2016 in the population, and M86 was killed by a vehicle strike (Vickers and Boyce unpublished data). Genetic analyses from 146 sampled pumas indicate that seven pumas crossed I-15 over the last 15 years, including four males from west to east, and three males from east to west (Gustafson et al. 2017). Vickers et al. (2015) demonstrated that survival rates in the Santa Ana Mountains are lower than in most other mountain lion populations throughout the west, compounding the threat posed to the Santa Ana Mountain's population by genetic isolation.

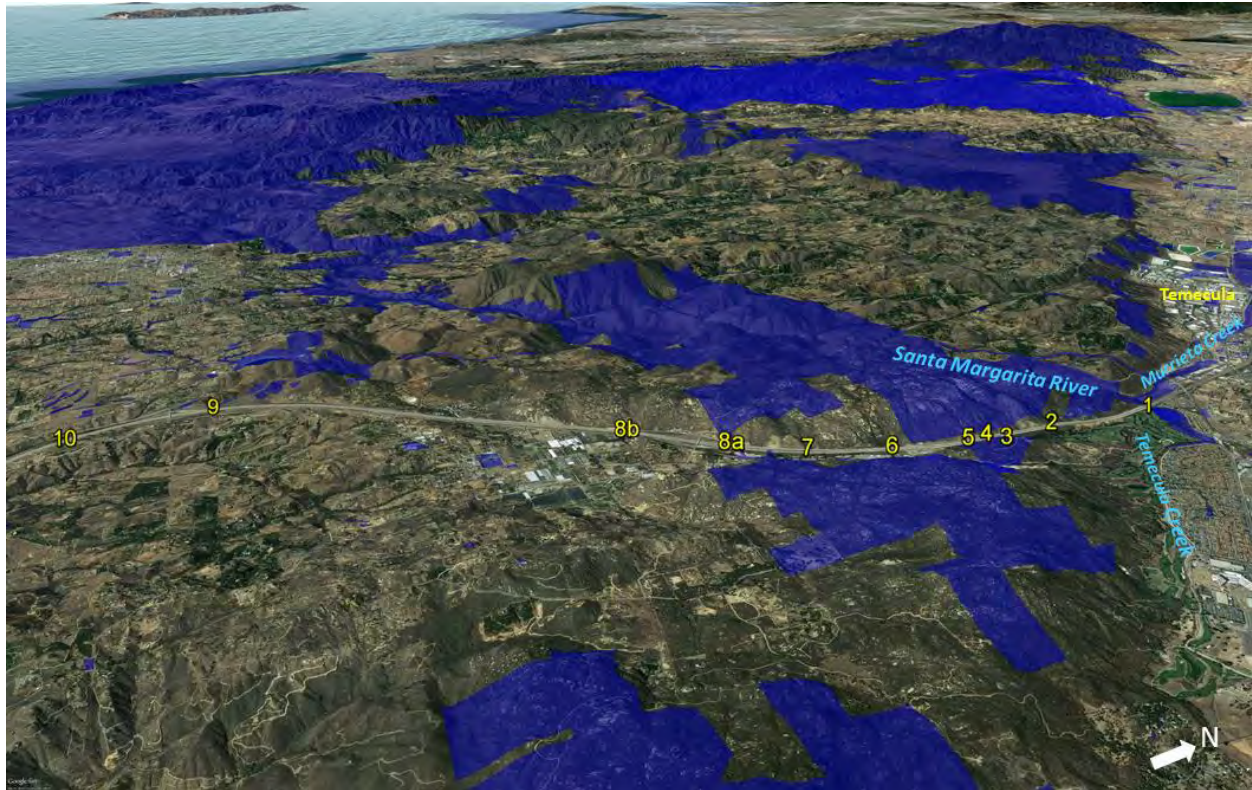
At least five separate modelling efforts have been performed using available data (landscape and vegetation characteristics, existing culvert and bridge locations, and mountain lion movement data) to determine the best locations for wildlife crossing structures in the approximately 10-kilometer section of I-15 south of Temecula (Tracey and Crooks 2001, Gibbons 2008, Zeller et al. 2015, Zeller et al. 2017b, Huber unpublished data). These modelling efforts have indicated that several different locations have potential as sites for new or improved wildlife crossing structures. However, no consensus crossing point locations have emerged from these models, or from discussions between local wildlife agency personnel, county conservation agency personnel, other governmental representatives, and conservationists.

### **Crossing Point Assessments – Santa Ana to Palomar Mountains I-15 Linkage**

A total of eleven potential crossings points along the roughly 10-kilometer (6-mile) segment of I-15 south of Temecula were evaluated as part of this project (Figure 3). Four of the eleven sites (Sites 8a, 8b, 9 and 10) were determined to be too highly constrained by existing development to be considered during the evaluation process. These four sites all received Landscape Scores (Table 3), but none were ranked by the experts as first, second, or third choices, possibly because of the extensive agricultural and human development on both sides of the freeway at those sites. Thus, those sites' scores were lower than any of the first seven sites described, and they are not described in depth in Appendix A, though more detailed maps of these sites are included there.



**Figure 4.** Eleven potential wildlife crossing points (1-8a,8b-10) along a 10-km (6-mile) stretch of I-15 in the Santa Ana to Palomar Mountains. Conserved lands are depicted in dark blue. View depicted is looking from the Palomar Mountains northwest to the Santa Ana Range with the Pacific Ocean to the west in the upper left corner.



Appendix A contains detailed information about each of the evaluated crossing points for the Santa Ana to Palomar Mountains I-15 Linkage, including: 1) a summary of existing conditions related to habitat, conservation status, documented wildlife use, threats, and existing crossing structures, if present, 2) Landscape Scores for the crossing based on available information about landscape structure and wildlife use, and 3) Expert Scores based on the experts' rankings of the location as a crossing.

#### **Brief Crossing Point Site Descriptions and Scoring Results – Santa Ana to Palomar Mountains Interstate 15 Linkage**

**Site 1: Temecula Creek Bridge:** This site is at the northern end of the linkage and consists of two separate span bridges for the north and south-bound traffic lanes of I-15. The bridge crosses over Temecula Creek, and each span is roughly 22 meters wide with a 15-meter separation between spans (60 meters total width). The bridge length is approximately 75 meters and the height is approximately 15 meters. Protected open space is located on either side of the bridge; however, proposed development threatens both the west and east side of this crossing. Residential uses and a civic use are proposed on a 76-hectare site just north of the west side of the bridge. In its current state, Site 1 received a Landscape Score of 4.25 out of 5 and an Experts' Score of 2.78, and ranked as the second highest priority crossing point location.

Note: Sites 2 through 4 all have steep up-slopes on the west side of the highway and downslopes on the east. All culverts noted as pre-existing are steeply sloped on their eastern ends making them unsuitable currently for regular wildlife use. It was beyond the expertise level of the group in this workshop to evaluate engineering factors that would determine whether any type of undercrossing could be constructed at these sites that would be adequately horizontal to allow for wildlife use.

Site 2: This site is the location of an existing 2m diameter culvert that drains from the west side of I-15 to the east. Intact but unprotected chaparral habitat is found on the west side of the freeway, while oak woodland and golf course development are found on the east side of the freeway at the base of the lightly vegetated downslope. Site 2 received a Landscape Score of 2.91 and an Experts' Score of 0.37 and ranked seventh overall.

Site 3: This site currently has a 2m culvert that drains west to east with intact chaparral habitat on both sides of the freeway. The property on the west side of the crossing point is currently being pursued for conservation, while the property on the east side of the culvert has been recently acquired for conservation. Site 3 received a Landscape Score of 3.33 and an Experts' Score of 1.67 and ranked fourth overall.

Site 4: This site has a 1.5m diameter culvert that drains from west to east across I-15. The west side is composed of an oak-lined drainage that is part of the Santa Margarita Ecological Reserve, while the east side of the culvert drains into intact chaparral habitat that was recently acquired for conservation. Site 4 received a Landscape Score of 3.83 and an Experts' Score of 2.59 and ranked third overall.

Site 5: This site is composed of a steep up-slope of varying height (approximately 15 - 30 meters) on both sides of the highway. The west side of the highway is protected habitat that is part of the Santa Margarita Ecological Reserve and supports rock outcrops and chaparral habitat. The east side is intact chaparral habitat that was recently acquired for conservation. Site 5 received a Landscape score of 5.0 and an Experts' score of 4.07 and was ranked as the highest priority location for a crossing structure, with the assumption by the experts that a wildlife bridge was the only type of structure that could be feasibly placed at that location.

Site 6: On the west side of I-15 at this site there are several small gullies with intact but unprotected chaparral, rock outcrops, and small oak trees. The east side includes a lightly vegetated down-slope that extends below the highway edge, and an adjoining open lot containing mixed native and non-native vegetation that is approximately 100 x 120 meters in size and bordered by commercial lots to the north and south and Rainbow Canyon Road to the east. The U.S. Border Patrol has a check station with off-ramp just north of the site where extensive light and human activity are present 24 hours a day. Site 6 received a Landscape Score of 2.33 and an Experts' Score of 0.74 and ranked sixth overall.

Site 7: The west side of I-15 at this location is a steep rocky up-slope adjoining a small canyon with intact chaparral, rock outcrops, and small oak trees. The east side includes a sparsely vegetated down-slope that extends below the highway edge and adjoins an open lot that is approximately 150 x 150 meters in size with scattered small buildings at the edge. This lot is bordered by commercial lots to the north and south and Rainbow Canyon Road to the east. Site 7 received a Landscape Score of 3.25 and an Experts' Score of 0.74 and ranked fifth overall.

Sites 8a, 8b, 9, and 10: These sites are all located along I-15 south of Site 7. All sites received Landscape Scores (Table 3), but none were ranked by the experts as first, second, or third choices because of the

extensive agricultural and human development on both sides of the freeway at these sites. Thus, the scores for these three sites were lower than any of the first seven sites described, and they are not described in depth in Appendix A, though more detailed maps of these sites are included there.

Table 2. Expert scores by crossing point in the Santa Ana to Palomar Mountains I-15 Linkage

Expert	Expert Scores by Site										
	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site 8a	Site 8b	Site9	Site 10
Paul Beier	1		2	2	3						
Patty Cramer	3		2	2	2	1	1				
Kathy Zeller	1		3	2	2						
Patrick Huber	2				3						
Julia Kintsch	1		2	2	3						
Tony Clevenger	2				3						
Kelsey Stricker	1	2				3	3				
Seth Riley	2			3	3						
Christy Brigham	2			3	3						
<b>Cumulative scores unweighted</b>	15	2	9	14	22	4	4	0	0	0	0
<b>Cumulative scores normalized to scale of 0-5</b>	2.78	0.37	1.67	2.59	4.07	0.74	0.74	0	0	0	0

Table 3. Landscape and Combined Expert-Landscape scores by crossing point in the Santa Ana to Palomar Mountains I-15 Linkage

Scoring components	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8a	Site 8b	Site 9	Site 10
<b>1. Evidence of mountain lion or other wildlife use</b>	1	0.66	0.33	0.33	1	1	1	1.0	1	0.33	0
<b>2. Landscape pattern - broad scale</b>	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.50	0.50	0.75	0.75
<b>3. Landscape pattern - fine scale</b>	0.75	0.75	1	1	1	0.50	0.75	0.50	0.50	0.75	0.75
<b>4. Land securement - broad scale</b>	0.75	0.75	0.75	0.75	0.75	0.75	0.75	.75.	0.50	0	0
<b>5. Land securement - fine scale</b>	1	0	0.50	1.0	1.0	0	0	0.50	0.50	0	0
<b>Total landscape scores (0-5)</b>	4.25	2.91	3.33	3.83	4.50	3.00	3.25	3.25	3.00	1.83	1.50
<b>Expert Scores (from Table 2)</b>	2.78	0.37	1.67	2.59	4.07	0.74	0.74	0	0	0	0
<b>Total score (expert plus landscape, 0-10)</b>	7.03	3.28	5.0	6.42	8.57	3.74	3.99	3.25	3.00	1.83	1.5
<b>Overall rank</b>	<b>2</b>	<b>7</b>	<b>4</b>	<b>3</b>	<b>1</b>	<b>6</b>	<b>5</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>

## **Summary of Results – Santa Ana to Palomar Mountains Interstate 15 Linkage**

Site 5 ranked highest in the expert scoring with 6 out of 9 experts selecting it as the highest priority, and a wildlife bridge structure at this site was considered by the experts to be the most functional for the widest array of wildlife and plant species, including mountain lions and deer. Both the location and wildlife bridge concept are consistent with previous studies (Beier and Barrett 1993, Fisher and Crooks 2001, Luke et al. 2004). This site ranked first in the landscape scoring. The exact location where a bridge structure would be placed in the stretch of the freeway encompassed by Site 5 would be dependent on engineering feasibility studies.

All experts ranked Site 1, Temecula Creek Bridge, as one of the top three crossing point locations; however, eight of the nine experts ranked this site as second or third priority, with only one expert ranking it as the highest priority location. Experts pointed to the fact that this site currently has the highest existing potential for wildlife movement, but has significant challenges to its proper function due to road noise and human presence. They felt that road noise and human disturbances could be sufficiently mitigated to increase this location's functionality for species such as mountain lions and deer. Recommended improvements include substantial reduction of sound and light pollution from traffic crossing the bridge, removal of lighting at the pump station on the west side of the bridge, prohibition of human presence under the bridge and in the creek bed at night, prohibition of further human development and nighttime activity on the Temecula Creek golf course and near the confluence of Temecula and Murrieta creeks and the Santa Margarita River on the west side of the bridge. In addition, experts agreed that increased native vegetative cover should be established on the golf course to promote the use of the site by deer and other wildlife. Even if the proposed residential development moves forward, the experts felt that this crossing could still function for medium-sized carnivores, smaller wildlife and plants, but its function for mountain lions and mule deer would be further degraded.

Site 4 ranked third overall in the cumulative Landscape and Experts' score; however, like Site 5, making this crossing site functional would necessitate construction of a new structure. The experts were equally divided on whether the crossing structure for this location should be an overpass or an underpass.

Site 3, previously suggested by some county staff and wildlife agency personnel as a possible location for an underpass to accommodate mountain lions and medium-sized carnivores, ranked fourth overall, and was a second or third priority for four of the nine experts.

Sites 2, 6, and 7 ranked similarly low in the expert scoring, each only receiving one vote as a first, second or third priority, though site 7 ranked fifth overall due to the occurrence of two puma roadkills at that location, confirming as at some other sites that pumas would potentially use a crossing if constructed at that location.

Sites 8a, 8b, 9, and 10 did not receive any support from the experts, although 8a and 8b both had puma roadkill occur very near their locations. Due to the lack of support from the experts, the cumulative score for each of these crossing points were very low.



## Discussion – Santa Ana to Palomar Mountains Interstate 15 Linkage

Overall, when combined, the Expert and Landscape scores for the Santa Ana to Palomar Mountains I-15 Linkage support Site 5 as the highest priority location for the placement of a ***new wildlife crossing structure***.

However, Site 1, Temecula Creek Bridge, received the second highest Landscape Score ***in its current state*** based on existing landscape structure and evidence of use by many species including those requiring water for connectivity, and it placed second in overall scoring. It was also recognized as the only site of the 11 evaluated that currently functions for any significant wildlife movement, and that function is threatened by a development proposal recently approved by the City of Temecula. It was also the site that the experts felt had the most economic viability with regards to near term improvement.

Sites 4 and 3 were the next highest ranked crossing sites, but like Site 5, both ***would require construction of a new crossing structure*** (either over or under crossing) to become viable wildlife crossings. It is notable that sites 3, 4, and 5 all lie within a short (~0.3 mi) section of I-15 and have similar vegetation structure on either side of the freeway, and similar large-scale connectivity potential. Because landscape structure does not favor one over the other enough to rule either of the others out, if funding for a new structure becomes feasible, the ultimate choice between these three may rest most strongly on engineering factors and whether the land is conserved where any new crossing structure would have its end points.

The expert consensus was that ***more than one structure should be constructed or enhanced*** to provide the best potential for improved connectivity for a variety of wildlife species. Relying on only one highway crossing structure to provide adequate connectivity, especially for a wide range of species, between two entire mountain ranges, was regarded by the experts as risky and likely to fail. Thus, ***retention and enhancement of function of the Temecula Bridge is indicated even if a new wildlife structure may someday be built at Site 3, 4, or 5.***

Additional measures recommended by the experts for any new or improved wildlife crossing structures include: 1) wildlife fencing along both sides of I-15 to help funnel wildlife to the crossing structures (Huijser et al. 2016), 2) habitat modification of dense chaparral slopes on either side of the roadway, such as the construction of wildlife trails, to facilitate wildlife movement through the habitat to a new or improved structure, and 3) construction of an additional wildlife crossing structure across Rainbow Canyon Road, a busy secondary road to the east of I-15.

The crossing point rankings and the recommendation for more than one crossing structure are consistent with the findings of local experts who have evaluated crossing options over the last 25 years. In the last five years, local agencies and experts have prioritized a wildlife undercrossing structure at Site 3, and a wildlife overpass at Site 5. Although a wildlife overpass is viewed by local experts as the best option to serve the widest variety of species, local government agencies have generally expressed greater interest in an undercrossing due to a lower perceived expense. However, relative expense levels have not yet been determined via engineering studies, and we urge that such studies be done in order that informed decisions may be made on this question.

## Santa Monica to Sierra Madre Mountains Linkage: Assessments of Crossing Points for the 101 Freeway

Santa Monica Mountains National Recreation Area (SMMNRA) is the largest urban national park in the country. Its 150,000 acres of mountains and coastline in Los Angeles and Ventura counties are a network of local, state, and federal parks interspersed with private lands and communities. SMMNRA is part of a globally rare Mediterranean ecosystem that is exceptionally biodiverse, with more than 450 animal species and 84 distinct plant alliances.

The Santa Monica Mountains, which run east-west to the north of Malibu, to the west of the Los Angeles Basin, and to the south of the San Fernando and Conejo Valleys, are substantially cut off from other large natural areas to the north by the 101 Freeway. This freeway is 8-10 lanes and receives very heavy traffic: it is one of the busiest freeways in the world, and in fact the 101-405 Freeway interchange (about 19 kilometers, or 12 miles to the East of the study area) is the second most trafficked in the entire country. As a national park in the Los Angeles area, at Santa Monica Mountains National Recreation Area the National Park Service has always been interested in and concerned about the effects of urbanization and habitat fragmentation on natural resources, including wildlife populations, particularly for wide-ranging species such as mammalian carnivores.

For more than two decades, the park, along with other partner agencies in the region such as the Santa Monica Mountains Conservancy and California State Parks, has been concerned about habitat connectivity between the Santa Monica Mountains and other remaining natural areas in the region. These and other agencies and groups have worked hard and spent millions of dollars in land acquisition money to strategically acquire and conserve land near the 101 Freeway, especially in the Liberty Canyon area in Agoura Hills. It was easy to see from the beginning of these efforts, and it is easy to see on any current map of the region, that the Agoura Hills-Calabasas grade area, specifically from Palo Comado Canyon Rd. to Mureau Rd., is one of the last areas where wildlife connectivity would be possible across the 101 Freeway (Figure 3). This area is one of the few remaining places along the Freeway where there is natural habitat adjacent to it on both sides. Planners did not consider the connectivity needs of wildlife when it was built in this area in 1949, or in the ensuing decades, and thus there is urban development along the 101 Freeway throughout the San Fernando and Conejo Valleys. The one other place in the Santa Monica Mountains where there is remaining natural habitat on both sides of the road is in the Conejo Grade area, just east of Camarillo. This area is less desirable for a wildlife crossing primarily because north of the Freeway, connectivity to other large natural areas is seriously compromised by roads and development. This area is also at the far western end of the Santa Monica Mountains, making it less accessible to as many animals as areas in the middle of the Mountains. However, two sub-adult mountain lions did cross the 101 Freeway in the Conejo Grade area in 2015 (National Park Service, unpublished data). Multiple crossings and connectivity in multiple areas are both generally desirable, so creating a safe wildlife crossing in this area in the future would be optimal.

The consensus maps developed as part of the South Coast Wildlands Linkage Design show the 101 Freeway crossing near the Agoura Hills-Calabasas grade area as the best location for providing connectivity for multiple species (Penrod et al. 2006). Starting in 2011, multiple agencies in the region formed the Linkage Implementation Alliance (LIA) to develop and coordinate efforts to turn the linkage maps into conservation reality through land acquisition, easements, education, etc. This group continues to meet quarterly.

In 1996, the park began studies of mammalian carnivores, specifically bobcats and coyotes and later (in 2002) mountain lions as well, to better understand wildlife movement in the area and the effects of the major barrier of the 101 Freeway. These studies have found that while carnivores can and sometimes do use developed areas, they largely use remaining natural areas, subsist on natural foods, and are subject to regular mortality from anthropogenic sources such as vehicles and toxicants (Riley et al. 2003, Riley et al. 2007, Riley et al. 2010, Gehrt and Riley 2010, Beier et al. 2010). The 101 Freeway was found to be a major barrier to movement for all three species, and in fact was also found to be a barrier to gene flow, such that significant genetic differentiation was present across it (Riley et al. 2006, Riley et al. 2014, Serieys et al. 2015). For mountain lions, the barrier effects of 101, along with other freeways in the region such as 405 and 5, are particularly severe. Genetic diversity for Santa Monica mountain lions is very low (Riley et al. 2014), lower than has been measured anywhere else in the west and like that in the isolated Santa Ana Mountains population (Ernest et al. 2014). The barrier effects of the freeway are also likely contributing to close inbreeding between relatives (e.g., fathers and daughters) and potentially to increased mortality from intraspecific strife (adult males killing subadult males and females, and even an adult female) because of the severely restricted dispersal of subadults out of the Santa Monicas (Riley et al. 2014). A recent population viability model incorporating both demographic and genetic factors predicted a continued steep decline in genetic diversity, leading to likely quick extinction once inbreeding depression compounds the effects of the already small population (Benson et al. 2016). The model found that even modest increases in immigration greatly ameliorated both demographic and genetic problems. Finally, research on smaller, less mobile species has also documented the genetic effects of roads and urban development. Specifically, significant genetic differentiation related to habitat fragmentation was found for three different lizard species, western fence lizards, side-blotched lizards, and western skinks, as well as for a common chaparral bird, wrentits (Delaney et al. 2010).

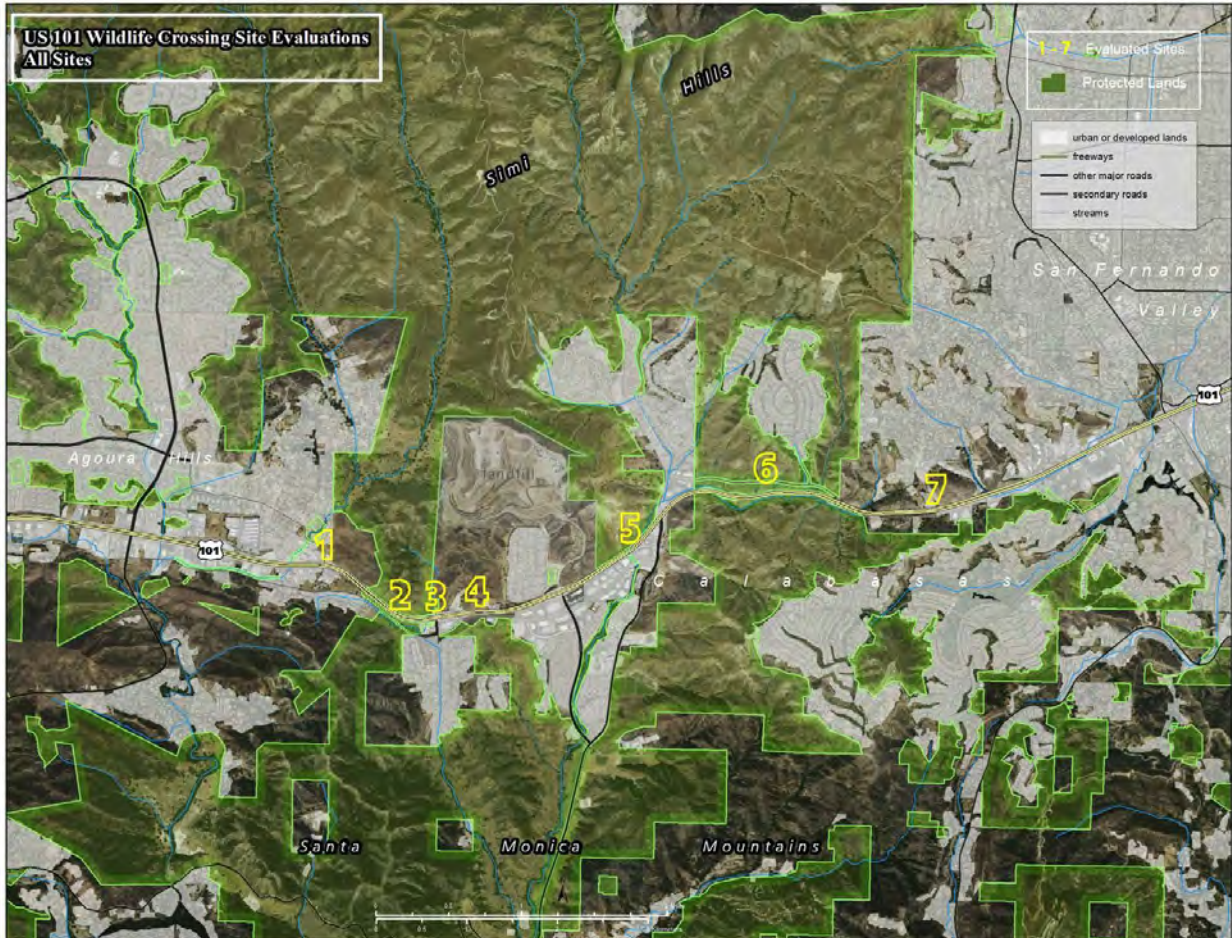
Overall, the mandate of the National Park Service, and the goal of the other open space agencies in the region, is to preserve the natural populations and communities present in the Santa Monica Mountains and the surrounding region as much as possible. The 101 Freeway, and the massive interruption in connectivity that it represents, is a significant impediment to this goal. Connectivity between natural areas is critical for all components of the natural communities, especially for wide-ranging species such as mountain lions or mule deer, but for all species of plants and animals as well. Over the long-term, we cannot hope to have naturally functioning ecosystems without increasing the effective connections between the Santa Monica Mountains and other natural areas to the north. Therefore, it has been a high priority to establish more connectivity across the 101 freeway for wild populations, particularly for wide-ranging animal species. Multiple agencies in the region, including the National Park Service, Caltrans, SMMC/MRCA, California State Parks, and others have been working towards this goal for more than two decades.

Specifically, for this workshop, the goal was to bring in experts who had experience with wildlife connectivity and road challenges around the country and the world, and to obtain their input on our situation here with the 101 Freeway and connecting the Santa Monicas to other protected areas to the north. In this report, the goal was also to integrate landscape information and current wildlife knowledge with the expert opinion to provide the fullest picture of the challenges and potential solutions.

### **Crossing Point Assessments – Santa Monica to Sierra Madre Mountains 101 Freeway Linkage**

A total of seven potential wildlife crossing points along a 9.5-kilometer (5.9-mile) stretch of the 101 Freeway in the Agoura Hills-Calabasas area were evaluated as part of this analysis (Figure 5). A brief description of each of these potential crossing points is presented below.

**Figure 5.** Seven potential wildlife crossing points along a 9.5 km (5.9 mile) stretch of the 101 Freeway in the Agoura Hills-Calabasas area of the Santa Monica to Sierra Madre Mountains Linkage.



Appendix B provides more detailed information about each crossing location, including: 1) a summary of existing conditions related to habitat, conservation status, documented wildlife use, threats, and existing crossing structures, if present; 2) Landscape Scores for the location based on existing data related to landscape conservation status and wildlife use, particularly for mountain lions, and 3) Expert Scores based on their rankings of the crossing locations.

## **Brief Crossing Point Site Descriptions and Scoring Results – Santa Monica to Sierra Madre Mountains 101 Freeway Linkage**

Site 1: Palo Comado Canyon Road Bridge. This farthest west site is a bridge for a two-lane paved road that receives moderate vehicle use, including entering and exiting freeway traffic. The bridge is immediately adjacent to residential development on both sides, although at the broader scale there is protected open space in three of four directions. The site received a Landscape score of 1.25 (6th) and a 0 from the experts, for a total score of 1.25 out of 10 (sixth overall).

Site 2: West Liberty Canyon. This site is just west of Liberty Canyon. It has natural vegetation on both sides, connects to protected open space both immediately adjacent to and farther away from the crossing location, and has extensive known use by wildlife including mountain lions and other carnivores. This was by far the best site, based on both Landscape scores (5) and Expert evaluation (5): it received a 10 out of 10 overall, while no other site had a landscape score above 3.33 or an overall score above 5.

Site 3: Liberty Canyon Road. This is the road underpass where Liberty Canyon Road passes under the freeway. It is well connected to open space on the north side, and broadly to the south, with known wildlife use. However, there is commercial development immediately adjacent on the south side, and the underpass itself is unvegetated and open with regular traffic entering and exiting the freeway. There was some underpass use by wildlife in a study from 1999-2000, but recent monitoring has found very little, despite extensive use of nearby areas by all species, including mountain lions. The overall score was 3.70, fourth out of seven.

Site 4: Agoura Road Pass. This site is east of Liberty Canyon, where there are hills rising above the freeway on both sides which could assist with overpass construction, and a mountain lion was killed on the freeway here. However, the land is not protected immediately to the north or south, and the broader connectivity is poor to the south. This site received a Landscape score of 3 (4th of 7), but was given no priority by the experts, for an overall score of 3.

Site 5: Las Virgenes Creek. This site is where Las Virgenes Creek goes under the freeway. It is a nice wide, natural underpass, with some documented use by wildlife including deer. Although it is well connected to natural and protected areas to the north, to the south the creek passes through intensive residential and commercial development for a long stretch before it connects with natural protected lands. This was the third highest ranked site for the experts, second in Landscape Score, and third overall (4.76 out of 10).

Site 6: Mureau Road Tunnels. This site includes multiple culverts for water passage in the vicinity of Mureau Rd (north of the freeway). The site is well connected and protected immediately adjacent to the crossing points, but at a broader scale there is development in some directions on both sides. There is also generally standing water on the south side of the culverts, decreasing their effectiveness. The experts felt this site had some potential (ranking second, with 1.95 out of 5), and it was second in Landscape Score at 3.08, ranking second overall (4.98 out of 10).

Site 7: Mureau Road Bridge. This is the farthest east site, another road bridge over the freeway where Mureau Road crosses it. It is one lane each way with a sidewalk on the east side and regular traffic between Hidden Hills and Agoura Hills to the north and Calabasas to the south. It is not well-connected



on either side at the fine or the broad scale, although there is some land protection to the southwest. This was the lowest ranked site by every measure, with a 0.75 out of 10 overall score.

### **Summary of Results – Santa Monica to Sierra Madre Mountains 101 Freeway Linkage**

Overall, the results of the crossing point assessment for the 101 Freeway were very clear in terms of the best location for a new crossing structure, with the same conclusion coming from both the Expert and the Landscape Score assessments: West Liberty Canyon is the best location for a new wildlife crossing structure. As noted in the site descriptions and as is clear from Tables 4 and 5, on both sides this site has protected, natural habitat both adjacent to the freeway and farther away, and it has had known use nearby by multiple wildlife species including mountain lions and other carnivores. This site scored 5 out of 5 on the Landscape Score assessment, and was the unanimous top choice among the seven sites for the experts.

The Mureau Road culverts, Las Virgenes Creek, and Liberty Canyon Road all scored between 3.7 and 4.98 overall, reflecting some potential, but all were far behind West Liberty Canyon because of various problems. Liberty Canyon Road is an active road with traffic coming on and off the freeway, and it is completely open and unvegetated underneath the bridge. It also has development immediately adjacent to the road on the south side, both to the southeast and southwest. Recent monitoring with remote cameras has documented no confirmed crossings by wildlife in two years (through April 2017), despite detections of many species, including mountain lions, immediately adjacent to it (National Park Service, unpublished data). Las Virgenes Creek has a natural, vegetated crossing under the freeway and good direct connections to open space immediately on the north side, but to the south there is a long stretch of thin riparian vegetation through intense urban development (Fig. 5). The Mureau Road Culverts are across a major secondary road, Mureau Road, from large areas of open space, and many of them are small, dark, and have bends, so the other side is not visible. Of the two tunnels that do have line of sight all the way across, one has a large pool of standing water on the south side which would seriously impede use from either direction. All of these locations could have some value as redundant sites, especially with improvements (see below), but again, all are far inferior to the West Liberty Canyon site.

Table 4. Expert scores by crossing point for the Santa Monica to Sierra Madre 101 Freeway Linkage

Expert (Note: Expert Kathy Zeller was not able to visit this linkage)	Expert Scores by Site						
	Site 1 PC Canyon Road Bridge	Site 2 West Liberty Canyon	Site 3 Liberty Canyon Road	Site 4 Agoura Road Pass	Site 5 Las Virgenes Creek	Site 6 Mureau Road Tunnels	Site 7 Mureau Road Bridge
Paul Beier		3			1	2	
Patty Cramer		3			2		
Patrick Huber		3			2		
Julia Kintsch		3	2			1	
Tony Clevenger		3	2			1	
Winston Vickers		3				2	
Trish Smith		3			1	2	
<b>Cumulative scores unweighted</b>	0	21	4	0	6	8	0
<b>Cumulative scores normalized to scale of 0-5</b>	0	5.0	0.95	0	1.43	1.90	0

Table 5. Landscape and Combined Expert-Landscape scores by crossing point in the Santa Monica to Sierra Madre Mountains 101 Freeway Linkage

	<b>Site 1</b> PC Canyon Road Bridge	<b>Site 2</b> West Liberty Canyon	<b>Site 3</b> Liberty Canyon Road	<b>Site 4</b> Agoura Road Pass	<b>Site 5</b> Las Virgenes Creek	<b>Site 6</b> Mureau Road Tunnels	<b>Site 7</b> Mureau Road Bridge
<b>1. Evidence of mountain lion or other wildlife use</b>	0	1	1	1	0.33	0.33	0
<b>2. Landscape pattern - broad scale</b>	0	1	0.50	0.75	1	0.75	0
<b>3. Landscape pattern - fine scale</b>	0.50	1	0.75	0.50	0.50	0.50	0
<b>4. Land securement - broad scale</b>	0	1	0.25	0.50	1	1	0.50
<b>5. Land securement - fine scale</b>	0.75	1	0.25	0.25	0.50	0.50	0.25
<b>Total landscape scores (0-5)</b>	<b>1.25</b>	<b>5.0</b>	<b>2.75</b>	<b>3.00</b>	<b>3.33</b>	<b>3.08</b>	<b>0.75</b>
<b>Total score (expert plus landscape, 0-10)</b>	<b>1.25</b>	<b>10.0</b>	<b>3.70</b>	<b>3.00</b>	<b>4.76</b>	<b>4.98</b>	<b>0.75</b>
<b>Overall rank</b>	<b>6</b>	<b>1</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>2</b>	<b>7</b>

## **Discussion - Santa Monica to Sierra Madre Mountains 101 Freeway Linkage**

In terms of what kind of structure would be best, the consensus of the experts was that an overpass, over both 101 and Agoura Rd., at the West Liberty Canyon site would be the best solution for the most number of taxa. The experts agreed that an overpass just over the Freeway, which based on the site characteristics would need to end right next to Agoura Rd, would not be desirable because it would endanger animals coming off the structure, they would not be delivered across the road to nearby natural habitat, and it would be a bad precedent and perception both for this and future projects. Given the quality of the site, the next most effective solution would be a tunnel also at the Liberty Canyon West Site, although the tunnel also would not convey animals across Agoura Rd, south of 101. A tunnel, regardless of size, would also not be as effective for smaller species such as small mammals, reptiles, and amphibians. Both an overpass and a large tunnel were considered to likely be functional for all the medium and large mammals considered, including mountain lions and deer, although a tunnel large enough for deer under a freeway that wide (10 lanes of pavement) would pose serious engineering and traffic challenges, and therefore come at great monetary and social and political cost.

In the long run, multiple crossing structures should be available for a wide range of species to effectively cross the 101 Freeway between the Santa Monica Mountains and areas to the north. In terms of other sites, the existing Las Virgenes Creek underpass was thought to be functional for some species, including deer, smaller vertebrates, and aquatic species such as amphibians, since it has permanent water. However, though the area north of the freeway is natural and protected, connectivity south of the freeway is limited by the thin vegetated corridor that is surrounded by development for several hundred meters. In the past, the presence of invasive aquatic species, specifically crayfish, made this crossing less ideal for native aquatic species, although recent extensive efforts to remove crayfish in Las Virgenes Creek have reduced this concern. The second-best site in terms of expert opinion and total score was the Mureau Road Tunnels. This site is well connected to protected natural habitat near the Freeway, has some connectivity farther away, and has existing tunnels that could be improved. Although these tunnels are long and relatively small, they could be valuable for carnivores, and could serve to augment an overpass at West Liberty Canyon. A disadvantage here is that Mureau Road separates the crossing area from the open space to the north, so animals would have to cross four lanes of pavement and a median. This would be a significant barrier for many smaller species, and a potential mortality source for larger ones. Experts agreed that wildlife fencing should also be constructed in association with any new or improved structures to help funnel wildlife to the crossings (Huijser et al. 2016).

## **4. OVERALL CONCLUSIONS**

Both the Santa Ana to Palomar Mountains and the Santa Monica to Sierra Madre Mountains Linkages in southern California have been a focus of regional wildlife research and conservation planning efforts for over 25 years. These two linkages are widely recognized as critical for maintaining biodiversity in the two largest coastal southern California mountain ranges, and both these linkages represent the last local opportunity for securing connectivity with larger intact natural lands.

For both linkages, the expert consensus was that, to maximize connectivity for multiple wildlife species, a diversity of crossing structures should be enhanced or constructed. While wildlife overpasses would likely serve the broadest suite of species, experts also pointed to the opportunities provided by enhancing existing creek crossings. Temecula Creek in the Santa Ana Mountains and Las Virgenes Creek in the Santa Monica Mountains might provide the best and most economical option for improving

connectivity for smaller mammals, amphibians, and fish. These are the only potential aquatic crossings for either the I-15 or 101 Freeways; however, both Temecula and Las Virgenes Creeks have urban edge issues of noise, exotic species, light, and human activity that would require mitigation and long-term management.

In addition to wildlife fencing to funnel wildlife to the crossing structures, some form of habitat modification would benefit both linkages. For the I-15 linkage, which has dense chaparral on both sides of the freeway, it was recommended that wildlife trails be constructed through the chaparral to attract carnivores and deer to the crossing structures. For the 101 Freeway, the restoration of coastal sage scrub in areas currently dominated by non-native grassland would provide needed cover for wildlife approaching the crossing, such as on the north side at the West Liberty Canyon site.

Participants also stressed that secondary roads that run parallel to both freeways – such as Rainbow Canyon Road in the I-15 Linkage and Agoura Road in the 101 Freeway Linkage - can be problematic for wildlife and that both linkages need to incorporate crossing structures for these secondary roads.

The authors recognize that assuring adequate connectivity for wildlife in these two areas will require significant public investment and political will, particularly because of significant costs associated with crossing structure construction and land protection. We hope that the results of this workshop will help guide all parties to a consensus opinion relating to crossing improvements, which can then allow progress towards improving wildlife connectivity at both critical locations.

## 5. ACKNOWLEDGEMENTS

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## Original Article

# Mitigating Roadway Impacts to Migratory Mule Deer—A Case Study With Underpasses and Continuous Fencing

HALL SAWYER,<sup>1</sup> *Western EcoSystems Technology, Incorporated, 200 S 2nd Street, Suite B, Laramie, WY 82070, USA*

CHAD LEBEAU, *Western EcoSystems Technology, Incorporated, 200 S 2nd Street, Suite B, Laramie, WY 82070, USA*

THOMAS HART, *Wyoming Department of Transportation, 5300 Bishop Boulevard, Cheyenne, WY 82009, USA*

**ABSTRACT** Wildlife–vehicle collisions pose a major safety concern to motorists and can be a significant source of mortality for wildlife. Additionally, roadways can impede movements and reduce habitat connectivity. For migratory ungulates, these problems can be exacerbated when roadways bisect migration routes, as is the case in Southwest Wyoming, USA, where a 21-km section of U.S. Highway 30 overlaps with a critical winter range and migration route used by thousands of mule deer (*Odocoileus hemionus*). In an effort to reduce deer–vehicle collisions (DVC) and maintain migratory connectivity, the Wyoming Department of Transportation installed 7 concrete box-culvert underpasses with continuous game-proof fencing between each crossing structure. To evaluate the effectiveness of this mitigation project, we used remote cameras to quantify the number of mule deer that used the underpasses, estimate passage rates through time, and compare rates of DVCs before and after underpass construction. Through 3 years of monitoring (which encompassed autumn migration [2008, 2009, and 2010], winter use, and spring migration [2009, 2010, and 2011] for 3 migration cycles), we documented 49,146 mule deer move through the underpasses. Passage rates of deer approaching underpasses steadily increased from 54% in Year 1 to 92% in Year 3. Peak movements during the autumn migration occurred in mid-December, while peak spring movements were in mid-March and early May. Underpass and fence installation effectively reduced DVCs by 81%. Had fence gates remained closed and cattle guards clear of snow, DVCs could be eliminated altogether. Our results suggest that underpasses, combined with game-proof fencing, can improve highway safety for motorists while providing safe and effective movement corridors for large populations of migratory mule deer. © 2012 The Wildlife Society.

**KEY WORDS** connectivity, fencing, highways, migration, mitigation, mule deer, *Odocoileus hemionus*, underpass, wildlife–vehicle collisions (WVC), Wyoming.

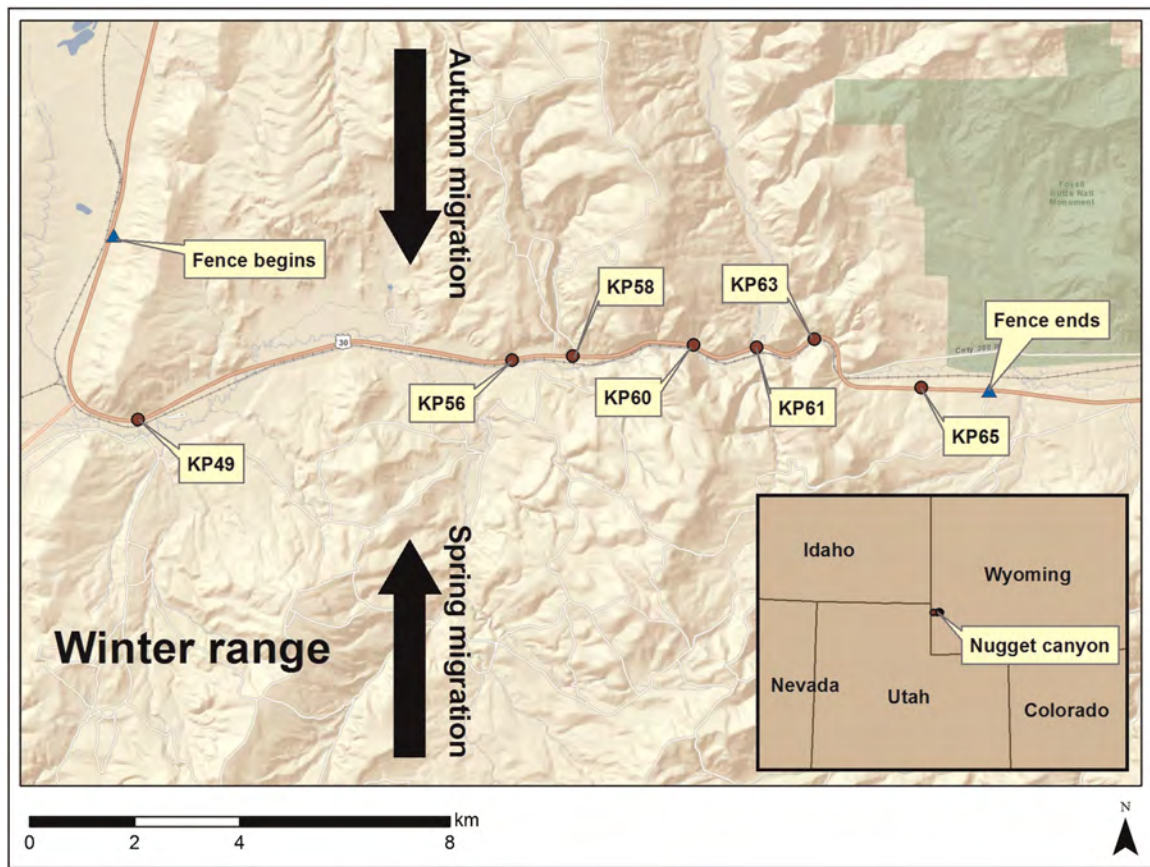
Wildlife–vehicle collisions (WVC) are a serious safety concern for motorists and can be a significant source of mortality for affected wildlife (Romin and Bissonette 1996, Putman 1997, Forman et al. 2003, Langbein et al. 2011). Additionally, roadways can restrict animal movements and increase fragmentation (Forman and Alexander 1998, Trombulak and Frissell 2000). For ungulate populations, potential impacts can be especially problematic when roads intersect with migration routes (e.g., Berger 2004, Sawyer et al. 2005). A case in point is U.S. Highway 30 in western Wyoming, USA. This 2-lane rural highway extends 21 km through crucial winter range and a migration route used by thousands of mule deer (Fig. 1). Deer–vehicle collisions (DVC) have historically been high along this roadway, with an average of 130 deer killed/year between 1989 and

2001 (Plumb et al. 2003). Despite a variety of mitigation measures implemented through the 1990s aimed at slowing traffic and warning motorists of potential collisions with wildlife (e.g., signs, reflectors, flashing lights), dozens of DVCs continued to occur each year in this segment of highway (Reeve and Anderson 1993, Gordon et al. 2004). The high rates of DVCs created safety concerns for motorists and, as traffic volumes increased by 42% between 1990 and 2000, managers were also concerned with maintaining habitat connectivity across the highway for migratory mule deer. In an effort to move deer underneath the highway and reduce DVCs, the Wyoming Department of Transportation installed a concrete box culvert at the western edge of the highway segment in 2001 (Fig. 1). To facilitate mule deer use of the underpass, a 2.4-m-high fence extended approximately 5.5 km on either side of the underpass. Although several hundred deer used the underpass in subsequent years (Gordon and Anderson 2003), remaining portions of the 21-km roadway continued to have high rates of DVCs, and it was apparent that additional crossing structures were needed. Accordingly, 6 new underpasses

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<sup>1</sup>E-mail: [hsawyer@west-inc.com](mailto:hsawyer@west-inc.com)



**Figure 1.** Location of game-proof fencing and 7 mule deer underpasses constructed along U.S. Highway 30 in Southwest Wyoming, USA.

and 10 km of fence were constructed in the summer of 2008.

Although previous studies have documented how many animals move through a particular underpass (Foster and Humphrey 1995, Ng et al. 2004, Kleist et al. 2007, McCollister and Van Manen 2010), none have focused on large migratory populations where animals can migrate at grade-level during one year, while the next year they cannot. Ungulates show strong fidelity to their migration routes (Berger et al. 2006, Sawyer et al. 2009, Sawyer and Kauffman 2011) and how they respond to fencing and underpasses is generally unknown. Our goal was to evaluate whether underpasses and associated fencing effectively reduced roadway impacts to this migratory deer population. First, we quantified the number of mule deer that used the underpasses. Second, we identified the seasonal and daily temporal patterns of deer movements through underpasses. Third, we estimated the passage rates of deer through underpasses to evaluate habituation through time. Finally, we evaluated DVCs before underpass construction (1990–2000), after construction of 1 underpass (2002–2007), and after construction of 6 additional underpasses (2009–2011). A clear understanding of whether underpasses and fencing can mitigate roadway impacts (i.e., DVCs, habitat connectivity) to migratory mule deer will improve the ability of wildlife and transportation agencies to sustain migratory ungulate populations and improve public safety on roadways.

## STUDY AREA

Our study site was a 21-km section of U.S. Highway 30 situated in Southwest Wyoming, in an area locally known as Nugget Canyon (Fig. 1). The canyon was characterized by steep sagebrush (*Artemisia tridentata*) canyons and open hill-sides. Elevations along the 2-lane roadway ranged from 1,890 m to 1,950 m, but the edges of the canyon reached elevations of 2,320 m. The Nugget Canyon area provided critical winter range to thousands of mule deer that migrated north each year to summer in the Wyoming Range. Because U.S. Highway 30 bisected this winter range, animals that wintered on the south side of Nugget Canyon must cross U.S. Highway 30 to complete their seasonal migrations. To reduce the number of DVCs, the Wyoming Department of Transportation installed 11 km of game-proof fence and 1 concrete box-culvert underpass (KP49) in 2001 (Fig. 1). In 2008, the fence was extended another 10 km, and an additional 6 underpasses (KP56, KP58, KP60, KP61, KP63, and KP65) were installed (Fig. 1). Underpass dimensions were approximately 6 m (width) × 18 m (length) × 3.0–3.5 m (ht), with an openness ratio of 1.10 (Fig. 2). We note that the openness ratio (opening width × ht/length of crossing) was calculated in metric units (Foster and Humphrey 1995). The height varied by as much as 0.5 m because of the amount of dirt fill used at each site. We refer readers to Reeve and Anderson (1993) and Gordon





**Figure 2.** Standard concrete-box underpass along U.S. Highway 30 in Southwest Wyoming, USA, with full-size pickup for reference (top). Mule deer moving through underpass (bottom).

et al. (2004) for detailed history of roadway mitigation efforts in Nugget Canyon, Wyoming.

## METHODS

We installed 3 digital infrared Reconyx<sup>®</sup> (Holmen, WI) cameras in each of the 7 underpasses, including one at the entrance, one in the middle, and one at the exit. This camera configuration allowed us to count the number of deer that approached and passed through each underpass from either direction. Underpasses were equipped with cameras from 1 October through 31 May for 3 years. The study period encompassed autumn migration (2008, 2009, and 2010), winter use, and spring migration (2009, 2010, and 2011) for 3 migration cycles. We defined the autumn migration as 1 October through 31 December and spring migration as 1 March through 31 May. The winter period was January and February. We note that cameras were not installed the first year until 16 December, so only the later part of the autumn migration was documented that year. We refer to years 1, 2, and 3 as monitoring seasons 2008–2009, 2009–2010, and 2010–2011, respectively. We used digital photos to count the number of deer and other wildlife that used each underpass. We examined seasonal temporal patterns by calculating the number of deer that passed through each underpass each day. We examined the daily temporal

patterns by calculating the number of deer that moved through underpasses each hour of the day, during a 10-day sampling period that corresponded with the peak level of use during spring and autumn migrations.

When faced with a novel disturbance such as an underpass, ungulates may take some time to habituate before using it (e.g., Gagnon et al. 2011). We evaluated the passage rate success by calculating the proportion of animal approaches that resulted in successful crossings (Dodd et al. 2007). We defined an approach as any event in which animals moved to within 50 m of the underpass entrance (Gagnon et al. 2007b). The passage rate was then calculated by dividing the number of animals that successfully passed through the underpass by the number of animals that approached. This metric was intended to quantify the effectiveness of each underpass and help evaluate whether passage rate success improved over time (e.g., Xia et al. 2007, Gagnon et al. 2011). We calculated passage rates during the 10-day peak migration period of each season (autumn 2008 [17–26 Dec], autumn 2009 [08–17 Dec], autumn 2011 [21–30 Nov], spring 2009 [23 Apr–02 May], spring 2010 [17–26 Apr], spring 2011 [01–10 May]).

We used DVC data collected by the Wyoming Department of Transportation to assess how underpass and fence construction reduced DVCs. We compared the number of DVCs during 3 time periods: 1) 1 January 1990–1 October 2001, (141 months) prior to construction of the first underpass, 2) 1 October 2001–1 October 2008, (82 months) following construction of the first underpass, and 3) 1 October 2008–1 May 2011, (31 months) following construction of 6 additional underpasses. To make comparisons between the 3 periods that differed in temporal length, we standardized the number of DVCs by the number of months in each period.

## RESULTS

### Underpass Use by Mule Deer

We documented 49,146 mule deer that moved through the 7 underpasses between December 2008 and May 2011 (Table 1), including 12,483 during the 2008–2009 monitoring season, 13,403 during 2009–2010, and 23,260 during the 2010–2011 monitoring season. Overall, most deer movement occurred at the KP49 (47%;  $n = 22,924$ ) and KP58 (28%;  $n = 14,012$ ) underpasses (Table 1; Fig. 3). However, use at the other 5 underpasses steadily increased through the 3 years of study and accounted for the remaining 12%, 28%, and 34% of deer use during the 2008–2009, 2009–2010, and 2010–2011 monitoring seasons, respectively. Most underpass activity occurred during spring (37%;  $n = 18,194$ ) and autumn (46%;  $n = 22,569$ ) migrations, but deer crossings (17%;  $n = 8,383$ ) also occurred on a regular basis throughout the winter period (Table 1).

Deer use varied between underpasses, with most use occurring at KP49 and KP58 (Fig. 3). Additionally, the amount of deer use varied between spring and autumn migrations at several of the underpasses (Fig. 3). For example, the proportion of deer use was higher at underpass KP49 during the

**Table 1.** Number of mule deer that moved through underpasses during the autumn migration (Oct–Dec), the winter period (Jan–Feb), and the spring migration (Mar–May), December 2008 through May 2011, Nugget Canyon, Wyoming, USA.

Underpass	2008–2009	2009–2010	2010–2011	Total
Autumn migration				
KP49	1,552	3,308	5,553	10,413
KP56	83	274	855	1,212
KP58	638	885	4,242	5,765
KP60	149	1,062	1,529	2,740
KP61	18	151	298	467
KP63	3	199	943	1,145
KP65	47	374	406	827
Sub-total	2,490	6,253	13,826	22,569
Winter period				
KP49	2,112	1,228	1,527	4,867
KP56	69	40	1,782	1,891
KP58	233	104	379	716
KP60	56	110	371	537
KP61	16	22	55	93
KP63	5	48	104	157
KP65	37	75	10	122
Sub-total	2,528	1,627	4,228	8,383
Spring migration				
KP49	3,496	2,298	1,850	7,644
KP56	258	136	900	1,294
KP58	2,957	1,786	1,613	6,356
KP60	96	557	423	1,076
KP61	95	179	68	342
KP63	400	314	287	1,001
KP65	163	253	65	481
Sub-total	7,465	5,523	5,206	18,194
Total	12,483	13,403	23,260	49,146

autumn compared with the spring, whereas deer use at underpass KP58 was higher during the spring compared with autumn. With the exception of KP49 and KP58, the proportion of deer use generally increased throughout the study period (Fig. 3).

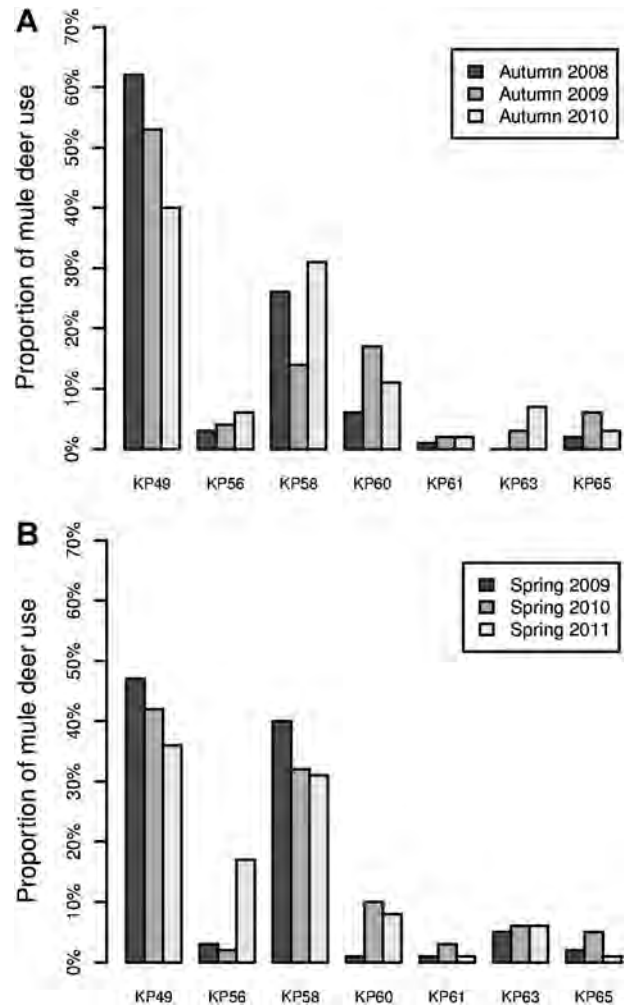
The timing of peak movements during the autumn migrations occurred in mid-December, with a maximum of 284 animals/day (Fig. 4). Spring migrations were characterized by multiple peaks of deer movement that generally occurred in mid-March and early May, with a maximum of 223 animals/day (Fig. 4). On a daily basis, peak levels of underpass use occurred in the mornings (0600–0800 hours) and evenings (1800–2000 hours; Fig. 5). Morning use was more prominent during the spring, whereas evening use was more common in the autumn.

### Passage Rates

Passage rates averaged 54% among all 7 structures during the first year of study and increased to 72% during the second year and 92% in the third year (Fig. 6). The oldest underpass (KP49) had a relatively high success rate to begin with, presumably because it had been in place already for 7 years. Passage rates observed at the 6 new underpasses steadily increased through the 3-year study period, further suggesting that it may take mule deer up to 3 years to habituate to underpasses before using them without hesitation.

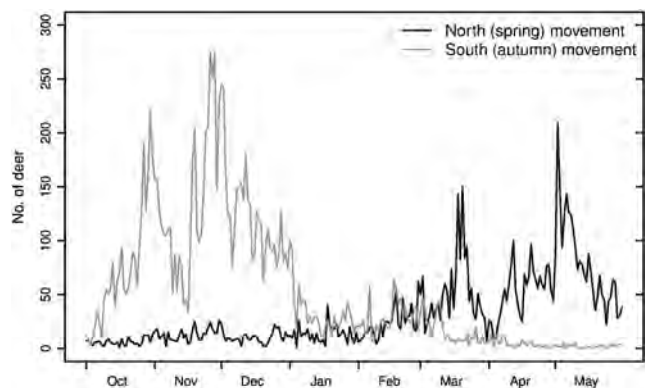
### Mule Deer–Vehicle Collisions

Prior to underpass construction, the average number of DVCs in the 21-km study area was 9.75/month.

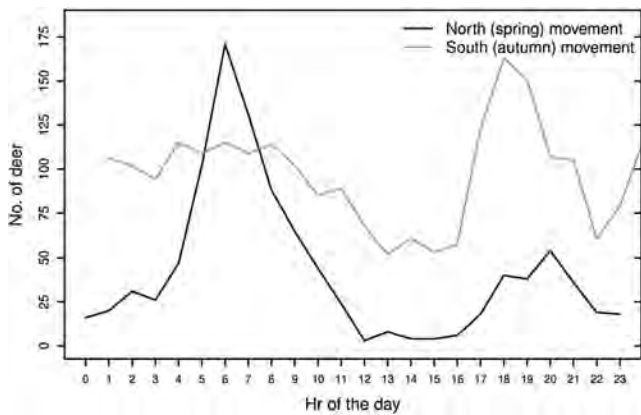


**Figure 3.** Proportional level of mule deer use at each underpass during spring and autumn migrations, December 2008 through May 2011, Nugget Canyon, Wyoming, USA.

Following construction of the first underpass in 2001, the average number of DVCs declined by 12% to 8.58/month. After construction of 6 additional underpasses and fencing in 2008, the average number of DVCs was further reduced to



**Figure 4.** Mean number of mule deer moving south to north (spring migration) and north to south (autumn migration) underneath U.S. Highway 30, Nugget Canyon, Wyoming, USA.



**Figure 5.** Number and time of day that mule deer moved through underpasses during the spring and autumn migrations, December 2008 through May 2011, Nugget Canyon, Wyoming, USA.

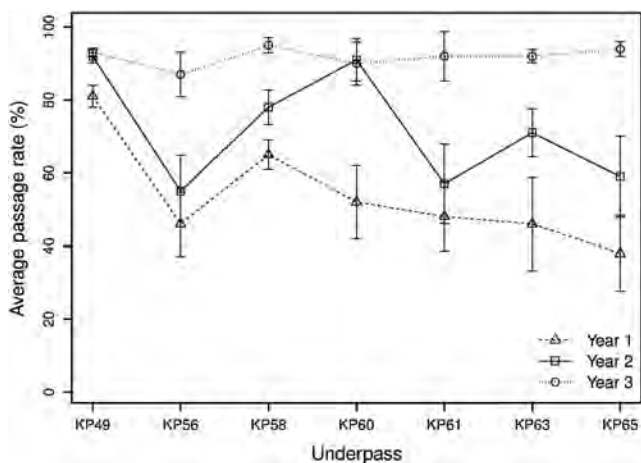
1.82/month. Overall, the construction of 7 underpasses and associated fencing reduced mule DVCs by 81%.

### Underpass Use by Other Wildlife

In addition to mule deer, we recorded 1,953 elk (*Cervus elaphus*), 201 pronghorn (*Antilocapra americana*), 13 coyotes (*Canis latrans*), 77 bobcats (*Lynx rufus*), 9 badgers (*Taxidea taxus*), 13 moose (*Alces alces*), 3 raccoon (*Procyon lotor*), and 1 cougar (*Puma concolor*) as they moved through the underpasses.

## DISCUSSION

Reducing DVCs is needed across wide regions of North America to improve highway safety and minimize deer mortality (Romin and Bissonette 1996, Putman 1997, Forman et al. 2003, Langbein et al. 2011). We found underpass and fence construction reduced DVCs by 81% in a 21-km stretch of U.S. Highway 30, where thousands of animals must cross the highway to complete their seasonal migrations. Previous studies have shown that game-proof fencing used in conjunction with underpasses can effectively move animals underneath roadways and reduce WVCs (Romin and



**Figure 6.** Average passage rates ( $\pm$ SE) of mule deer at each underpass during 3 years of study, December 2008 through May 2011, Nugget Canyon, Wyoming, USA.

Bissonette 1996, Clevenger et al. 2001, McCollister and Van Manen 2010). Our study broadens support of these findings and suggests that this mitigation approach can effectively move thousands of migrating mule deer underneath roadway segments that extend  $>20$  km. Importantly, DVCs did not increase in areas immediately adjacent to the fence ends, where deer were free to move across the highway at grade-level (Sawyer and LeBeau 2011). Rather than shift their migration routes and move around the fencing, deer moved underneath the highway, presumably through the underpass closest to their original migration route. We note that DVCs were not completely eliminated from the project area. Deer occasionally accessed the roadway through cattle guards filled with snow or gates left open by recreational users. Fortunately, both of these problems are correctable and if the fence infrastructure (i.e., cattle guards, gates) is managed properly, especially during the peak movement periods during spring and autumn migrations, then DVCs could be eliminated altogether.

As traffic volumes increase and roadways are widened, it also becomes more difficult to maintain habitat connectivity (Forman et al. 2003). Our study suggests that underpass and fence construction did not affect the permeability of U.S. Highway 30 to migratory mule deer. Rather, underpasses provided mule deer with a safe means to cross the 2-lane highway and maintain connectivity with their distant seasonal ranges. We documented 49,146 mule deer that moved underneath U.S. Highway 30 during a 3-year period and 83% of those animals were in the process of migrating. During peak migration periods,  $>200$  deer/day moved through the underpasses, with most use occurring in morning and evenings. Other studies suggest that underpass and fence construction may actually improve highway permeability because animals are less affected by traffic volume when moving underneath the roadway, compared with crossing at grade-level (Gagnon et al. 2007a, Dodd and Gagnon 2011).

Across the globe, migratory ungulates tend to outnumber their nonmigratory counterparts (Fryxell et al. 1988). Mule deer are no exception (e.g., Garrott et al. 1987, Brown 1992) and typically migrate 15–150 km between their seasonal ranges (Sawyer et al. 2005, Sawyer and Kauffman 2011). Sustaining these herds will require that mule deer safely cross roadways that overlap with established migration routes. Given the strong fidelity that mule deer show to their migration routes (Thomas and Irby 1990, Sawyer et al. 2009), maintaining routes across roadways with high traffic volume will likely require some form of crossing structure (e.g., underpass or overpass). In general, structures with high openness ratios are considered more appealing to wildlife (Foster and Humphrey 1995, Clevenger and Waltho 2000, Gordon and Anderson 2003). Yet, regardless of the openness ratio of a structure, some habituation period for animal use should be expected. For example, Gagnon et al. (2011) recently showed that elk may take up to 4 years to habituate to open-span bridge underpasses. Similarly, we found mean passage rates of mule deer through concrete-box underpasses steadily increased from 54% in Year 1 to 92% in Year 3, suggesting that mule deer habituation may also take several



years. Passage rates are likely influenced by a variety of factors including structure design, traffic levels, and species of animal (Clevenger and Waltho 2000; Gagnon et al. 2007*a, b*). Nonetheless, having some knowledge of the expected habituation period will help refine expectations and public perceptions of mitigation projects, especially in high-profile areas where animal movements are visible from the roadway.

Of the 7 underpasses we monitored, most deer use occurred at KP49 and KP58. Given that each underpass was the same size, it is of interest why those two were used more than others. Certainly, factors such as vegetation, human activity, and topography may influence the effectiveness of underpasses (Clevenger and Waltho 2000, 2005; Ng et al. 2004). Although we did not conduct any formal analysis to evaluate how these factors differ between the 7 underpasses, we suspect that the location of the underpasses relative to established migration routes was the most likely explanation for the differential use. In other words, because underpasses KP49 and KP58 were situated in close proximity to existing migration routes, they received the highest levels of deer use. Although we do not have telemetry data to document where established migration routes occurred before construction, we do know that road segments with the highest levels of DVCs closely corresponded with the locations of KP49 and KP58 (Sawyer and LeBeau 2011), which suggests that higher numbers of deer historically crossed the highway in these areas. It has long been recognized that wildlife-crossing structures should be situated along existing movement corridors or migration routes to increase the effectiveness of the structure (Singer and Doherty 1985, Bissonette and Adair 2008). New methods to identify migration routes and prioritize sites for crossing structures are quickly emerging (e.g., Sawyer et al. 2009, Lewis et al. 2011) and will improve the ability of transportation planners to ensure underpasses are located within existing movement corridors. Collecting migratory data prior to designing a mitigation project can improve the effectiveness of underpasses by ensuring they are sited correctly, and potentially reduce costs by determining the minimum number of underpasses needed. For example, Bissonette and Adair (2008) recommend underpasses be spaced every 1.6 km in areas with high DVCs. The average spacing in Nugget Canyon was 2.7 km, and it is possible that our mitigation project would have been equally successful with even fewer underpasses, provided we had spatially explicit migration data to refine planning and determine the number and location of underpasses.

The benefits of reduced DVCs and migratory connectivity across U.S. Highway 30 were not limited to mule deer. We documented a variety of other ungulates, carnivores, and small mammals that moved through the underpasses. Of particular interest was use by pronghorn, moose, and elk. Use of concrete-box underpasses by all 3 species is considered relatively rare (Forman et al. 2003), but our results suggest these types of underpasses may benefit them as well as mule deer.

Given the ability of underpasses in Nugget Canyon to reduce DVCs and maintain permeability to thousands of animals across U.S. Highway 30, it may be of interest to

consider the economic and logistical challenges for a construction project of this type. The 6 new underpasses and 10 km of fencing constructed in 2008 cost approximately US\$ 4.1 million, with \$2.8 million used for underpasses and \$1.3 million for fencing. Four million dollars is a sizable amount, but when we consider that each DVC has an estimated cost of US\$ 8,388 (Huijser et al. 2008) and the underpasses effectively eliminate 95 DVCs/year, the savings per year is \$796,860. Thus, the 4.1 million could be realized in approximately 5 years. Of additional concern are construction time and traffic delays. Construction of the 6 underpasses in 2008 began in May and was completed in September, outside of the migratory time period. Two underpasses were constructed at a time, such that traffic lights could be placed at each end and a pilot car directed traffic through a 1-lane dirt detour on the side of the road. Each set of 2 underpasses took approximately 50 days to complete. In short, it is possible to complete underpass projects such as Nugget Canyon in one construction season with minimal traffic delays.

## MANAGEMENT IMPLICATIONS

Ideally, mitigation measures aimed at reducing WVCs should also maintain habitat connectivity by encouraging animals to travel underneath or over the roadway via crossing structures. Installation of underpasses and continuous fencing can effectively reduce DVCs and maintain habitat connectivity for migratory mule deer populations that number in the thousands. However, careful maintenance of fence infrastructure (e.g., gates and cattle guards) is needed to ensure that animals stay off the roadway, especially during periods of peak animal movements. Similar to elk (Gagnon et al. 2011), mule deer may take up to 3 years to habituate to underpasses and move through them with no hesitation. For migratory ungulates, underpasses should be located as close to existing migration routes as possible. Collection of migratory data prior to project design can help ensure that the correct number of underpasses is constructed and that they are placed in the best location. Although some ungulates are believed to prefer overpasses (Forman et al. 2003), our results suggest that underpasses may be a viable option for moving a variety of ungulates, including mule deer, elk, moose, and pronghorn, underneath 2-lane highways.

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## REVIEW SUMMARY

## CLIMATE CHANGE

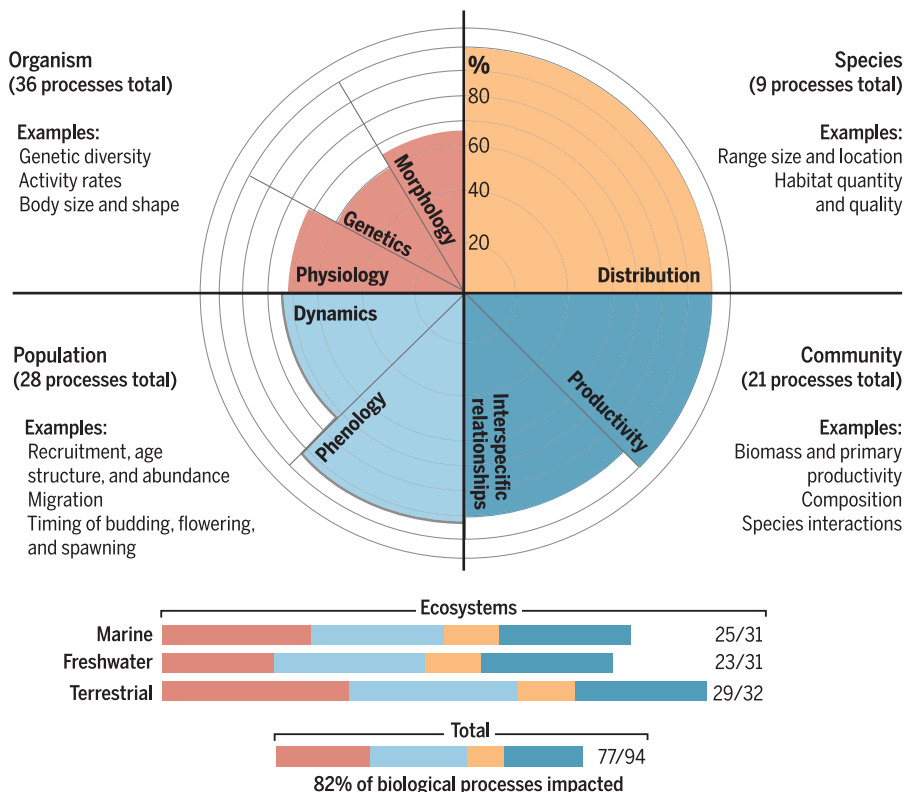
# The broad footprint of climate change from genes to biomes to people

Brett R. Scheffers,\* Luc De Meester, Tom C. L. Bridge, Ary A. Hoffmann, John M. Pandolfi, Richard T. Corlett, Stuart H. M. Butchart, Paul Pearce-Kelly, Kit M. Kovacs, David Dudgeon, Michela Pacifici, Carlo Rondinini, Wendy B. Foden, Tara G. Martin, Camilo Mora, David Bickford, James E. M. Watson

**BACKGROUND:** Climate change impacts have now been documented across every ecosystem on Earth, despite an average warming of only ~1°C so far. Here, we describe the full range and scale of climate change effects on global biodiversity that have been observed in natural systems. To do this, we identify a set of core ecological processes (32 in terrestrial and 31 each in marine and freshwater ecosystems) that underpin ecosystem functioning and support services to people. Of the 94 processes

considered, 82% show evidence of impact from climate change in the peer-reviewed literature. Examples of observed impacts from meta-analyses and case studies go beyond well-established shifts in species ranges and changes to phenology and population dynamics to include disruptions that scale from the gene to the ecosystem.

**ADVANCES:** Species are undergoing evolutionary adaptation to temperature extremes,



**Climate change impacts on ecological processes in marine, freshwater, and terrestrial ecosystems.** Impacts can be measured on multiple processes at different levels of biological organization within ecosystems. In total, 82% of 94 ecological processes show evidence of being affected by climate change. Within levels of organization, the percentage of processes impacted varies from 60% for genetics to 100% for species distribution.

and climate change has substantial impacts on species physiology that include changes in tolerances to high temperatures, shifts in sex ratios in species with temperature-dependent sex determination, and increased metabolic costs of living in a warmer world. These physiological adjustments have observable impacts on morphology, with many species in both aquatic and terrestrial systems shrinking in body size because large surface-to-volume ratios are generally favored under warmer conditions. Other morphological changes include reductions in melanism to improve thermoregulation, and altered wing and bill length in birds.

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Broader-scale responses to climate change include changes in the phenology, abundance, and distribution of species. Temperate plants are budding and flowering earlier in spring and later in autumn. Comparable adjustments have been observed in marine and freshwater fish spawning events and in the timing of seasonal migrations of animals worldwide. Changes in the abundance and age structure of populations have also been observed, with widespread evidence of range expansion in warm-adapted species and range contraction in cold-adapted species. As a by-product of species redistributions, novel community interactions have emerged. Tropical and boreal species are increasingly incorporated into temperate and polar communities, respectively, and when possible, lowland species are increasingly assimilating into mountain communities. Multiplicative impacts from gene to community levels scale up to produce ecological regime shifts, in which one ecosystem state shifts to an alternative state.

**OUTLOOK:** The many observed impacts of climate change at different levels of biological organization point toward an increasingly unpredictable future for humans. Reduced genetic diversity in crops, inconsistent crop yields, decreased productivity in fisheries from reduced body size, and decreased fruit yields from fewer winter chill events threaten food security. Changes in the distribution of disease vectors alongside the emergence of novel pathogens and pests are a direct threat to human health as well as to crops, timber, and livestock resources. Humanity depends on intact, functioning ecosystems for a range of goods and services. Enhanced understanding of the observed impacts of climate change on core ecological processes is an essential first step to adapting to them and mitigating their influence on biodiversity and ecosystem service provision. ■

The list of author affiliations is available in the full article online.  
\*Corresponding author. Email: [brett.scheffers@ufl.edu](mailto:brett.scheffers@ufl.edu)  
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## REVIEW

## CLIMATE CHANGE

# The broad footprint of climate change from genes to biomes to people

Brett R. Scheffers,<sup>1\*</sup> Luc De Meester,<sup>2</sup> Tom C. L. Bridge,<sup>3,4</sup> Ary A. Hoffmann,<sup>5</sup> John M. Pandolfi,<sup>6</sup> Richard T. Corlett,<sup>7</sup> Stuart H. M. Butchart,<sup>8,9</sup> Paul Pearce-Kelly,<sup>10</sup> Kit M. Kovacs,<sup>11</sup> David Dudgeon,<sup>12</sup> Michela Pacifici,<sup>13</sup> Carlo Rondinini,<sup>13</sup> Wendy B. Foden,<sup>14</sup> Tara G. Martin,<sup>15</sup> Camilo Mora,<sup>16</sup> David Bickford,<sup>17</sup>† James E. M. Watson<sup>18,19</sup>

Most ecological processes now show responses to anthropogenic climate change. In terrestrial, freshwater, and marine ecosystems, species are changing genetically, physiologically, morphologically, and phenologically and are shifting their distributions, which affects food webs and results in new interactions. Disruptions scale from the gene to the ecosystem and have documented consequences for people, including unpredictable fisheries and crop yields, loss of genetic diversity in wild crop varieties, and increasing impacts of pests and diseases. In addition to the more easily observed changes, such as shifts in flowering phenology, we argue that many hidden dynamics, such as genetic changes, are also taking place. Understanding shifts in ecological processes can guide human adaptation strategies. In addition to reducing greenhouse gases, climate action and policy must therefore focus equally on strategies that safeguard biodiversity and ecosystems.

Atmospheric concentrations of greenhouse gases from burning fossil fuels and deforestation are approaching levels that have not been detected in the past 20 million years (1). This has altered the chemical composition of the Earth's atmosphere, oceans, and fresh waters (2). As a result, temperatures

in the upper ocean and on land are now ~1°C higher than in preindustrial times, and temperature, wind, and precipitation regimes have become more variable and extreme (3, 4). These changes are having clear impacts on planetary biophysical processes, including desalinization and acidification of the world's oceans (5) and melting of permafrost, ice sheets, and glaciers (6, 7). Lakes and rivers have increased in temperature, altering seasonal patterns of mixing and flows (8).

Changing climate regimes have been an important driver of natural selection in the past (9) and, as in the past, species are responding to the current human-induced climate event in various ways. Previous reviews have covered many of the more obvious changes in species ranges, phenologies, and population dynamics (10–15) but have usually focused on one ecological system at a time. Here, we discuss the full range and scale of climate change effects on biota, including some of the less obvious disruptions observed in natural systems. We present examples of case studies of observed impacts across terrestrial and aquatic biomes and find evidence that climate change is now affecting most biological and ecological processes on Earth—spanning genetics, organismal physiology and life-history, population distributions and dynamics, community structure, and ecosystem functioning (Fig. 1 and table S1). People depend on intact, functioning ecosystems for a range of goods and services, including those associated with climate adaptation (16). Understanding the observed impacts of current climate change on core ecological processes is therefore an essential first step in humans planning and adapting to changing ecosystem conditions.

Although inherently different, marine, freshwater, and terrestrial realms share a common hierarchy of levels of biological organization, ranging from genes to organisms, populations, species, communities, and ecosystems. Broadly adapting from Bellard *et al.* (17), we screened the literature (supplementary materials) to evaluate evidence that climate change is affecting ecological components across different levels of biological organization, each of which comprises a core set of ecological processes (Fig. 1, fig. S1, and table S1). We identify a set of core ecological processes on Earth (32 in terrestrial and 31 each in marine and freshwater), which together facilitate ecosystem functioning that supports services to people (17). These processes include changes in genetic diversity (genetics), metabolic rates (physiology), body size (morphology), timing of migration (phenology), recruitment (population dynamics), range size (distribution), loss of synchronization (interspecific relationships), and biomass (productivity) (17). Because our main goal is to assess what processes are affected by climate change, we define “impact” on each process as an observed change in that process linked to climate change. We do not differentiate between “positive” (adaptive, buffering, or mitigating) and “negative” (stress or damage) responses because responses may be positive at one level of biological organization (such as genetic adaptation to climate change) but negative at another (such as reduced genetic variation and capacity to deal with other stressors). We then consider the relevance of the affected ecological processes in human systems and illustrate observed impacts to ecosystem services such as food and resource security (fisheries, agriculture, forestry, and livestock production), human health, and hazard reduction.

## Ecological impacts of climate change

### Organisms Genetics

There is now growing evidence that species are undergoing evolutionary adaptation to human-induced climate change. For example, between the 1960s and 2000s the water flea (*Daphnia magna*) evolved to cope with higher thermal extremes in the UK (18), and cornflower (*Centaurea cyanus*) life history traits have recently evolved in response to warmer springs across northern France (19). Other examples include the evolution of earlier migration timing in anadromous pink salmon (*Oncorhynchus gorbuscha*), with decreased frequency of incidence of a genetic marker that encodes for late migration (20). Time-series data that control for physiological acclimatization also show strong evidence for genetic responses to climate change. For example, Bradshaw and Holzapfel showed that genotypic values for the critical day length that induces diapause in the pitcher plant mosquito (*Wyeomyia smithii*) change with latitude, and that the latitudinal relationship has changed over the period from 1972 to 1996 (21). Onset of diapause now occurs later, which is consistent with a longer

<sup>1</sup>Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611-0430, USA. <sup>2</sup>Laboratory of Aquatic Ecology, Evolution and Conservation, KU Leuven, Ch. De Beriotstraat 32, 3000 Leuven, Belgium. <sup>3</sup>Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Townsville QLD 4811, Australia.

<sup>4</sup>Queensland Museum, Townsville, Queensland 4810, Australia.

<sup>5</sup>Bio21 Institute, School of Biosciences, University of Melbourne, Victoria 3010, Australia. <sup>6</sup>School of Biological Sciences and the Australian Research Council Centre of Excellence for Coral Reef Studies, The University of Queensland, Brisbane, Queensland 4072, Australia. <sup>7</sup>Center for Integrative Conservation, Xishuangbanna Tropical Botanical Gardens, Chinese Academy of Sciences, Yunnan 666303, China. <sup>8</sup>BirdLife International, David Attenborough Building, Pembroke Street, Cambridge CB2 3QZ, UK. <sup>9</sup>Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK. <sup>10</sup>Zoological Society of London, Regent's Park, London NW1 4RY, UK. <sup>11</sup>Norwegian Polar Institute, FRAM Centre, 9296 Tromsø, Norway. <sup>12</sup>School of Biological Sciences, University of Hong Kong, Hong Kong SAR, China. <sup>13</sup>Global Mammal Assessment Program, Department of Biology and Biotechnologies, Sapienza Università di Roma, Viale dell'Università 32, I-00185 Rome, Italy. <sup>14</sup>Department of Botany and Zoology, University of Stellenbosch, P/Bag XI, Matieland, 7602 Stellenbosch, South Africa. <sup>15</sup>Department of Forest and Conservation Sciences, University of British Columbia, Vancouver, British Columbia, Canada. <sup>16</sup>Department of Geography, University of Hawaii, Honolulu, Hawaii, USA.

<sup>17</sup>Department of Biological Sciences, National University of Singapore, 14 Science Drive 4, 117543, Singapore. <sup>18</sup>School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, Queensland 4072, Australia.

<sup>19</sup>Global Conservation Program, Wildlife Conservation Society, 2300 Southern Boulevard, Bronx, NY 10460, USA.

<sup>20</sup>Department of Biology, University of Florida, Gainesville, FL 32611-0430, USA.

<sup>21</sup>Department of Biology, University of Florida, Gainesville, FL 32611-0430, USA.

\*Corresponding author. Email: brett.scheffers@ufl.edu

†Present address: Rimba, 4 Jalan 1/9D, 43650 Bandar Baru Bangi, Selangor, Malaysia.

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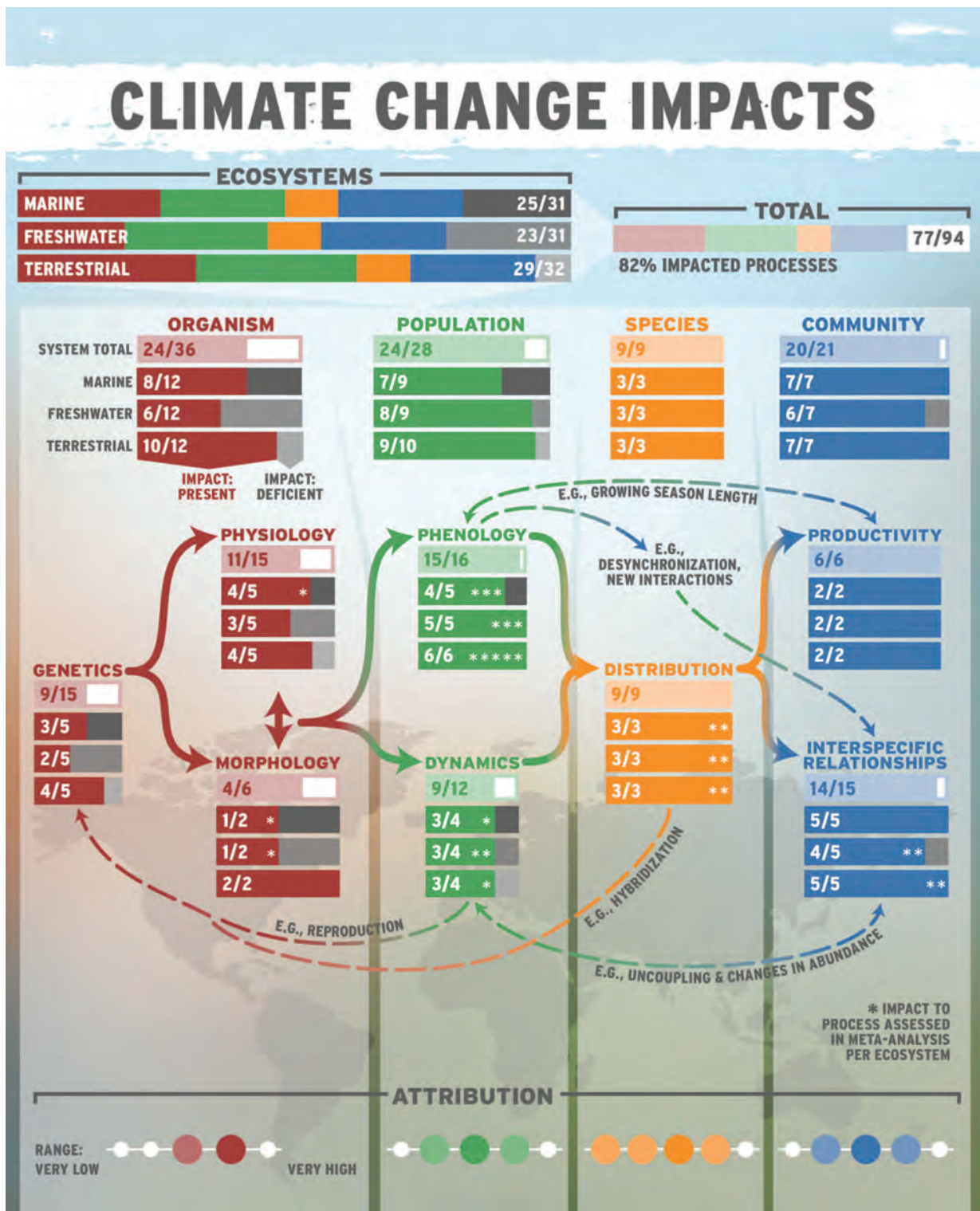
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**Fig. 1. Climate change impacts on Earth's marine, terrestrial, and freshwater systems.** The presence of observed impacts on the different levels of biological organization and its inner components across the Earth's marine, terrestrial, and freshwater ecosystems. The denominator represents the total number of processes that we considered for each group, and the numerator is the number of these processes with evidence of impact (a complete list of processes is provided in fig. S1 and table S1). In total, 82% of all ( $n = 94$ ) ecological processes that were considered have observed evidence of impact by climate change.

Each process has at least one supporting case study. The asterisk indicates whether the affected process was assessed in a meta-analysis in addition to case studies. Thus, double-asterisk indicates that two processes were assessed in at least one meta-analysis. Confidence that the observed impact can be attributed to climate change was assigned for each level of organization and ranges from very low, low, medium, high, to very high; this assessment is based on tables 18-7, 18-8, and 18-11 in (13). The darkest circle indicates confidence level with the most literature support.

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growing season under warmer conditions. Oceanic phytoplankton have adapted to a temperature change of +0.73°C associated with 15 years of climate warming in the Gulf of Cariaco, Venezuela, by adjusting their thermal niche by +0.45°C (22). Although such evidence from small organisms with short generation times is accumulating, we found little documented evidence of evolutionary change from species with longer generation times such as birds, mammals, and trees (14, 23), although adaptation appears to be possible in some long-lived reef corals (24).

Changes in species ranges have altered or created new “hybridization zones” across the planet. For example, in North America, hybrid zones between black-capped (*Poecile atricapillus*) and Carolina chickadees (*P. carolinensis*) are shifting in response to warmer winter temperatures (25), and because the southern flying squirrel (*Glaucomys volans*) has expanded its range northward in eastern North America, it is now hybridizing with the northern flying squirrel (*G. sabrinus*) (26). In North American rivers and streams, hybridization between invasive rainbow trout (*Oncorhynchus mykiss*) and native cutthroat trout (*O. clarkia*) has increased in frequency as the former expand into warming waters (27). Such hybridization events have also been observed in some marine fishes, such as the coastal West Coast dusky cob (*Argyrosomus coronus*), and are expected to increase as species shift their ranges poleward in response to rapidly warming ocean conditions (28).

### Physiology

Many species display temperature-driven trait plasticity in physiological processes such as thermal optima (29). Whereas some responses, such as acclimation to high temperatures, maximize fitness, others can reflect failure to cope with temperature stress and other climate-mediated changes. These responses can occur within a generation or between generations through maternal or epigenetic effects (30).

There is some observational evidence that warming has affected temperature-dependent sex determination (TSD) of species in marine and terrestrial systems. Snake pipefish (*Entelurus aequoreus*) in the northeastern Atlantic have altered their operational sex ratios and reproductive rates as a consequence of warmer sea surface temperatures (31). Most evidence for impacts on TSD in marine systems, however, is derived from experimental studies, which provide strong support for TSD changes in sea turtles and various fish species (32, 33). In terrestrial and freshwater systems, TSD has been implicated in masculinization and feminization, respectively, of lizard and turtle populations (34, 35).

In marine systems, physiological responses to both climate warming and changing ocean conditions are widespread (36, 37). Matching field and laboratory data for the eelpout (*Zoarces viviparus*) show increased metabolic costs associated with warming in the North and Baltic Seas (38). In aquatic systems, warming increases oxy-

gen demand but decreases oxygen content of the water, resulting in substantial metabolic costs (39). Although climate change per se does not cause acidification of the oceans, both arise directly from higher atmospheric carbon dioxide, and experimental evidence has raised concerns regarding negative effects of ocean acidification on calcification, growth, development, and survival of calcifying organisms (12). For example, acidification has led to extensive shell dissolution in populations of the pteropod *Limacina helicina* in northwest North America and in the Southern Ocean off Antarctica (40, 41).

### Morphology

Individuals in some species are becoming smaller with increasing warming because large surface-to-volume ratios are generally favored under warmer conditions (42)—a phenomenon that is linked to standard metabolic principles (43). In the Appalachian Mountains, six species of *Plethodon* woodland salamander have undergone, on average, an 8% reduction in body size over the past 50 years (44). Similarly, three species of passerine birds from the northeast United States show an average 4% decrease in wing length correlated with recent warming (45), and the long-distance migrant bird the red knot (*Calidris canutus*) is now producing smaller offspring with smaller bills, which reduces survival in juveniles because of altered foraging success on underground bivalves (46). In general, decreasing body size with warming is expected, but evidence from cold, high-altitude habitats suggests that increased primary productivity and longer growing seasons from warming have led to increased body size in some mammal species such as American marten (*Martes americana*) and yellow-bellied marmot (*Marmota flaviventris*) (47, 48). In South Australia, leaf width in soapberry (*Dodonaea viscosa*) has decreased compared with the ancestral condition documented under cooler temperatures 127 years ago (49). Other climate change impacts on morphology include color changes in butterflies, dragonflies, and birds (50–53) and pronounced changes in skull shape in the alpine chipmunk (*Tamias alpinus*) (54).

### Population

#### Phenology

For most species, migrations and life-history processes (such as budding and flowering in plants, hatching and fledging in birds, and hibernation in mammals) are closely tied to seasonal and interannual variation in climate, and there is now overwhelming evidence that both have been affected by climate change (10, 37, 55, 56). Across marine, freshwater, and terrestrial ecosystems, spring phenologies have advanced by 2.3 to 5.1 days per decade (10, 57). A combination of climate warming and higher atmospheric CO<sub>2</sub> concentrations has extended the growing period of many plant populations (58). In a large global analysis, which included 21 phenological metrics such as leaf-off and leaf-on dates and growing-season length, plant phenologies were found to have shifted by more than 2 standard deviations

across 54% of Earth’s land area during the past three decades (59).

In marine and freshwater systems, advances in the timing of annual phytoplankton blooms—the basis for many aquatic food webs—have occurred more rapidly than temporal shifts in terrestrial plants (37, 60). Such changes in plankton phenology have been attributed to increases in water temperatures, reduction in the duration of ice cover, and the alteration of the seasonal duration of thermal stability or stratification of the water column.

Shifts in spawning times have been documented for 43 fish species in the northeast Pacific Ocean from 1951 to 2008, with earlier spawning associated with increased sea surface temperature and later spawning associated with delays in seasonal upwelling of nutrients toward the ocean surface (61). Similar impacts on breeding have been observed in terrestrial and marine bird species (62).

Changes in the timing of migration events have been extensively documented, including advances in spring arrival dates of long-distance migratory bird species in Europe, North America, and Australia (63–65). Similarly, long-term data on many amphibians and mammals have shown advancements in spring and delays in autumn migration (66–68) and altered peak calling periods of male amphibians (67–69). In the largest meta-analysis to date of phenological drivers and trends among species in the southern hemisphere, 82% of terrestrial data sets and 42% of marine data sets demonstrated an advance in phenology associated with rising temperature (70).

#### Abundance and population dynamics

Acute temperature stress can have severe negative effects on population dynamics such as abundance, recruitment, age structure, and sex ratios. Meta-analyses across thousands of species report that ~80% of communities across terrestrial, freshwater, and marine ecosystems exhibited a response in abundance that was in accordance with climate change predictions (10, 70). In a meta-analysis of marine species, 52% of warm-adapted species increased in abundance, whereas 52% of cold-adapted species decreased (71). Temperature spikes may cause mass mortality of key ecosystem engineers in both temperate and tropical oceans. Excessive heat kills canopy-forming macroalgae in temperate marine systems (72) and causes bleaching and mass mortality of corals in the tropics (73). Reductions in sea ice extent have caused declines in abundances of ice-affiliated species in the Arctic [for example, ivory gulls (*Pagophila eburnea*), ringed seals (*Pusa hispida*), and polar bears (*Ursus maritimus*) (74)] whereas in some cases, such as on Beaufort Island in the southern Ross Sea, the loss of ice from receding glaciers resulted in increased abundances of Adélie penguins (*Pygoscelis adeliae*) (75). In the United States, the bull trout (*Salvelinus confluentus*) has lost >10% of its spawning grounds in central Idaho over the past 13 years because of increased water temperatures (76), while the brown trout (*Salmo*



*trutta*) has lost habitat in the Swiss Alps (77). In western Canada, reduced survival of adult migrating Fraser River sockeye salmon (*Oncorhynchus nerka*) has been observed with increased water temperatures (78), and in eastern Canadian lakes, golden-brown algae dramatically increased in abundance as water temperature increased 1.5°C during the latter part of the 20th century (79). Some of the best evidence for climate-change impacts on the abundance of terrestrial species comes from analyses of bird population trends derived from systematic monitoring schemes in Europe, with warm-adapted species having increased in abundance on average since the 1980s and cold-adapted species having declined (80).

Climate change can increase the abundance of temperature-sensitive disease vectors, with subsequent effects on disease outbreaks. In the African Serengeti, there is some evidence that a combination of extreme weather, high abundances of ticks carrying *Babesia*-piroplasm, and suppressed immunity to canine distemper virus led to widespread mortality of lions (*Panthera leo*) (81). In marine systems, field evidence shows that corals are increasingly susceptible to white band disease at higher temperatures, leading to declines in two of the most important reef-building acroporid (branching) corals in the western Atlantic (82).

### Species Distribution

One of the most rapid responses observed for marine, freshwater, and terrestrial species is a shift in their distributions to track optimal habitat conditions (71, 83, 84). Across land and aquatic ecosystems, species have expanded their leading (cold limit) edge by 19.7 km per decade, with marine species expanding by 72 km per decade compared with 6 km per decade in terrestrial species (37). The distributions of many marine taxa have shifted at higher velocities than those of terrestrial taxa (37) because areas with rapid changes in climate extend across broader regions of the ocean than on land, and connectivity in marine environments tends to be high (85). To illustrate this point, corals around Japan have shifted their range by up to 14 km per year over the past 80 years (86), and in waters off the southeast coast of Australia, intertidal invertebrate species have shifted their geographic distributions polewards at an average rate of 29 km per decade (87). Where connectivity allows for dispersal, some freshwater fishes are capable of shifting at rates comparable with those of marine and terrestrial taxa (88), but mean shifts by river fishes in some regions have been insufficient to compensate for measured temperature rises (89).

There has been a consistent overall trend for tropical, warm-adapted species to expand their ranges into environments previously dominated by temperate cold-tolerant species (“tropicalization”) (90). A similar phenomenon has been documented in the Arctic, where boreal fish communities have responded to warming in the Barents Sea by shifting northward, resulting in a

high turnover in Arctic fish communities (“borealization”) (91). Similarly, on land, increased minimum temperatures have driven rapid changes in the range size (as well as distribution) of Swedish birds, with northern species retracting and southern species expanding northward (92).

In addition to latitudinal changes, many observed shifts in species distributions have occurred across elevation gradients. In the mountains of New Guinea, birds have shifted their distributions upslope by 95 to 152 m from 1965 to 2013 (93). A similar upslope shift was observed in recent decades in mountainous stream-dwelling fish in France (89), North American plants (94), and Bornean insects (95). An analogous response has been the shift to deeper, colder waters among some marine fishes (91).

In some cases, species have shown no response or even downhill shifts in their distributions (96) or increased frequency of range disjunction rather than poleward or upward range shifts (97). Savage and Vellend (98) found upward range shifts in North American plant species and an overall trend toward biotic homogenization from 1970 to 2010, but their study also documents considerable time lags between warming and plant responses (99, 100). Delayed community responses to increasing temperature may be in part due to the buffering effects of microhabitats (101, 102) and possibly moisture, which is a critical, but less often studied, driver in the redistribution of species (103). For example, Crimmins *et al.* observed downhill movements for North American plants under climate change over an 80-year period, which they attribute to changes in water balance rather than temperature (104).

### Community Interspecific relationships

As a by-product of the redistribution of species in response to changing climate, existing interactions among species are being disrupted, and new interactions are emerging (105, 106). These novel biotic interactions can exacerbate the impacts of abiotic climate change (107, 108). Woody plants are invading arctic and alpine herb-dominated communities in response to rapid warming in recent decades, leading to secondary shifts in distribution of other plants and animals (92). In the Sierra Nevada Mountains of California, Tingley and Beissinger found high levels of avian community turnover during the past 100 years at the lowest and highest elevations (109), and in Greece, Sgardeli *et al.* found similar patterns of temperature-driven turnover in butterfly communities (110). There are surprisingly few studies of observed impacts of climate change on competitive interactions (108). In one example from Sweden, Wittwer *et al.* found that among four bird species occupying the same ecological guild, resident birds were able to adapt to warmer temperatures and out-compete the sole long-distance migrant, *Ficedula hypoleuca* (111).

New interactions among species can also lead to trophic disruptions such as overgrazing. In western Australia, for example, overgrazing of

subtropical reefs by the poleward spread of tropical browsing fish has suppressed recovery of seaweeds after temperature-induced mortality (112). These types of trophic disruptions are escalating, with range shifts by tropical herbivorous fishes increasing herbivory rates in subtropical and temperate coastal ecosystems where seaweeds are the dominant habitat-forming taxa (90).

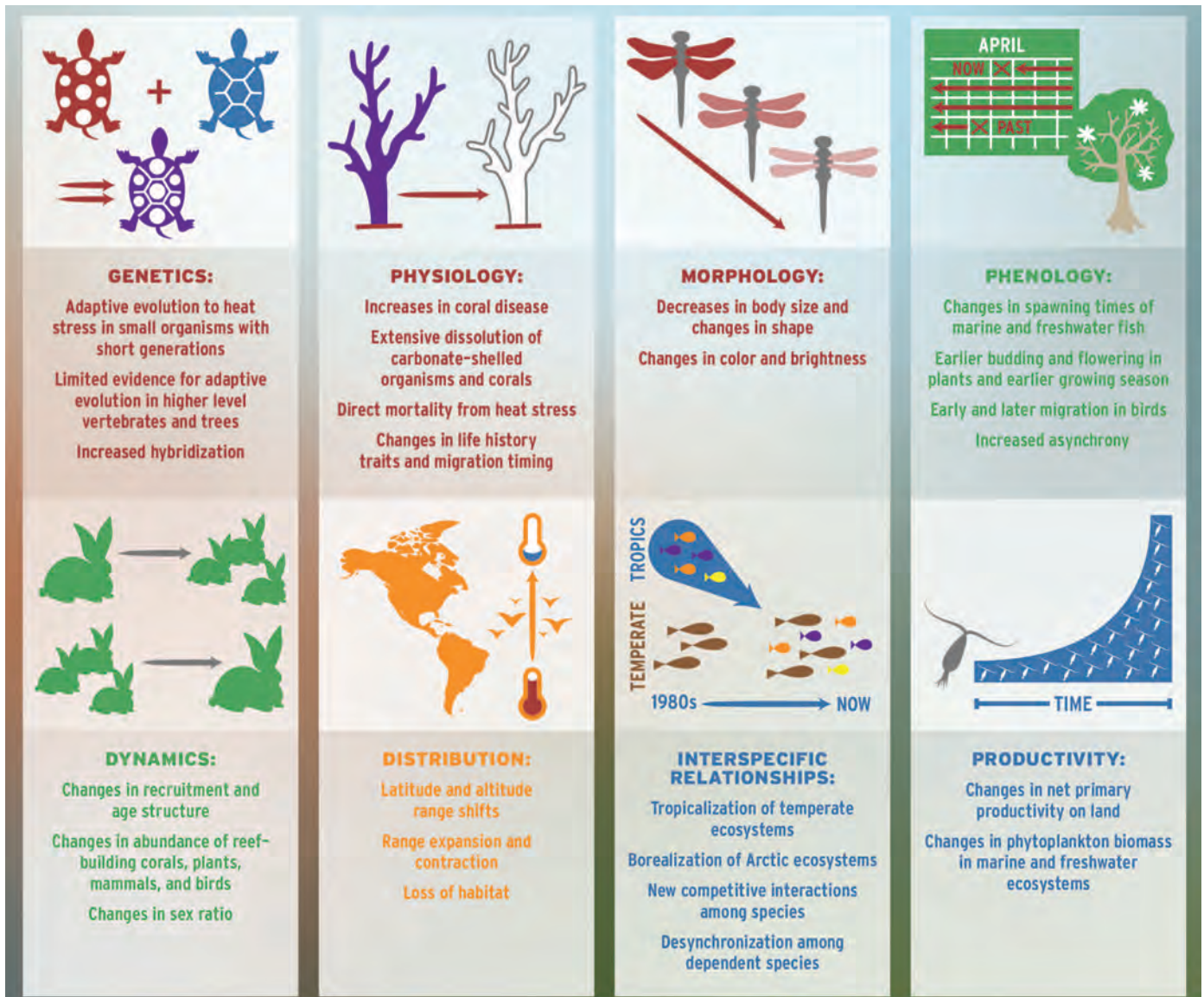
Phenological mismatches have been observed between butterflies and their annual host plants, with the plants dying before the insect larvae were ready to enter diapause (113). Similarly, an analysis of 27 years of predator-prey data from the UK showed asynchronous shifts between the tawny owl (*Strix aluco*) and its principle prey, the field vole (*Microtus agrestis*), which led to reduced owl fledging success (114). In Lake Washington, United States, spring diatom blooms advanced by over 20 days since 1962, resulting in predator-prey mismatches with their main grazer, the water flea (*Daphnia pulex*), and population declines in the latter (60). In Canadian Arctic lakes, asynchronous shifts in diatom blooms resulted in generalist water fleas being replaced by more specialist species (115). At higher trophic levels, warming has affected the fry and the juvenile life-history stages of lake char (*Salvelinus umbla*) via direct impacts on their zooplankton and vendace (*Coregonus alba*) food sources (116).

### Productivity

Changes in productivity are one of the most critical impacts of climate change across aquatic and terrestrial ecosystems (117, 118). In marine systems, climate-mediated changes in chlorophyll-*a* concentrations as a proxy of phytoplankton biomass have been highly variable (119). Depending on location, these include both dramatic increases and decreases in abundance as well as changes in phenology and distribution of phytoplankton over the past several decades. In a global study of phytoplankton since 1899, an ~1% decline in global median phytoplankton per year was strongly correlated with increases in sea surface temperature (120), whereas in the Antarctic Peninsula, phytoplankton increased by 66% in southern subregions and decreased by 12% in northern subregions over a 30-year period. These conflicting observations in the Antarctic are in part linked to changes in sea surface temperature but also changes in ice cover, cloudiness, and windiness, which effect water-column mixing (121).

In deep tropical freshwater lakes dominated by internal nutrient loading through regular mixing, warmer surface waters confer greater thermal stability, with reduced mixing and return of nutrients to the photic zone, substantially decreasing primary productivity (122), phytoplankton growth (123), and fish abundance (122). In contrast, eutrophication effects are exacerbated by higher temperatures in shallow lakes, resulting in increased productivity and phytoplankton and toxic cyanobacteria blooms (124).





**Fig. 2. Climate impacts on ecological processes.** Examples of ecological components and processes affected by climate changes across marine, freshwater, and terrestrial ecosystems (fig. S1 and table S1).

Globally, terrestrial plant growth has increased with increasing temperatures and CO<sub>2</sub> levels. This may in part explain the on average 6% increase in net primary productivity (NPP) from 1982 to 1999 (125), although these changes in NPP may also be related to natural variation in El Niño–La Niña cycles (126). However, responses are highly variable, and some terrestrial systems are not experiencing increased productivity owing to either extreme temperatures or lack of water. Severe short-term droughts in climatically stable rainforest environments are unusual but in recent years have increased in frequency. These events have led to changes in forest canopy structure in Amazonia (127) and decreases in above-ground woody and leaf biomass in the Congo basin (128). Across large expanses of the Amazon, there has been an overall reduction in above-

ground biomass owing to increased climate variability over the past three decades (129).

#### Impacts across ecosystems

All three biotic realms (terrestrial, freshwater, and marine) are being affected by climate change, and the evidence summarized here reveals that these impacts span the biological hierarchy from genes to communities. Of the 94 processes considered, we found that 82% have evidence of impact by climate change, and this has occurred with just 1°C of average warming globally (Fig. 1). Impacts range from genetic and physiological changes to responses in population abundance and distribution (Fig. 2).

The fact that evidence is missing for some processes is more likely to reflect data deficiencies than the absence of any response to climate

change. We only considered field-based case studies that report changes in the processes through time. For many components, such as genetics (23) and physiology (29), there is strong evidence from experiments on a wide range of species that individuals and populations can and likely will respond to climate change. Thus, even though we found compelling evidence of widespread responses across the biological hierarchy, we still consider our discussion of impacted processes to be conservative. To illustrate this point, Box 1 shows the range of observed responses in the water flea *Daphnia*, which spans the entire hierarchy of biological organization.

#### Ecosystem state shifts

As ecological systems continue to accumulate stress through compromised ecological processes



**Box 1. A complete hierarchy of climate change impact in one model system: the water flea *Daphnia*.**

Combining time-series data with experimental approaches can lend insights to the breadth of climate change impacts. For water fleas of the genus *Daphnia*, for instance, there is evidence for responses to temperature at all levels of biological organization. *Daphnia* are important grazers in lakes and ponds (180). They adapt to temperature increase through genetic changes in thermal tolerance (18), body size, and life history traits (181, 182). In the laboratory, *Daphnia* exhibit phenotypic plasticity in physiology to changing temperatures [for example, hemoglobin quality and quantity (183) or metabolic activity (184)], behavior [such as swimming activity (184)], life history traits (185), and body size (182). *Daphnia* adjust their phenology (186) and abundance (187) in response to increases in temperature, which results in mismatches with phytoplankton dynamics (60). Warmer, drier weather over two decades can lead to expanded distributions and increased colonization capacity (188). Temperature influences interactions of *Daphnia* with predators (189) and parasites (190), and adaptation to increased temperature influences competitive strength (185). In the absence of fish, high abundances of *Daphnia* in +4°C heated mesocosms exert strong top-down control on phytoplankton (191).

either directly from climate change or interactively with other forced disturbances (discussion is provided in the supplementary materials), diminished resilience may lead to ecological regime shifts—in which one ecosystem state shifts to an alternative and potentially undesirable stable state. For example, some reefs are transitioning from coral- to algal-dominated states as a consequence of mass coral mortality (130),

whereas kelp forests are turning into rocky barrens in temperate seas (90, 131, 132). In lakes, climate change has increased the risk of regime shifts from clear-water to turbid states and increased the occurrence of cyanobacteria blooms (124). If sufficient community-based processes are affected at regional scales, wholesale biome shifts can occur such as has been observed in Alaska, where tundra is transitioning to boreal conditions (133). These are clear signs of large-scale ecosystem change and disruption, in which disequilibrium rapidly pushes the system into a new state (134).

**Using ecology to better understand climate change impacts on human well-being**

*Threats to production*

The impacts of climate change on marine fisheries have major consequences for human societies because these currently provide ~17% of the global protein for people (135). There is, however, no current consensus on the costs and benefits of the ongoing global redistribution of fisheries because trends are highly variable. In the Arctic, commercially important fish, such as Atlantic cod (*Gadus morhua*) and walleye pollock (*Theragra chalcogramma*), have increased in biomass primarily because of increases in plankton production from reduced sea ice (136, 137), whereas changes in fish biomass in the Southern Ocean are less clear (138). In Switzerland, which has experienced twice the average global temperature increase, trout catches have been halved over two decades because of rising temperatures in Alpine streams (77).

Changes in total marine productivity are not just attributed to abundance shifts but also morphological shifts. Indeed, some fish species appear to be shrinking, but attributing this solely to ocean warming is difficult because size-dependent responses can be triggered by commercial fishing as well as long-term climate change (139). However, long-term trend analyses show convincingly that eight commercial fish species in the North Sea underwent simultaneous reductions in body size over a 40-year period because of ocean warming, resulting in 23% lower yields (140). Reduced body size in fish is also being recorded in lakes and rivers throughout Europe and has been linked to increased temperature and climate-induced shifts in nutrient inputs (141, 142).

Impacts on plant genetics and physiology are influencing human agricultural systems. For example, yields in rice, maize, and coffee have declined in response to the combined effects of rising temperatures and increasing precipitation variability over past decades (143–145). Genetics is being used to counteract decreasing yields in some key crops such as wheat [for which, globally, yields have declined by 6% since the early 1980s (146)] through crossing domesticated crops with wild relatives to maintain the evolutionary potential of varieties (147). Yet, some important wild strains are also showing signs of impact from climate change. Nevo *et al.* documented high levels of genetic changes in the

progenitors of cultivated wheat and barley in Israel over the past 28 years (148). These wild cereals exhibited landscape-level changes in flowering time and a loss of genetic diversity in response to increasing temperatures.

Losing genetic resources in nature may undermine future development of novel crop varieties (149) and compromise key strategies that humans use to adapt to climate change. One such strategy is to use assisted gene flow, the managed movement of individuals or gametes between populations to mitigate local maladaptation in the short and long term (150). Where genetic introgression—the movement of genetic material from one species into the genome of another—can occur from unexploited natural populations to managed or exploited populations that are poorly adapted to warmer or drier conditions, adaptive changes may be facilitated (147), as in white spruce (*Picea glauca*), a tree commonly harvested for timber (151). Human-assisted evolution may also be a key strategy in maintaining reef-dependent fisheries by accelerating and enhancing the stress tolerance of corals (152).

Phenological changes due to milder winters are influencing crop and fruit production (153). Climate change has reduced winter chill events in temperate agricultural areas (154), which can desynchronize male and female flowers and trigger delayed pollination, delayed foliation, and reduced fruit yield and quality. To counter this, tree crop industries have developed adaptation measures such as low-chill cultivars with dormancy-breaking chemicals. For example, the “UFBest” peach requires four times fewer chill days than cultivars from more temperate climates (155). Advances in the timing of budding, flowering, and fruiting of plant species has induced earlier harvesting periods in some countries [such as Japan (156)].

Pollination is a key process linked to yields for a large number of crops. The short-lived, highly mobile insect species that provide pollination services to numerous crops have responded rapidly to changing climates by shifting their ranges throughout North America and Europe (157). Additionally, over the past 120 years, many plant-pollinator networks have been lost with overall decline in pollination services, which is attributed to a combination of habitat loss, pollution, and climate warming (158). Yet, observed changes in the phenology, abundance, and distribution of common pollinators have not been directly linked to declines in yields of animal-pollinated crops. This is likely due to limited data that directly link pollination services to crop yield over time and may, in part, reflect resilience provided by the diversity of insect species that pollinate many crops (159, 160). More specialized pollination systems are expected to be more vulnerable to climate change. Humans have adapted to the declines in native pollinators by transporting domesticated pollinators to crop locations.

*Pest and disease threats*

Climate-induced ecosystem-level changes, such as forest die-offs, have an obvious impact on



**Table 1. Climate change consequences for humans.** Affected ecological processes have direct consequences in food systems and human health.

	Organism	Population	Species	Community
	Genetics, physiology, morphology	Phenology, dynamics	Distribution	Interspecific relationships, productivity
<b>Resource security</b>	Rapid genetic adaptation to climate change in timber species	Increased herbivory on crops and timber by pests	Overall distribution shifts in marine and freshwater fisheries	Decline in plant-pollinator networks and pollination services
	Decreased crop yields in hot climates and increases in cool climates	Decreased genetic diversity and altered flowering time in wild cereals and novel crop varieties	Reduced range size or changes in pollinator abundance	Novel pests and invasive species
	Increased weed-crop competition and parasite-livestock interactions	Reduced fruit yields from fewer winter chill events		
	Decreased yield in fisheries from reduced body size	Reduced productivity in commercial fisheries		
<b>Human health</b>	Decline in reef calcifiers threatens coastal communities; loss of protection from storm surges and loss of food/protein sources	Increased costs and risk to subsistence communities from loss of sea ice and permafrost	Expanding and/or new distributions of disease vectors	Increased human-wildlife conflicts
	Rapid adaptation of disease vectors to new climatic conditions		Redistribution of arable land	Novel disease vectors

people, with a reduction in timber supplies and carbon sequestration, and changes in water quality and watershed volume (161–163). Several native insect species from North America, with no prior records of severe infestation, have recently emerged as severe pathogens of forest resources because of changes in population dynamics. These include the Aspen leaf miner (*Phyllocnistis populiella*), the leafblotch miner (*Micrurapteryx salicifoliella*), and the Janet's looper (*Nepytia janetae*), which have decimated millions of hectares of aspen, willows, and spruce-fir forests since the early 1990s (164). Known pests such as mountain and southern pine beetles (*Dendroctonus frontalis* and *D. ponderosae*, respectively) and spruce beetles (*D. rufipennis*) have recently expanded their distribution and infestation intensity on commercially important pine and spruce trees (161, 164). These outbreaks may increase in the future because hundreds of plant pest and pathogen species have shifted their distributions 2 to 3.5 km year<sup>-1</sup> poleward since the 1960s (165).

An emerging threat to human health under climate change is vector-borne disease (166). Vectors that have shifted their ranges and abundance can be found in marine, freshwater, and terrestrial systems. For example, in marine systems, unprecedented warming in the Baltic Sea led to emergence of *Vibrio* infections in Northern Europe (167, 168), a geographic locality that had limited prior occurrence of this water-borne bacterial pathogen. Mosquitoes (e.g., *Aedes japonicus*, *A. aegypti*, *A. albopictus*) are extending their distribution into areas that are much warmer than their original habitats. As a result of eco-

logical adaptation, mosquitoes have become more competent vectors for spreading diseases such as chikungunya, dengue, and possibly the emerging Zika virus (169). Last, in terrestrial systems Levi *et al.* found that the nymph stage of the Lyme disease-carrying blacklegged tick (*Ixodes scapularis*) exhibited an overall advancement in nymph and larvae phenology since 1994, shifting the timing of greatest risk for pathogen transfer to humans to earlier in the year (170).

#### Losing intact ecosystems and their function

Changes in ecological processes might compromise the functionality of ecosystems. This is an important consideration because healthy systems (both terrestrial and marine) sequester substantial amounts of carbon (171), regulate local climate regimes (172), and reduce risks associated with climate-related hazards such as floods, sea-level rise, and cyclones (173). In island and coastal communities, coral reefs can reduce wave energy by an average of 97% (174), and coastal ecosystems such as mangroves and tidal marshes buffer storms (175), while on land intact native forests are important in reducing the frequency and severity of floods (176). In many cases, maintaining functioning systems offers more sustainable, cost-effective, and ecologically sound alternatives than conventional engineering solutions (16).

#### Science and action in a warmer world

The United Nations Framework Convention on Climate Change (UNFCCC) and the recent COP21 agreement in Paris presently offer the best

opportunity for decisive action to reduce the current trajectory of climate change. This latter agreement set global warming targets of 1.5 to 2°C above preindustrial levels in order to avoid “dangerous climate change,” yet the current 1°C average increase has already had broad and worrying impacts on natural systems, with accumulating consequences for people (Table 1). Minimizing the impacts of climate change on core ecological processes must now be a key policy priority for all nations, given the adoption of the UN Sustainable Development Goals aiming to increase human well-being. This will require continued funding of basic science focused on understanding how ecological processes are interacting with climate change, and of programs aimed at supporting ecosystem-based adaptations that enhance natural defences against climate hazards for people and nature and ensure ongoing provision of natural goods and services (177).

We must also recognize the role that intact natural ecosystems, particularly large areas, play in overcoming the challenges that climate change presents, not only as important repositories for carbon but also because of their ability to buffer and regulate local climate regimes and help human populations adapt to climate change (16, 173). These systems are also critical for maintaining global biodiversity because the connectivity provided by large, contiguous areas spanning environmental gradients—such as altitude, depth, or salinity—will maximize the potential for gene flow and genetic adaptation while also allowing species to track shifting climate spatially (178).

The overriding priority of the UNFCCC is to set in motion a sustained global reduction in greenhouse gas emissions. This must be achieved alongside an improvement in our understanding of key ecological processes that form the foundation of biological and human systems, and in tandem with efforts to conserve the natural habitats in which such ecological processes operate.

It is now up to national governments to make good on the promises they made in Paris through regular tightening of emission targets, and also to recognize the importance of healthy ecosystems in times of unprecedented change (179). Time is running out for a globally synchronized response to climate change that integrates adequate protection of biodiversity and ecosystem services.

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#### SUPPLEMENTARY MATERIALS

[www.sciencemag.org/content/354/6313/aaf7671/suppl/DC1](http://www.sciencemag.org/content/354/6313/aaf7671/suppl/DC1)  
Supplementary Text  
Fig. S1  
Table S1  
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**The broad footprint of climate change from genes to biomes to people**

Brett R. Scheffers, Luc De Meester, Tom C. L. Bridge, Ary A. Hoffmann, John M. Pandolfi, Richard T. Corlett, Stuart H. M. Butchart, Paul Pearce-Kelly, Kit M. Kovacs, David Dudgeon, Michela Pacifici, Carlo Rondinini, Wendy B. Foden, Tara G. Martin, Camilo Mora, David Bickford and James E. M. Watson (November 10, 2016)

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Editor's Summary

**Accumulating impacts**

Anthropogenic climate change is now in full swing, our global average temperature already having increased by 1°C from preindustrial levels. Many studies have documented individual impacts of the changing climate that are particular to species or regions, but individual impacts are accumulating and being amplified more broadly. Scheffers *et al.* review the set of impacts that have been observed across genes, species, and ecosystems to reveal a world already undergoing substantial change. Understanding the causes, consequences, and potential mitigation of these changes will be essential as we move forward into a warming world.

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# Anticoagulant rodenticides in urban bobcats: exposure, risk factors and potential effects based on a 16-year study

L. E. K. Serieys · T. C. Armenta · J. G. Moriarty ·  
E. E. Boydston · L. M. Lyren · R. H. Poppenga ·  
K. R. Crooks · R. K. Wayne · S. P. D. Riley

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**Abstract** Anticoagulant rodenticides (ARs) are increasingly recognized as a threat to nontarget wildlife. High exposure to ARs has been documented globally in nontarget predatory species and linked to the high prevalence of an ectoparasitic disease, notoedric mange. In southern California, mange associated with AR exposure has been the proximate cause of a bobcat (*Lynx rufus*) population decline. We measured AR exposure in bobcats from two areas in southern California, examining seasonal, demographic and spatial risk factors across landscapes including natural and urbanized areas. The long-term study included

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L. E. K. Serieys (✉) · T. C. Armenta · R. K. Wayne  
Department of Ecology and Evolutionary Biology, University of  
California, Los Angeles, CA 90095, USA  
e-mail: laurelsSerieys@gmail.com

J. G. Moriarty · S. P. D. Riley  
Santa Monica Mountains National Recreation Area, National  
Park Service, Thousand Oaks, CA 91360, USA

E. E. Boydston  
U.S. Geological Survey, Western Ecological Research Center,  
Thousand Oaks, CA 91360, USA

L. M. Lyren  
U.S. Geological Survey, Western Ecological Research Center,  
Carlsbad, CA 92008, USA

R. H. Poppenga  
California Animal Health and Food Safety, University of  
California, Davis, CA 95616, USA

K. R. Crooks  
Department of Fish, Wildlife, and Conservation Biology,  
Colorado State University, Fort Collins, CO 80523, USA

bobcats sampled over a 16-year period (1997–2012) and a wide geographic area. We sampled blood ( $N = 206$ ) and liver ( $N = 172$ ) to examine exposure ante- and post-mortem. We detected high exposure prevalence (89 %, liver; 39 %, blood) and for individuals with paired liver and blood data ( $N = 64$ ), 92 % were exposed. Moreover, the animals with the most complete sampling were exposed most frequently to three or more compounds. Toxicant exposure was associated with commercial, residential, and agricultural development. Bobcats of both sexes and age classes were found to be at high risk of exposure, and we documented fetal transfer of multiple ARs. We found a strong association between certain levels of exposure (ppm), and between multiple AR exposure events, and notoedric mange. AR exposure was prevalent throughout both regions sampled and throughout the 16-year time period in the long-term study. ARs pose a substantial threat to bobcats, and likely other mammalian and avian predators, living at the urban-wildland interface.

**Keywords** Bobcats · Secondary poisoning · Anticoagulant rodenticides · Notoedric mange · Urbanization · Residential · Fetal transfer

## Introduction

Anticoagulant rodenticides (ARs) are toxicants increasingly recognized as a threat to nontarget wildlife (Erickson and Urban 2004; US EPA 2008; Elmeros et al. 2011; Gabriel et al. 2012; California Department of Pesticide Regulation 2013). As vitamin K antagonists, ARs interrupt the production of vitamin K-dependent blood clotting proteins, leading to the depletion of these proteins over a period of days inducing mortality by hemorrhage (Erickson

and Urban 2004). Comprised of two classes of compounds, ARs are the primary chemical method used worldwide for the control of rats and mice (Stone et al. 1999; Eason et al. 2002). First-generation ARs, including warfarin, diphacinone, and chlorophacinone, are more readily metabolized, have a shorter half-life in hepatic tissue (2 weeks to several months) (Eason et al. 2002), and must be consumed in multiple feedings to reach a lethal dose (Erickson and Urban 2004). Second-generation ARs include brodifacoum, bromadiolone, and difethialone, and were developed to target rodents with genetic resistance to warfarin (Hadler and Buckle 1992). Second-generation ARs have prolonged action and increased potency (Petterino and Paolo 2001), with hepatic half-lives ranging 6–12 months, and may persist in liver tissue for more than a year in some species (Eason et al. 2002). Both classes of compounds have delayed onset of action, and death from AR consumption can occur up to 10 days after ingestion (Cox and Smith 1992). Individual rodents may continue to accumulate the compounds over a period of days, increasing their attractiveness to predators as they become weakened by the toxicant, and are easier to capture (Cox and Smith 1992; Berny et al. 1997; Berny 2007). For predators that consume prey targeted with ARs, both acute and chronic secondary exposure to the toxicants can occur (Erickson and Urban 2004; Riley et al. 2007; Elmeros et al. 2011; Gabriel et al. 2012).

Exposure of nontarget wildlife to ARs has been documented for numerous predatory mammal and bird species (McDonald et al. 1998; Stone et al. 1999; Riley et al. 2003, 2007; McMillin et al. 2008; Walker et al. 2008; Elmeros et al. 2011). Detection rates for ARs can exceed 80–90 % in wildlife and are directly responsible for mortalities in many species including coyotes (*Canis latrans*, Riley et al. 2003), San Joaquin kit foxes (*Vulpes macrotis mutica*, McMillin et al. 2008), California fishers (*Martes pennanti*, Gabriel et al. 2012), mountain lions (*Puma concolor*; Riley et al. 2007), red kites (*Milvus milvus*, Berny and Gaillet 2008), barn owls (*Tyto alba*), barred owls (*Strix varia*) and great horned owls (*Bubo virginianus*) (Stone et al. 2003; Albert et al. 2009). Factors that lead to secondary exposure of nontarget species are complex (Eason et al. 2002; Shore et al. 2006) because exposure is related to the persistence of compounds, levels of usage, how and where the compounds are applied, and trophic ecology (Eason et al. 2002; Shore 2003; Erickson and Urban 2004; Shore et al. 2006). The accurate assessment of AR exposure in wildlife is difficult because studies often rely on post-mortem sampling of liver tissue from carcasses found opportunistically. This may lead to a bias towards detection of those compounds with the longest persistence in hepatic tissue and at lethal dosages, and an underestimation of the number of animals that are exposed to ARs.

In southern California, more than a decade of research by U.S. National Park Service biologists in and around Santa Monica Mountains National Recreation Area (SMMNRA), a national park bordering Los Angeles, has documented widespread AR exposure in multiple carnivore species. AR exposure was the second leading cause of mortality during a 9-year coyote study in which 83 % of individuals tested were exposed (Riley et al. 2003; Gehrt and Riley 2010). Approximately 90 % of mountain lions and bobcats (*Lynx rufus*) in the study area were also exposed (Riley et al. 2007; Beier et al. 2010). Using telemetry data on bobcats and mountain lions, AR toxicant load, or the concentration of AR residues detected, was positively associated with use of developed areas (Riley et al. 2007, 2010; Beier et al. 2010) suggesting that developed areas are a major source of AR contamination.

Although high rates of exposure were documented for bobcats in SMMNRA, death as a result of AR exposure was reported only once (Riley et al. 2010). However, secondary AR exposure at  $\geq 0.05$  ppm was significantly associated with death due to severe notoedric mange (*Notoedres cati*), an ectoparasitic disease (Riley et al. 2007). Further, a precipitous population decline and genetic bottleneck in bobcats occurred as a result of the mange outbreak from 2002 to 2006 (Riley et al. 2007; Serieys et al. 2014). Notoedric mange was previously reported only in isolated cases in free-ranging felids (Pence et al. 1982; Maehr et al. 1995; Pence et al. 1995), however, the disease may be increasing in bobcats across California (Serieys et al. 2013; Stephenson et al. 2013). To date, all bobcats with mange that have been tested were positive for ARs ( $N = 19$ , Riley et al. 2007;  $N = 11$ , Serieys et al. 2013). These correlative findings suggest that chronic, sublethal exposure to ARs may influence immune function in bobcats, increasing their susceptibility to mange infestation and decreasing anti-mite immune response (Riley et al. 2007; Serieys et al. 2013).

We investigated risk factors for exposure to ARs in bobcats from two areas in southern California: in the SMMNRA area northwest of Los Angeles, and in Orange County to the southeast. We used blood and liver to detect exposure to ARs across varied landscapes that included fragmented urban and protected natural areas. Liver samples were collected postmortem to evaluate exposure history of individuals. Blood samples were collected primarily during animal capture to evaluate recent exposure. We used multiple measures of AR exposure including prevalence of exposure to any AR, prevalence of exposure to specific ARs, the number of different compounds detected, and compound residue concentrations (toxicant load). We evaluated AR exposure from 1997 to 2012 as part of the long-term study at SMMNRA, and from 2006 to 2010 in Orange County. We assessed risk factors for exposure



including sex, age, season, and landscape characteristics, specifically proximity to residential, commercial, and other developed areas. Using a much larger number of samples collected over a longer period of time and from a greater geographic area than a previous study (Riley et al. 2007), we examined the potential association between ARs and notoedric mange by evaluating the association between mange and a range of residue concentrations and the number of compounds detected.

## Methods

### Study area and sample collection

Sampling primarily occurred in two areas (Fig. 1). In Los Angeles and Ventura Counties, samples were collected by NPS and University of California, Los Angeles (UCLA) biologists from 1997 to 2012 during an ongoing NPS bobcat ecology study in SMMNRA (Riley et al. 2003, 2006, 2007, 2010; Serieys et al. 2013; Serieys et al. 2014). The eastern boundary of SMMNRA is less than 10 km from downtown Los Angeles and the park encompasses both large regions of continuous protected habitat with minimal urban development, including state and national park lands, and highly fragmented areas with intense urban development. In the Orange County study area (OCSA), bobcats were sampled from 2006 to 2010 by the U.S. Geological Survey (USGS) across a network of public nature reserves within landscapes experiencing rapid urbanization and near the more protected Santa Ana Mountains (Lyren et al. 2006, 2008; Poessel et al. 2014). The Santa Ana Mountains straddle Riverside, Orange, and San Diego Counties but most of the samples (93 %) were collected in Orange County. Anthropogenic development across both study areas includes residential, commercial, and agricultural development, as well as many “altered open” areas such as golf courses and landscaped parks (Table 1). Samples were also opportunistically collected in two additional areas north and south of our study areas in San Barbara ( $N = 3$ ) and San Diego Counties ( $N = 8$ ) when animals died in wildlife rehabilitation facilities or were reported dead by residents.

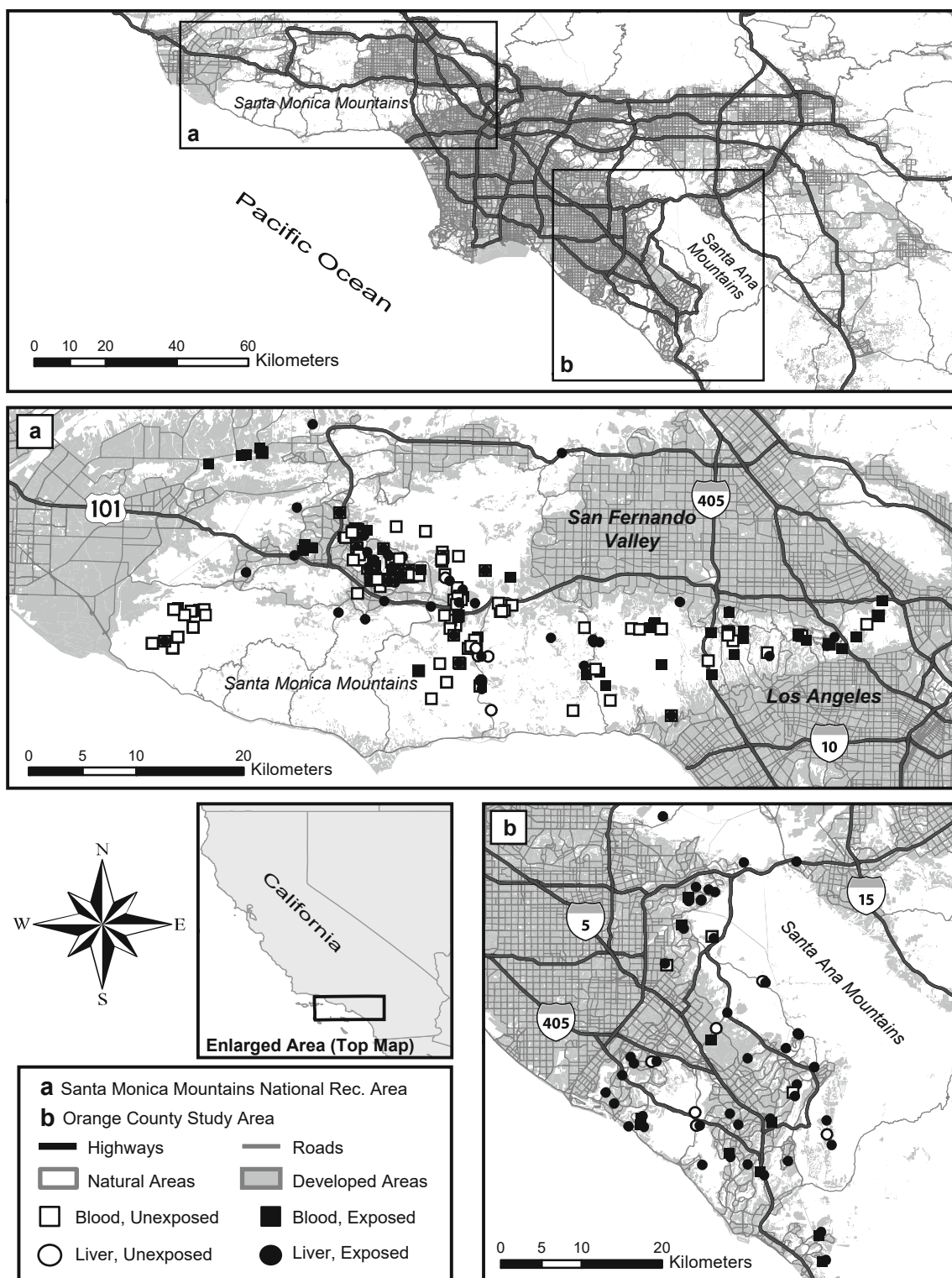
Bobcats were captured and handled as previously described (Riley et al. 2003, 2006, 2007; Serieys et al. 2013) with approval by the Office of Animal Research Oversight of UCLA (Protocol ARC#2007-167-12) and by the Colorado State University Animal Care and Use Committee (Protocol #11-2453A). Scientific collecting permits were authorized by the California Department of Fish and Wildlife (SC-9791). From 2000 to 2009, the majority of trapping efforts occurred from mid-October to mid-February, and thus collected during the non-breeding, wet

season (November 1–April 30). Individuals were chemically immobilized with a mixture of ketamine HCl (10 mg/kg) and xylazine HCl (1 mg/kg) or ketamine HCl (5 mg/kg) and medetomidine HCl (0.1 mg/kg). We recorded age class, sex, weight, and morphological measurements (i.e., chest circumference, body length, tail length, ear length, head circumference, etc.). Individuals were classified as juveniles (<2 years) or adults (>2 years) based on body size, weight, tooth wear and eruption, and reproductive status (Riley et al. 2003, 2006). A subset of individuals were also radio-collared as part of the NPS and USGS studies (Riley et al. 2003, 2006, 2007; Poessel et al. 2014). To obtain serum samples, blood was centrifuged within 24 h of collection and serum was collected. All samples, including liver (see below), were transported from the site of collection to storage facilities on ice packs.

In both study areas, we obtained liver samples during necropsies from opportunistically found carcasses (e.g. road-kill) or from animals that died in rehabilitation centers (Table 2). In SMMNRA, when possible liver samples were also collected from radio-collared animals that died. For 20 individuals, blood and liver were simultaneously obtained postmortem (Table 2). The cause of mortality, collection date, sex, age class, and location found were recorded. All animals were visually inspected for clinical signs of notoedric mange that included severe dermatitis, alopecia, and lichenification of the skin. If clinical mange was observed, skin scrapings in the affected areas were performed to identify mite species as previously described (Riley et al. 2007; Serieys et al. 2013; Stephenson et al. 2013). To measure specific age, an upper canine tooth was extracted during necropsy to determine age in years based on cementum annuli (Matson’s Laboratory LLC, Missoula, MT) (Crowe 1972). Capture and mortality locations were recorded using GPS devices. Blood, serum and liver were stored at  $-20$  or  $-80$  °C until tested. Anticoagulant rodenticide compounds are stable (Waddell et al. 2013) and so the length of time under refrigeration should not have affected the results.

### Anticoagulant assessment

We assessed the presence and amount of warfarin, coumachlor, bromadiolone, brodifacoum, diphacinone, chlorophacinone, and difethialone in 2 g of liver tissue, 1 g of serum, or 2 g of whole blood by high performance liquid chromatography (HPLC) and liquid chromatography-mass spectrometry (LC–MS/MS) (Riley et al. 2007; Ruder et al. 2011; Waddell et al. 2013). Samples were first screened for the presence of each AR by LC–MS/MS. Positive AR samples were then quantitated by HPLC using either UV diode array detection (diphacinone, chlorophacinone and difethialone) or fluorescence detection (warfarin, coumachlor, bromadiolone, and



**Fig. 1** Map of the study areas. **a** Santa Monica Mountains National Recreation Area (SMMNRA) and **b** Orange County Study Area (OCSA). Sampling locations and exposure results are shown. Blood

sampling locations are represented with *squares* while liver sampling locations are represented with *circles*

brodifacoum). Limits of quantitation for these anticoagulants in liver tissue were 0.01 ppm for brodifacoum, 0.05 ppm for bromadiolone, warfarin, and coumachlor, and 0.25 ppm for

chlorophacinone, diphacinone, and difethialone. Thirty-nine of 172 liver results were from Riley et al. (2007) (Table 2) and here we performed anticoagulant assessments using the same

**Table 1** Classification of predictor land use variables used for analysis of dependent AR exposure measures

Broad classification	Specific land use tested in models	Percent of study areas			Percent of buffer zones		
		SMMNRA	OCSA	Mean	SMMNRA	OCSA	Mean
Agriculture	Crops, pastures orchards and vineyards	3.39	3.00	3.20	2.18	1.62	2.07
	Horse ranches	0.53	0.23	0.38	0.53	0.58	0.54
	Other agriculture	0.50	0.89	0.70	1.33	1.56	1.38
	Total agriculture	4.42	4.12	4.27	4.04	3.76	3.99
Commercial and industrial	Schools and religious	1.04	1.61	1.33	0.57	2.15	0.88
	Office and retail	1.29	2.89	2.09	1.18	1.20	1.18
	Mixed commercial and industrial	1.61	5.20	3.41	1.85	3.64	2.20
	Water facilities	0.34	0.57	0.46	0.49	3.79	1.13
	Total commercial and industrial	4.28	10.27	7.28	4.09	10.78	5.39
Residential	Multifamily/commercial high-density (>25 units/ha)	1.38	4.55	2.97	2.14	4.00	2.50
	Single-family high-density (5–10 units/ha)	14.80	17.04	15.92	10.76	7.58	10.14
	Single-family low-density (<5 units/ha)	5.63	1.96	3.80	3.90	8.22	4.74
	Total residential	21.81	23.55	22.68	16.80	19.80	17.38
Altered open space	Golf courses and cemeteries	1.02	1.75	1.39	0.55	2.67	0.96
	Other recreational/altered open space	0.61	1.43	1.02	0.53	1.86	0.79
	Total altered open space	1.63	3.18	2.41	1.08	4.53	1.75
Natural	Undeveloped natural	66.82	58.82	62.82	54.08	23.32	48.01

The percentage of each land use within a single polygon drawn around all bobcat buffer zones for each study area and the mean across both study areas is shown. Additionally, the mean value of each land use type across bobcat buffer zones for each study area and across all composite bobcat buffer zones is shown. The sum of land-use variables for each study area do not equal 100 % because some land-use types (e.g. open water, roads, railroads), comprising a mean of 0.55 % of the study areas, were not included in analyses

approach. In blood, limits of quantitation were 1 ppb for each compound with method detection limits ranging from 0.28 to 0.45 ppb. ARs that were determined to be positive by LC–MS/MS, but were below the limit of quantitation by HPLC, were defined as above the limit of detection (LOD) or “above LOD.”

Finally, to make comparisons between AR exposure in bobcats, and the amount of toxicants applied where bobcats were sampled, we obtained data on reported use in Los Angeles, Orange, and Ventura Counties (measured in pounds) as posted in the California Department of Pesticide Regulation online database from 1997 to 2012 (<http://www.cdpr.ca.gov/docs/pur/purmain.htm>) for the four most commonly detected compounds. Records for Orange County were accessed only for the years for which we had samples from the study area (2006–2010). We averaged the pounds applied across the counties for each sample year (see Fig. 2c, Supplemental Fig. S1c).

#### Land use analysis

To evaluate the land use characteristics of surrounding landscape for all sampled bobcats, we created circular buffer zones with each capture or mortality location as the center. Each buffer zone was equal to the area of an

average home range (95 % minimum convex polygon) for animals that have been radio-tracked in each study area (males: 5.2 km<sup>2</sup> SMMNRA; 5.6 km<sup>2</sup> OCSA; females: 2.3 km<sup>2</sup>, SMMNRA; 3.2 km<sup>2</sup> OCSA) (Riley et al. 2010). Animals that were sampled in Santa Barbara and San Diego Counties were excluded from land use analysis because exact sampling locations were unavailable. We used the 2005 land use dataset provided by Southern California Association of Governments (SCAG, <http://gisdata.scag.ca.gov/Pages/Home.aspx>) with bobcat buffer zones in ArcGIS 10.1 (ESRI, Redlands, CA) to quantify land use types for each bobcat. Seventy-six land use types were included in bobcat buffer zones. These land use types were grouped into five general classes including: (1) agriculture; (2) commercial and industrial; (3) residential; (4) altered open areas such as landscaped parks, golf courses, and cemeteries; and (5) undeveloped natural areas (Table 1). We merged the 76 SCAG land use variables into 13 groups that were broadly characterized into five classes of land uses based on similarity and relevance to this study (Table 1, Supplemental Tables S1–S3). Using the five general classes of land use and the 13 specific variables, we used a total of 17 spatial predictor variables for analyses (Table 1). We quantified percent cover of each predictor variable in each buffer zone. To estimate percentage of

**Table 2** Sample size and information

Sample type	Sample information	Total number
All	Total number of blood and liver samples	378 (individuals, $N = 304$ )
	Paired blood and liver information	64 (Simultaneous collection postmortem, $N = 20$ ; blood collected at captures and liver collected postmortem, $N = 44$ )
Blood	Total number	206 (individuals, $N = 195$ ; recaptures, $N = 11$ )
	Type of blood collection event	Live captures, $N = 186$ ; postmortem, $N = 20$
	Total collected in SMMNRA	189 (LAC, $N = 88$ ; VC, $N = 101$ )
	Total collected in OCSA	16
Liver <sup>a</sup>	Total collected outside of SMMNRA and OCSA	1 (SDC)
	Liver samples	172 <sup>b</sup> (Independent samples used in analyses, $N = 169$ )
	Total collected in SMMNRA	105 (LAC, $N = 39$ ; VC, $N = 56$ , NA = 10)
	Total collected in OCSA	56 (OC, $N = 52$ ; RC, $N = 1$ ; SDC, $N = 3$ )
	Total collected outside of SMMNRA and OCSA	11 (SBC and SDC: Rehab centers, $N = 9$ ; Reported dead, $N = 2$ )
Spatial data	Available buffer zone data	Blood, $N = 196$ ; liver, $N = 121$
Mortalities <sup>b</sup>	Known mortality sources	172 (Mange, $N = 70$ ; Mange status unknown, $N = 16$ ; HBC, $N = 67$ ; Other, $N = 16$ ; NA = 17; Fetal, $N = 2$ ; Neonate, $N = 1$ )
Mange	Number of cases during each season	Dry season, $N = 43$ ; Wet season, $N = 26$

SMMNRA Santa Monica Mountains National Recreation Area, LAC Los Angeles County, VC Ventura County, OCSA Orange County Study Area, OC Orange County, SDC San Diego County, RC Riverside County, SBC Santa Barbara County

<sup>a</sup> Twenty-three percent of these samples were also used in the Riley et al. (2007) study

<sup>b</sup> Anticoagulant data from three individuals were not used in analyses (fetuses,  $N = 2$ ; neonate,  $N = 1$ )

each land use type within study areas, we created a single minimum convex polygon surrounding all buffer zones for each study area, and then calculated the percentage of each of the 17 land use variables within each study area's polygon (Table 1).

#### Data analysis

Descriptive statistics are presented as the mean, standard deviation, median, and range because all data were not normally distributed. Anticoagulant prevalence and 95 % confidence intervals for males, females, adults, and juveniles for wet (November 1–April 30) and dry (May 1–October 31) seasons were calculated separately for blood and liver samples. For prevalence calculations based on blood of recaptured animals, only the data from the most recent capture event was used. For spatial analyses using buffer zone data, we used only recaptures and post-mortem sampling that occurred a minimum of 4 months apart because ARs in blood are expected to decay by this time from an initial exposure (Eason et al. 2002; Erickson and Urban 2004; Vandenbroucke et al. 2008). Consequently, these successive samples of individuals are effectively independent measures of an exposure event, avoiding inflated values caused by multiple recaptures. For a subset of animals ( $N = 64$ ), we had both liver and blood results

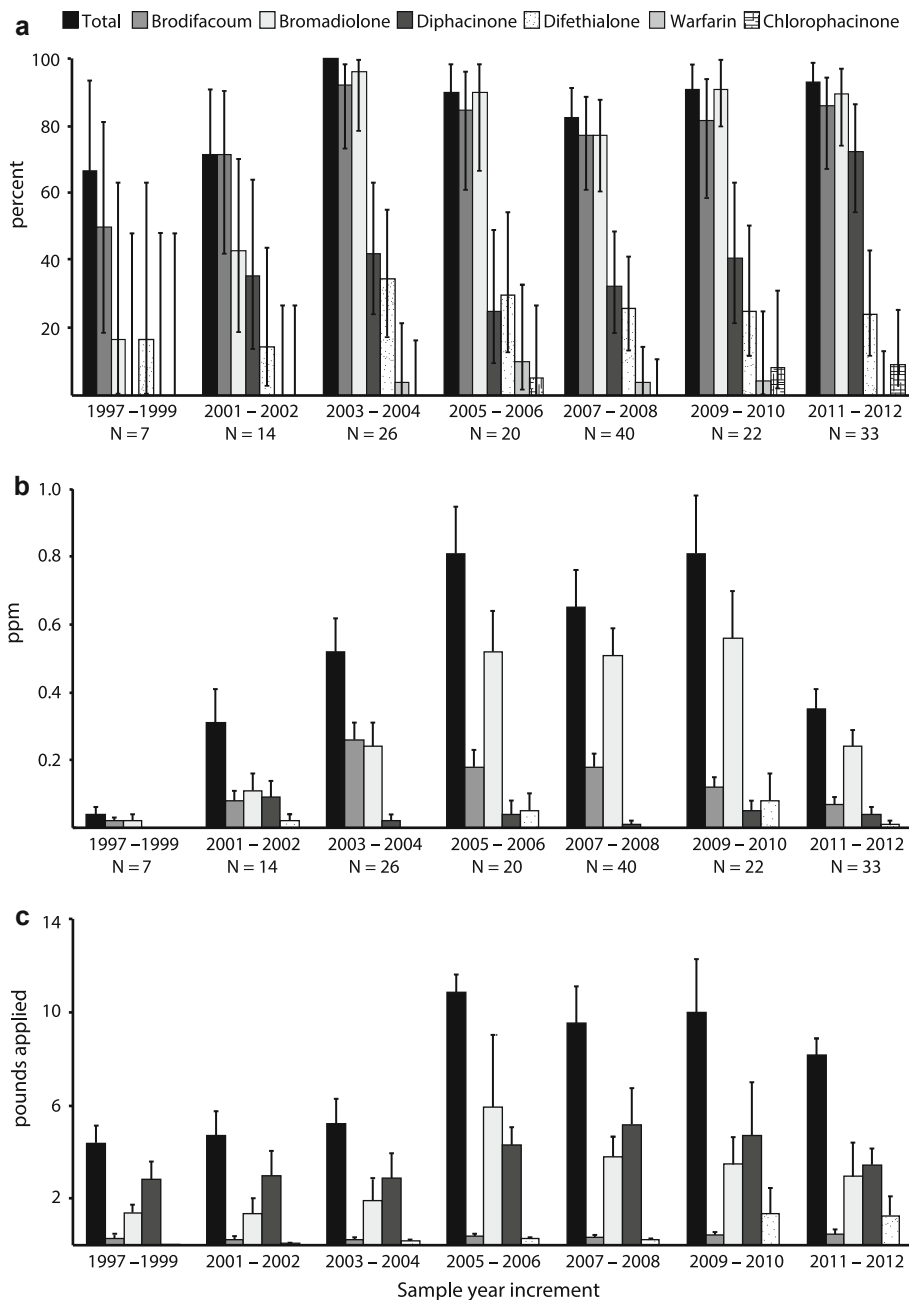
(Table 2). For this group, we combined the AR residue data for both tissue types to calculate the anticoagulant exposure overall, and 95 % confidence intervals as well as range, mean and median number of compounds detected per individual.

We used 11 different measures of AR exposure for liver samples, and one measure for blood samples (Supplemental Table S4). For liver samples, we evaluated total exposure as presence or absence of any compound as well as individual exposure to each of the four most commonly observed individual compounds (brodifacoum, bromadiolone, diphacinone, and difethialone). We also measured the amount of AR exposure as the total residue concentration in parts per million (ppm) of all compounds detected ("total residues"), as well as separately for each of the four most commonly detected individual compounds. Finally, we used the total number of compounds detected (0–7). Using blood results, we evaluated total exposure only because the majority of detections for ARs in blood were diphacinone, and the total concentration of ARs was quantifiable for less than 10 % of samples tested (24 % of positive samples).

We evaluated risk factors for AR exposure using three types of generalized linear models (GLM). For presence/absence, we used a logistic regression to evaluate risk factors for total exposure measured using blood and liver,



**Fig. 2** AR data across 2–3 year time increments. **a** Exposure prevalence overall and by compound per 2–3 year increment. *Error bars* represent 95 % confidence intervals. **b** Concentrations detected per 2–3 year increments. *Error bars* represent standard errors. Warfarin, chlorophacinone, and coumachlor were rarely detected, and if so, were detected at above LOD levels (with the exception of chlorophacinone from 2006 to 2006 when 0.03 ppm was detected). Although lower concentrations of compounds were detected in 2011–2012, the difference, in comparisons with sample years from 2003 to 2010 was not significant. **c** Reported pounds of each compound applied per year increment in the three primary study area counties. *Error bars* represent standard errors. Los Angeles and Ventura Counties are represented across all years and Orange County data was included from 2006 to 2010



and separately, for exposure to brodifacoum, bromadiolone, diphacinone, and difethialone based on liver samples. We used a log-linear GLM to evaluate risk factors for the amount of exposure, both overall using total residues, and using residue concentrations for each of the four most commonly detected compounds in liver tissue. Two of 169 individuals from OCSA had outlier residue concentrations of greater than two standard deviations above the mean, one for difethialone and the other individual for bromadiolone. These individuals were excluded from concentration analyses for these specific compounds and for total residue analyses because preliminary analyses indicated that they

dominated model results. We used a Poisson regression to evaluate risk factors for exposure to multiple compounds (0–7) for liver exposure data.

For each model type, we first performed univariate analyses to identify potential predictors, or risk factors, of exposure (Supplemental Table S4). We tested land use categories within each individual buffer zone, study area (SMMNRA, OCSA), sex (male, female), age class (adults  $\geq 2$ ; juveniles  $< 2$  years), age (in years), and season (wet, dry). For each age dataset, we performed separate analyses to avoid potential confounding effects. To evaluate the change in detection rates over time, animals were grouped



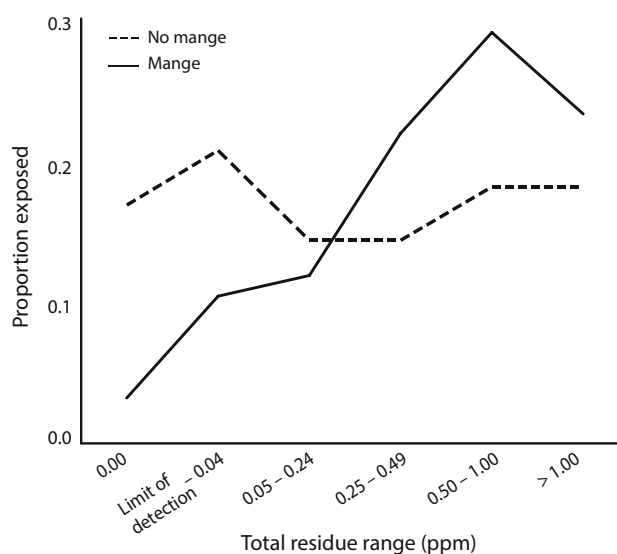
into 2–3 year increments depending on the number of animals sampled yearly such that in all time increments,  $N \geq 7$  ( $N = 23$ ; Fig. 2). Only four liver samples were collected during 1997–1999, so this time increment was excluded from temporal analyses.

Next, we performed multivariate GLMs to examine the influence of particular predictor variables on AR exposure while controlling for all other significant variables. Variables in the multivariate GLMs were selected by backward stepwise selection using Akaike's Information Criterion (AIC) for model selection. We report the strongest models with  $\Delta\text{AIC}$  values  $\leq 2$  (Burnham and Anderson 2002). We report  $\beta$ , the standard error of  $\beta$ , and 95 % confidence intervals for  $\beta$ . A positive  $\beta$  indicates a positive association between the predictor and the exposure outcome, while a negative  $\beta$  indicates a negative association.

We also used logistic regression to examine anticoagulant exposure measures as predictors for notoedric mange. Our predictor variables for these analyses included the 11 anticoagulant exposure measures and the 17 land use predictors. Analyses were performed as above with univariate models followed by multivariate analyses. We also examined the association between notoedric mange and anticoagulant exposure using Fisher's exact tests to evaluate the number of compounds detected ( $\geq 2$ ,  $\geq 3$ , and  $\geq 4$ ) and the threshold value of total residues  $\geq 0.05$  ppm suggested by Riley et al. (2007). To further examine the potential relationship between mange and different levels of AR residues, we plotted the proportion of animals exposed to a range of anticoagulant residue concentrations, for animals with and without mange (Fig. 3). For animals with mange, we observed an increase in the proportion exposed to a residue range of 0.25–0.49 ppm. Consequently, we also used a Fisher's exact test to evaluate the association between mange and total residues  $\geq 0.25$  ppm. Next, we used a Kolmogorov–Smirnov test to evaluate the difference in the distribution of residue concentrations in bobcats that died with mange compared with those that died without mange. Finally, we used a Wilcoxon-rank sum test to evaluate the difference in median residue concentrations between the two groups.

Because commonly used methods of correction for multiple tests have been described as overly conservative with a higher probability of generating Type II errors in comparison with Type I errors (Moran 2003), we did not correct for multiple tests. Thus, all statistical tests were considered significant when  $\alpha \leq 0.05$ , but some of these may represent false positives. All statistical analyses were performed in the program R (R Development Core Team 2011).

When data were unavailable for sex (liver,  $N = 18$ ; blood,  $N = 2$ ), age class (liver,  $N = 25$ ; blood,  $N = 3$ ), year sampled (liver,  $N = 7$ ), season sampled (liver,



**Fig. 3** The proportion of bobcats that died with and without severe mange when exposed to a range of total anticoagulant residues (ppm). The proportion of mange cases, compared with bobcats without mange, increases in the range of 0.25–0.49 ppm, and thus we investigated the relationship between mange and total residues  $\geq 0.25$  ppm. The limits of detection vary by compound. For brodifacoum and bromadiolone, the detection limits were 0.05 ppm, whereas the detection limits of chlorphacinone, diphacinone, and difethialone are 0.25 ppm

$N = 7$ ), or mange status ( $N = 13$ ), AR results for those individuals were excluded from prevalence estimates and statistical analyses requiring these data. We also excluded exposure results from statistical analyses for livers from two fetuses (one from each study area), and a liver from a 1 day-old kitten because their exposure was likely not independent from that of their mother.

## Results

### Prevalence of exposure

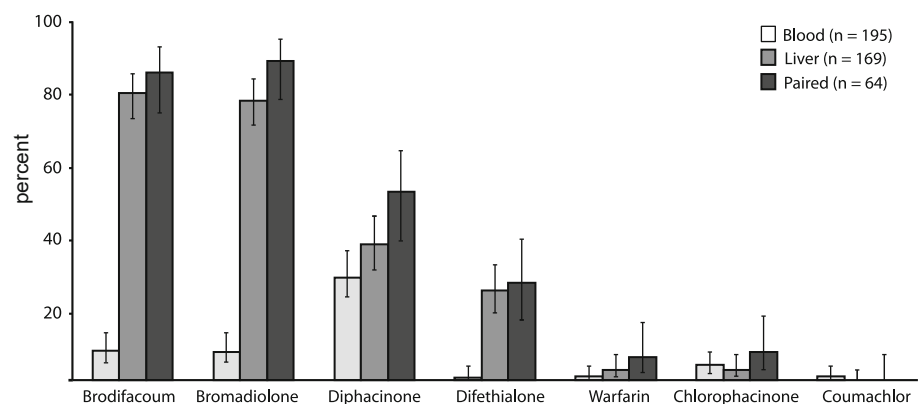
Eighty-eight percent of liver samples had 1–5 AR compounds (Table 3; mean = 2.32, median = 2.00). The range of total residues detected in liver was 0.00–5.81 ppm (mean = 0.59, SD = 0.80, median = 0.40). The compounds most frequently detected were second-generation bromadiolone, brodifacoum, and difethialone, and first-generation diphacinone. Mean values for the four most commonly detected compounds were: brodifacoum, 0.14 ppm (SD = 0.20); bromadiolone, 0.38 ppm (SD = 0.55); difethialone, 0.04 ppm (SD = 0.31); diphacinone, 0.03 ppm (SD = 0.12). Brodifacoum and bromadiolone were the two most frequently detected ARs in liver samples (Fig. 4) and were detected approximately twice as frequently as difethialone or diphacinone. Warfarin and

**Table 3** Proportion (Prop.) and 95 % confidence intervals of anticoagulant exposure across the study areas

Variable	Group	Liver			Blood		
		N	Prop.	95 % CI	N	Prop.	95 % CI
Sex	All	169	0.88	0.82–0.92	195	0.39	0.32–0.46
	Female	77	0.88	0.78–0.94	86	0.38	0.28–0.50
	Male	74	0.89	0.79–0.95	107	0.40	0.31–0.50
Age class	Adult	107	0.91	0.83–0.95	127	0.40	0.32–0.49
	Juvenile	37	0.86	0.70–0.95	65	0.37	0.26–0.50
Season	Wet	96	0.90	0.81–0.95	139	0.32	0.25–0.41
	Dry	66	0.89	0.81–0.94	56	0.55	0.42–0.68

Prevalence is partitioned by sample type, sex, age class, and season. When information on sex, age class, or season collected was not available, those data were not included in the proportion estimates, and so data partitioned by sex, age class, and season may not sum to the total number of blood or liver samples

**Fig. 4** Detection prevalence of each anticoagulant compound in the liver, blood, and for a subset of individuals, paired blood and liver tissue results are provided



chlorophacinone were rarely detected and coumachlor was not detected in liver samples. Seventy-seven percent of all bobcats and 87 % of those exposed showed the presence of  $\geq 2$  compounds in the liver.

In contrast, 39 % of blood samples tested positive for ARs (Table 3), most frequently to one compound (76 % of positives), but ranging from 0 to 4 compounds (mean = 0.53 compounds, median = 0.00). The total residues detected in blood ranged from 0 to 0.16 ppm (mean = 0.002, SD = 0.01, median = 0.00). Diphacinone, the most commonly detected compound in blood, was detected more than three times as frequently as brodifacoum or bromadiolone (Fig. 4). For animals with both blood and liver samples ( $N = 64$ ), 92 % were exposed, most frequently to three or more compounds (median = 3.00, mean = 2.61, range 1–5).

Percent exposure was similar across sexes and age classes using liver or blood samples (Table 3). Sixty-six individuals were aged by cementum annuli (age range: 0–12 years). Fourteen individuals had age class data estimated during capture, and cementum annuli data collected postmortem. We used these paired data to test the accuracy of our age class estimations during captures and found we

assigned correct age classes to 12 of 14 individuals. We did not detect a significant association between age and AR exposure measures.

Exposure did not vary by season when tested using liver samples (Table 3). In contrast, based on blood results, animals were significantly more likely to be exposed during the dry season [Odds ratio (OR) = 2.58] compared with the wet season (Tables 3, 4). Overall we detected 72 % more exposure in blood during the dry season than during the wet season with 32 % exposure detected during the wet season, and 55 % exposure detected during the dry season.

We examined exposure prevalence over time in liver samples and found exposure to exceed 67 % for all years, indicating high exposure prevalence throughout the study (Fig. 2a). Exposure rates varied for each of six compounds across sampling increments (Fig. 2a). Overall exposure was highest during 2003–2004 and 2011–2012. There was significantly less exposure overall and to bromadiolone in 2001–2002 compared with other years (Table 5; Fig. 2a). Diphacinone exposure was significantly greater in 2003–2004 and 2011–2012 compared with other time increments (Table 5; Fig. 2a). However, both total and

**Table 4** Results of Fisher's exact tests for parameters that were significant during univariate GLM analyses

Sample type	Parameter	Comparison	Odds ratio	95 % confidence interval	<i>P</i>
Liver	Total residues $\geq 0.05$ ppm	Severe mange versus no mange	4.00	1.67–10.48	<0.001
	Total residues $\geq 0.25$ ppm	Severe mange versus no mange	3.16	1.51–6.84	<0.001
	Exposure to $\geq 2$ AR compounds	Severe mange versus no mange	7.27	2.55–25.70	<0.001
	Exposure to $\geq 3$ AR compounds	Severe mange versus no mange	2.11	1.06–4.23	0.023
	Exposure to $\geq 4$ AR compounds	Severe mange versus no mange	3.98	1.54–11.26	0.002
Blood	Exposure detected	Dry season versus wet season	2.58	1.31–5.14	0.004
	Exposure detected	Capture event versus mortality	5.55	1.80–20.49	0.001
	Exposure detected	Capture event versus vehicle mortality	$\infty$	1.00– $\infty$	0.006

**Table 5** Significant predictors of presence or absence of exposure in blood and liver

Outcome	Predictors of exposure	$\beta$	$\beta$ SE	$\beta$ 95 % CI	<i>P</i>	
Total exposure (blood)	Dry season	0.95	0.32	0.31–1.56	0.003	
	Crops, pastures, orchards and vineyards	4.85	2.08	0.98–9.21	0.015	
	Horse ranches	88.75	36.10	21.90–166.11	0.011	
	Other agriculture	15.46	7.29	1.63–30.67	0.029	
	Water transfer and storage facilities	93.63	36.16	29.58–174.10	0.006	
	Golf courses	15.69	7.75	0.50–30.88	0.043	
	Multifamily high-density residential	9.47	3.56	2.49–16.44	0.008	
	Single-family high-density residential	1.87	0.88	0.14–3.60	0.035	
	Total residential	4.36	1.80	1.01–8.02	0.016	
	Total commercial/industrial	4.42	1.84	0.81–8.02	0.016	
	Total altered open	17.17	6.63	2.43–49.17	0.010	
	Total residential	2.61	0.82	1.01–4.20	0.001	
	Natural	–3.41	0.68	–4.74 to –2.09	<0.001	
Total exposure (liver)	Single-family high-density residential	7.58	3.45	0.81–14.34	0.028	
	Total residential	6.05	2.29	1.56–10.53	0.008	
	Year (2011–2012 reference)	2001–2002	–2.72	1.18	–5.03 to 5.51	0.021
Brodifacoum exposure	Crops, pastures, orchards and vineyards	–5.62	2.67	–10.87 to –0.38	0.036	
	Single-family high-density residential	6.19	2.36	1.56–10.82	0.009	
	Total residential	6.68	1.90	2.95–10.41	<0.001	
Bromadiolone exposure	Year (2011–2012 reference)	2001–2002	–1.54	0.67	–2.91 to –0.17	0.022
Diphacinone exposure	Single-family high-density residential	2.31	1.12	0.11–4.51	0.039	
	Total residential	2.07	0.99	0.14–4.01	0.035	
	Year (2011–2012 reference)	2001–2002	–1.46	0.70	–2.83 to –0.09	0.036
		2005–2006	–1.67	0.62	–2.98 to –0.52	0.005
		2007–2008	–1.30	0.48	–2.34 to –0.42	0.005
	2009–2010	–0.94	0.56	–2.26 to –0.01	0.048	

Only results from statistically significant univariate analyses are shown

bromadiolone residue concentrations detected were greatest between 2005 and 2010, although the variation in residue concentrations across time was not significant (Fig. 2b). These years included samples from OCSA, where significantly greater bromadiolone residues were detected (Table 6; Fig. 5). Although the residue concentrations we detected in 2011–2012 were lower for all compounds the differences in overall exposure and residue

concentrations were not significant. The apparent decrease in residue concentrations is the result of having OCSA samples, where bromadiolone residues were significantly higher for the years 2006–2010 (see below and Supplemental Fig. S1b). Further, the decrease in total and bromadiolone residues mirrors the County reports we compiled of the amount of rodenticide (in pounds) applied (Fig. 2c, Supplemental Fig. S1c). In blood samples, we did

**Table 6** Significant predictors of AR residue concentrations, total compounds detected, notoedric mange, and exposure detected in blood at the time of capture versus mortality

Outcome	Predictor variables	$\beta$	$\beta$ SE	$\beta$ 95 % CI	<i>P</i>	
Total concentration	Golf courses	5.88	1.01	3.90–7.85	<0.001	
	Single-family high-density residential	1.24	0.46	0.34–2.13	0.008	
	Total altered open	5.66	0.98	3.74–7.58	<0.001	
	Total residential	1.31	0.44	0.44–2.17	0.004	
	Natural	–1.20	0.35	–1.88 to –0.52	0.001	
	Study area: OCSA	0.74	0.17	0.41–1.08	<0.001	
Brodifacoum concentration	Office/retail	5.13	1.17	2.84–7.42	<0.001	
	Golf courses	4.16	1.45	1.30–7.20	0.006	
	Single-family high-density residential	1.31	0.54	0.25–2.37	0.017	
	Total altered open	4.28	1.42	1.49–7.07	0.003	
	Total residential	1.31	0.53	0.28–2.34	0.014	
	Natural	–0.93	0.42	–1.75 to –0.11	0.029	
Bromadiolone concentration	Study area: OCSA	0.58	0.22	0.11–0.96	0.014	
	Mixed commercial/industrial	5.10	1.29	2.57–7.63	<0.001	
	Golf courses	7.45	0.95	5.59–9.30	<0.001	
	Multifamily high-density residential	1.58	0.76	0.09–3.08	0.040	
	Single-family high-density residential	1.38	0.52	0.36–2.39	0.009	
	Total commercial/industrial	1.43	0.57	0.31–2.55	0.014	
	Total altered open	7.16	0.92	5.36–8.96	<0.001	
	Total residential	1.38	0.51	0.38–2.39	0.008	
Diphacinone concentration	Natural	–1.45	0.40	–2.24 to –0.67	<0.001	
	Study area: OCSA	1.03	0.21	0.61–1.45	<0.001	
	Mixed commercial/industrial	8.90	3.20	2.62–15.17	0.006	
Total compounds	Single-family high-density residential	0.80	0.32	0.16–1.43	0.014	
	Total residential	0.92	0.29	0.35–1.49	0.002	
	Natural	–0.47	0.22	–0.90 to –0.03	0.036	
Mange	Year (2011–2012 reference)	2001–2002	–0.57	0.24	–1.04 to –0.10	0.018
	Exposure	1.90	0.78	0.37–3.43	0.015	
	Brodifacoum exposure	1.74	0.52	0.71–2.76	0.001	
	Brodifacoum concentration	1.84	0.89	0.08–3.59	0.040	
	Difethialone exposure	1.16	0.39	0.39–1.92	0.003	
	Total compounds	0.56	0.15	0.26–0.85	<0.001	
	Total residential	2.38	1.01	0.39–4.37	0.019	
	Mortality	Exposure (blood)	1.72	0.54	0.67–2.78	0.001

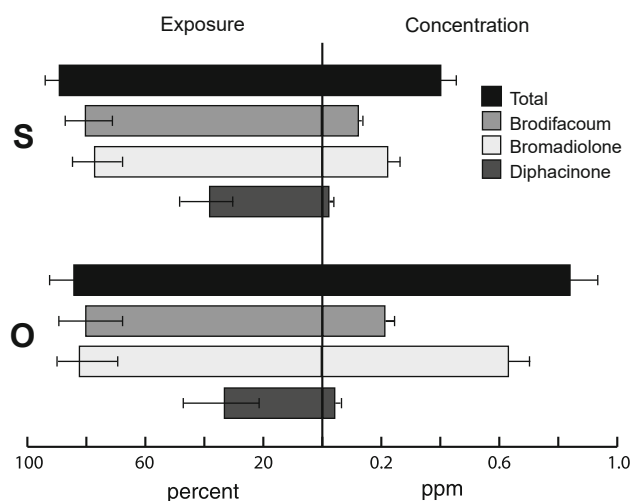
Only results from statistically significant univariate analyses are shown

not detect a trend of exposure prevalence across sampling years.

Two fetal bobcats were exposed to anticoagulant compounds. One animal was exposed to two compounds (brodifacoum and diphacinone) and the other was exposed to five compounds (brodifacoum, bromadiolone, diphacinone, difethialone, and chlorophacinone). For both fetuses, all compounds detected were above LOD but not quantifiable. The mother of the fetus with five compounds was also tested for exposure and had quantifiable levels of brodifacoum (0.32 ppm), bromadiolone (0.58 ppm) and was positive for difethialone, diphacinone, and chlorophacinone.

#### Spatial correlates of exposure

Exposure prevalence measured using liver tissue did not significantly differ between SMMNRA (89, 95 % CI 81–94;  $N = 104$ ) and OCSA (84, 95 % CI 71–92;  $N = 55$ ) (Fig. 5). The mean total residues were significantly greater in OCSA (Fig. 5; Table 6) even with two outliers removed (OCSA, 0.84 ppm; SMMNRA, 0.40 ppm). Brodifacoum and bromadiolone were each detected at significantly greater concentrations in liver tissue collected in OCSA (0.21 and 0.63 ppm) compared with SMMNRA (0.12 and 0.22 ppm) (Table 6).



**Fig. 5** *Left* Percent total exposure and exposure to individual compounds in SMMNRA (S) and OCSA (O). Bars represent 95 % confidence intervals. *Right* Total residue concentration and residue concentrations for each compound. Bars represent standard errors

Landscape variables were important predictors of exposure in both blood and liver samples (Tables 5, 6). Percent natural area in each individual buffer zone was negatively associated with multiple measures of exposure in blood and liver (Table 5). Golf courses and total altered open area were positively associated with exposure in blood (Table 5) and with total residues and the concentrations of bromadiolone and brodifacoum in liver (Table 6).

In terms of the non-residential urban and agricultural areas, all three more specific agricultural categories (Table 1, Supplementary Table S2) and total agricultural area were positively associated with exposure in blood (Table 5). However, brodifacoum exposure was negatively associated with the category comprised of open, active agriculture (crops, pastures, orchards, and vineyards; Table 5), and given that second-generation ARs are restricted for use indoors and within 100 m from human structures, this negative association is not surprising. Commercial and industrial areas were positively associated with bromadiolone and diphacinone concentrations in liver samples (Table 6). Water storage and transfer facilities and total commercial and industrial areas were positively associated with exposure in blood samples (Table 5). Office and retail area was positively associated with brodifacoum concentration in liver samples (Table 6).

Residential areas, by far the most common type of development in these study areas (22 %, SMMNRA and 23 %, OCSA), were frequently positively associated with AR values observed in both blood and liver samples (Tables 5, 6). In particular, single-family high-density residential area was among the most frequent land use type to have positive associations with anticoagulant exposure, and was significant for 8 of 11 anticoagulant exposure models tested

(Tables 5, 6). In terms of broader measures, single-family high-density residential area was positively associated with overall exposure in blood and liver and the total number of compounds and total residues in liver samples. For specific compounds, single-family high-density residential was also positively associated with brodifacoum and diphacinone exposure and brodifacoum and bromadiolone concentrations in liver. Total residential area was also frequently important in univariate models. In terms of exposure, total residential area was associated with exposure in blood and liver and exposure to brodifacoum and diphacinone in liver. Total number of compounds, total residues, and liver concentrations of brodifacoum and bromadiolone were also positively associated with total residential area.

Multivariate models were significant for five measures of ARs in bobcats (Table 7). In terms of exposure, year and total residential area were important for diphacinone, and for total exposure, percent natural area (the reciprocal of percent development) was significant, along with season. For the amount of ARs detected in liver tissue, the best-fit model included golf courses, single-family high-density residential, and OCSA as the most important risk factors. For brodifacoum concentration detected in liver tissue, office and retail, single-family high-density residential, and total altered open space were the three most important predictors of residue load. Finally, mixed commercial and industrial, golf courses, single-family high-density residential, and OCSA were the most important predictors of total bromadiolone concentration in liver tissue.

#### Anticoagulants and notoedric mange

The median total residues for bobcats with mange was 0.52 ppm (mean = 0.65, SE = 0.06), while for bobcats that died without mange, the median total residues was 0.24 ppm (mean = 0.53, SE = 0.09), a significant difference ( $W = 2141.00$ ,  $P = 0.005$ ). The distribution of residue concentrations within the two groups also differed significantly ( $D = 0.28$ ,  $P = 0.004$ ). The median number of compounds observed was 3 (mean = 3.00) in bobcats with mange and 2 (mean = 2.00) for bobcats without mange. Sixty-four percent of bobcats without mange tested positive for  $\geq 2$  compounds, while 93 % of bobcats with mange tested positive for  $\geq 2$  compounds.

Severe mange was positively associated with anticoagulant exposure, brodifacoum exposure, difethialone exposure, brodifacoum concentration, and the total number of compounds detected. In terms of land use, mange was positively associated with total residential area, but this was the only significant land use predictor (Table 6). The mean total residential area in mange bobcat buffer zones was 32.2 % (SD = 18.61, median = 29.39) compared with a mean of 23.3 % for bobcats without mange



**Table 7** Results of the best-supported statistically significant multivariate model analyses for anticoagulant exposure and mange

Outcome	Best-supported model	Predictor variables	$\beta$	$\beta$ SE	$\beta$ 95 % CI	<i>P</i>
Total exposure (blood)	Season + natural	Dry season	0.71	0.35	0.02–1.40	0.043
		Natural	−3.29	0.68	−4.62 to −1.95	<0.001
Diphacinone exposure	Total residential + year	Total residential	2.57	1.12	0.37–4.77	0.022
		2001–2002	−1.62	0.82	−3.23 to −0.02	0.048
		2003–2004	−1.42	0.69	−2.77 to −0.62	0.040
		2005–2006	−2.11	0.80	−3.68 to −0.55	0.008
		2007–2008	−1.78	0.65	−3.06 to −0.50	0.006
		2009–2010	−1.43	0.72	−2.84 to −0.01	0.048
Total concentration	Golf courses + single-family high-density residential + study area	Golf courses	3.91	1.06	1.84–5.98	<0.001
		Single-family high-density residential	0.99	0.43	0.15–1.82	0.022
		OCSA	0.69	0.20	0.30–1.07	0.001
Brodifacoum concentration	Office/retail + single-family high-density residential + total altered open	Office/retail	4.49	1.09	2.34–6.63	<0.001
		Single-family high-density residential	1.22	0.55	0.15–2.29	0.027
		Total altered open	3.88	1.55	0.85–6.91	0.013
Bromadiolone concentration	Mixed commercial/industrial + golf courses + single-family high-density residential + study area	Mixed commercial/industrial	3.48	0.99	1.55–5.42	0.001
		Golf courses	5.69	0.93	3.87–7.51	<0.001
		Single-family high-density residential	1.24	0.42	0.42–2.06	0.004
		OCSA	0.90	0.25	0.42–1.38	<0.001
Mange	Difethialone exposure + brodifacoum exposure	Brodifacoum exposure	1.54	0.53	0.49–2.58	0.004
		Difethialone exposure	0.93	0.40	0.14–1.72	0.021

(SD = 19.60, median = 19.05). In the multivariate model, after controlling for multiple AR parameters and land use, brodifacoum and difethialone exposure remained significant predictors of severe mange while land use was not (Table 6). We found a strongly significant association between mange and total residues  $\geq 0.05$  ppm and total residues  $\geq 0.25$  ppm (Fig. 3; Table 4). Bobcats that were exposed to  $\geq 0.05$  ppm were 4.0 times (95 % CI 1.67–10.48) more likely to die with severe notoedric mange than without, while those exposed to  $\geq 0.25$  ppm were 3.2 times (95 % CI 1.51–6.84) more likely to die with severe mange. Additionally, we observed a strong association between exposure to  $\geq 2$  compounds and severe mange (Table 4). Specifically, bobcats were 7.3 times (95 % CI 2.55–25.70) more likely to die with severe mange than without if they were exposed to 2 or more AR compounds. There were also significant associations between mange and exposure to  $\geq 3$  and  $\geq 4$  compounds (Table 4).

#### Anticoagulants and mortality

Anticoagulant exposure detected in blood was significantly more frequent in samples collected postmortem compared

with samples collected antemortem (Tables 4, 6). In 75 % of blood samples collected postmortem ( $N = 20$ ), we detected at least one AR compound. When blood samples collected at the time of mortality were excluded from blood AR prevalence estimates, we detected a 34 % exposure prevalence in blood samples collected at the time of animal capture ( $N = 175$ ) compared with 39 % overall ( $N = 195$ ). For blood samples collected at the time of mortality, ARs were detected in 77 % of bobcats that died of notoedric mange ( $N = 13$ ), 100 % of bobcats that died of vehicle collision ( $N = 5$ ), and one bobcat that died of starvation after a wildfire. Three bobcats that died of mange, one from a control action, and another that died of unknown cause did not have detectable ARs in their blood.

#### Discussion

We documented widespread exposure of bobcats to first- and second-generation ARs in two southern California areas. Bobcats are obligate carnivores that consume a wide range of small mammals (Anderson and Lovallo 2003) including mice, rats, and gophers (Fedriani et al. 2000;

Riley et al. 2010) that are frequent targets of pest control activities within SMMNRA (Morzillo and Mertig 2011a, b; Morzillo and Schwartz 2011; Bartos et al. 2012) and elsewhere (Morzillo and Mertig 2011b). Given that bobcats are obligate carnivores, it is very unlikely that they consume rodent baits directly. Thus, bobcat exposure to ARs is predominantly, if not entirely, secondary through prey consumption. Exposure rates and compounds detected varied considerably by sample type, but in individuals having blood and liver data (and therefore most comprehensively sampled), we detected an AR exposure rate of 92 % across the study areas, with animals most frequently exposed to three or more compounds. These findings are among the highest reported prevalence rates for AR exposure in a nontarget predatory species (e.g. Shore 2003; Fournier-Chambrillon et al. 2004; Riley et al. 2007; Walker et al. 2008; Gehrt and Riley 2010; Elmeros et al. 2011; Gabriel et al. 2012; Sánchez-Barbudo et al. 2012). Additionally, the combined liver and blood results indicate that exposure prevalence and exposure to certain compounds, specifically diphacinone, may be underestimated with liver samples alone (Fig. 4). We detected exposure to multiple AR compounds in two fetal bobcats, the first such cases, to our knowledge, reported for any wildlife species in a natural population. These data, including individuals caught multiple times more than 4 months apart, indicate multiple exposure events and suggest the potential for chronic exposure to ARs that can begin during prenatal development.

There are no toxicokinetic studies (the movement of toxic substances within the body) of ARs in wildlife, however, hepatic half-lives for ARs are reported across multiple species to be longer than plasma half-lives, particularly for second-generation ARs (Kamil 1987; Robben et al. 1998; Petterino and Paolo 2001; Vandenbroucke et al. 2008). The toxicokinetics of secondary AR exposure is more complex because the movement of the residues in both the primary and secondary consumer must be considered (Erickson and Urban 2004). Thus, we are limited in our ability to interpret bobcat AR exposure results with respect to dose and time since exposure using either blood or liver sample data. However, because we most frequently detect diphacinone in blood despite its shorter plasma half-life than second-generation ARs (Erickson and Urban 2004), diphacinone may be the compound that bobcats encounter most frequently in SMMNRA.

#### Risk factors for exposure

Exposure detected using liver tissue was high throughout the course of the 16-year study, ranging from 67 to 100 % for each 2- to 3-year time period, indicating high prevalence AR exposure in bobcats since at least 1997. Our samples indicated an increase in overall exposure both in

prevalence and residue concentrations since 2002. We detected significant increases in total AR exposure, bromadiolone exposure, and total number of detected compounds. With the exception of diphacinone, overall exposure prevalence and exposure to individual compounds appears to have been relatively constant from 2003 to 2012. Total residues and bromadiolone residues were highest from 2005 to 2010, the time increments for which OCSA samples were available, which appears to reflect the degree of bromadiolone use in Orange County. Diphacinone exposure also increased in frequency from 1997 to 2012, reaching a high in 2011–2012. Despite this increase, the quantity applied in each county as reported to Department of Pesticide Regulation does not appear to have significantly changed over the course of the study (Fig. 2c, Supplemental Fig. S1c). Thus, increased diphacinone exposure may be the result of increased use of the compound in residential areas by homeowners and pest control companies that are not required to report amounts of ARs applied annually. In fact, single-family high-density and total residential area were important predictors of diphacinone exposure. Diphacinone is a first-generation compound and is considered to pose less risk to nontarget wildlife than the more toxic second-generation ARs (Erickson and Urban 2004), although first-generation ARs still pose a risk for toxic effects to wildlife, and secondary exposure can be a direct source of mortality for some species (Littrell 1988; Stone et al. 1999; Riley et al. 2003). Further, the degree to which there are additive or interactive effects between diphacinone and second generation ARs is unknown.

As measured in blood, we detected more than twice as much AR exposure during the dry season compared with the wet season. In southern California, the dry season coincides with peak rodent activity (Meserve 1976), and residents in the region are known to use ARs to target rat, mice, squirrel, and gopher populations (Morzillo and Schwartz 2011; Bartos et al. 2012). Although we detected no seasonal differences in exposure in liver samples, the long hepatic half-lives of second-generation ARs likely obscured our ability to detect seasonal differences. Additionally, because second-generation ARs may persist in small mammal species from 90 to 135 days after removal of poison baits, poisoned small mammals may remain a continuing source of exposure for predatory species long after the end of poisoning programs (Murphy et al. 1998; Sage et al. 2008).

Because an accumulated risk of exposure may occur with bobcat age, and female bobcats have smaller home ranges and are less likely to use urban areas compared with males (Riley et al. 2003, 2010), we expected to detect demographic differences in AR exposure prevalence and residue concentrations. However, neither age nor sex significantly influenced exposure in our study areas. Within

our study areas, the high prevalence of exposure may have diminished our ability to detect demographic differences. Further, the movement patterns and relatively high mobility of some rodent species may lead to AR exposure in even those individuals that avoid the use of urban areas (Riley et al. 2010). For example, wood mice (*Apodemus sylvaticus*) and house mice (*Mus domesticus*) were found exposed to multiple AR compounds in Northern Ireland even though they were sampled in agricultural areas where ARs were not in use (Tosh et al. 2012). Thus, movement of poisoned prey between areas may occur where AR control efforts differ (Tosh et al. 2012). The risk of secondary AR exposure in predatory species, therefore, may not be limited to areas where ARs are in use. As a result, even individuals that use urban areas less, such as female bobcats and not yet dispersed young animals, may still be at high risk of AR exposure.

### Spatial predictors of exposure

The association between AR exposure and specific land use types likely reflects the degree of AR use in those areas. Previous studies have found an association between anthropogenic development and AR exposure in nontarget wildlife. For example, 95 % ( $N = 74$ ) of wildlife carcasses sampled across California from 1994 to 1999 with exposure to ARs were reported to have been collected in areas with significant urban development (Hosea 2000). However, there was no specific information about the type and intensity of urban development where individuals were sampled. Other previous studies in these areas found a positive association between total AR concentrations and the percent of bobcat (Riley et al. 2007) and mountain lion (Beier et al. 2010) radio-telemetry locations in areas affected by anthropogenic development, including areas classified as altered open and areas of more intense urban development (e.g. composite residential, commercial, and industrial areas).

Single-family high-density residential (5–10 housing units/ha) and golf courses were among the most frequent risk factors for various measures of AR exposure, despite comprising a relatively small percentage of the study areas (15.9 and 1.4 %), suggesting their importance as a risk factor for AR exposure and toxicant loads. In a recent study in two southern California areas (SMMNRA, Bakersfield), residents in single-family high-density structures were the most likely to use ARs to control pest populations compared with those in multifamily or single-family low-density structures (Morzillo and Schwartz 2011). Residential AR use was highest in areas in close proximity to open areas, whether natural or altered open, compared with residential areas farther away from open spaces. Golf courses and other altered open spaces in the study areas are

typically surrounded by, or very near to, single-family housing units. Of 21 golf courses in our study areas, 19 are bordered on at least 1 side by single-family high-density residential areas. Because residential AR use may be elevated in areas with altered open space in close proximity (Morzillo and Schwartz 2011), the association between AR exposure and altered open areas may also be the result of increased AR use in the single-family residential areas adjacent to golf courses. In OSCA, where bobcats had greater brodifacoum and bromadiolone residue loads, the mean percent of golf courses in bobcat buffer zones was nearly five times greater than in SMMNRA (0.6 vs. 2.7 %), potentially contributing to increased residue loads in OSCA. Although the residential and altered open types of urban development comprise a relatively small proportion (<25 %) of the study areas, Morzillo and Schwartz (2011) suggested a small degree of AR use in residential areas can lead to increased exposure risk for wildlife. Both bobcats (Riley et al. 2010) and coyotes (Gehrt and Riley 2010) have been observed to routinely utilize residential and altered open areas such as golf courses, increasing their probability of exposure to ARs if the compounds are regularly used there or nearby.

Although percent natural habitat was negatively associated with AR exposure and total residues, four bobcats whose buffer zones comprised 100 % natural habitat were found exposed to ARs. These data indicate that ARs may also affect wildlife living solely within protected park areas. Both of the individuals with bromadiolone residues were radio-collared during ongoing NPS research in SMMNRA, and their documented home ranges did not extend beyond protected park boundaries (Riley et al. NPS unpubl. data). Previous NPS research on coyote utilization of urban areas found that even animals with the lowest urban association died directly from AR toxicosis (Riley et al. 2003). A recent study on fishers (*Martes pennanti*), a remote forest carnivore in protected undeveloped parkland in northern California, found 79 % of fishers exposed to ARs and that four died directly of anticoagulant toxicosis (Gabriel et al. 2012). Gabriel et al. (2012) suggested illegal marijuana cultivation in remote areas could have been the source of ARs. Within SMMNRA, illegal marijuana cultivation also occurs, so this may also contribute to AR exposure for animals that reside entirely in protected park areas.

### Consequences of exposure

Although the prevalence of AR exposure was very high at 92 %, AR exposure alone does not appear to be a significant source of direct mortality for bobcats. At present, there are few cases of AR toxicosis in bobcats documented in the literature. None of the bobcats in OSCA died directly

of anticoagulant toxicity, and in a broader study of poisoning cases of wildlife in California, Hosea (2002) observed clinical signs consistent with anticoagulant toxicosis in two bobcats, one of which was an individual from SMMNRA (Riley et al. 2007). In Marin County, a radio-collared bobcat died of anticoagulant toxicity; chlorophacinone was detected in the liver tissue (Riley 1999). AR exposure was suspected to have caused gastrointestinal bleeding in bobcats that died of severe notoedric mange and were exposed to ARs in several counties in California, though other signs of anticoagulant toxicity were absent (Serieys et al. 2013). Domestic cats are reported to be more tolerant of AR exposure than dog or rodents (Petterino and Paolo 2001; Erickson and Urban 2004). Whether this tolerance is similar for wild felids is unknown, but if so, it may account for the few cases of toxicosis detected. However, felid tolerance to low-grade AR exposure may increase their vulnerability to sublethal toxicosis, or affect their ability to respond to external stimuli such as predators and vehicles (see below).

In SMMRNA, secondary anticoagulant rodenticide exposure was associated with a population decline (Riley et al. 2007) and a genetic bottleneck (Serieys et al. 2014) that occurred due to notoedric mange. Mange and vehicle collisions are the primary sources of mortality for bobcats in our two southern California study areas (Riley et al. 2010). Notoedric mange is now documented in eight counties in northern and southern California. Across all of these areas, animals that died of mange were found to be exposed to ARs whenever tests were conducted (Serieys et al. 2013; Clifford, pers.comm.). Interestingly, 65 % of severe bobcat mange cases observed in our study areas during this 16-year period occurred during the dry season, coincident with increased AR exposure detected in blood samples. Sixty-nine of 70 bobcats that died with severe mange (covering >70 % of their body) were exposed to ARs. We detected a strong association between exposure to  $\geq 2$  compounds and notoedric mange. Detection of multiple compounds in a single individual suggests multiple exposure events since rodenticide baits sold in California are each formulated with a single compound. Thus, we suggest that a single anticoagulant exposure event itself may not increase bobcat susceptibility to mange, but rather repeated exposure events may be an important predictor of potential sublethal effects such as increased susceptibility to mange.

Severe mange in free-ranging wildlife and domestic animals is often associated with decreased immune competence (Pence and Ueckermann 2002). Humans that are immunocompromised are also more likely to suffer severe, crusted forms of mange due to infestation with a related mite, *Sarcoptes scabiei* (Walton et al. 2004; Roberts et al. 2005). The mode by which anticoagulant rodenticide exposure could compromise bobcat immunity is unknown,

although recent studies in humans and laboratory animals have shown therapeutic doses of warfarin to have both immunostimulatory and suppressive effects when administered for  $\leq 30$  days (Kurohara et al. 2008; Belij et al. 2012; Popov et al. 2013). Laboratory experiments have shown that interactive effects between sublethal exposure to anticoagulants and other stressors can induce mortality. For laboratory subjects, sublethal anticoagulant doses produced 40–70 % mortality when combined with other stressors, such as frostbite (Jaques 1959). When stressed by shearing and captivity, sheep (*Ovis aries*) required lower doses of the first-generation AR pindone to die as a result of anticoagulant toxicosis (Robinson et al. 2005). A potential interaction between the toxic effects of chlorophacinone and a bacterial pathogen, tularemia (*Francisella tularensis*) was described in common voles (*Microtus arvalis*, Vidal et al. 2009). Voles that were infected with *F.tularensis* died at lower doses of chlorophacinone than uninfected voles. Tularemia prevalence was also higher in areas treated with chlorophacinone, and the authors suggested that the AR field treatment may have also facilitated the spread of the disease in the affected vole population.

Sublethal AR exposure may also negatively affect individuals directly. In Denmark, Elemeros et al. (2011) found a negative association between anticoagulant exposure and body condition in weasels (*Mustela nivalis*) and stoats (*Mustela erminea*). A reduced escape response has been observed in rats dosed with ARs (Cox and Smith 1992), and if carnivores secondarily exposed to ARs have a similarly reduced response to threats, they may be more vulnerable to vehicle collisions or predation. Elmeros et al. (2011) found that for both stoats and weasels, those that were sampled after being trapped had significantly lower total AR residue concentrations than those sampled after vehicle collisions and predation events. Although we have a limited sample size ( $N = 5$ ), all animals that died of vehicle collisions for which we collected blood post-mortem had detectable AR residues in their blood (compared with 34 % of captured animals). Thus we speculate that recent AR exposure events may increase bobcat vulnerability to vehicle collision but additional data are needed to test this hypothesis.

Bobcats with severe notoedric mange exhibit altered behavior increasing their susceptibility to other primary sources of mortality. For example, although bobcats are primarily nocturnal, especially in urban populations (Riley et al. 2003), we have observed bobcats with severe mange infestation frequently wandering in urban areas during daylight hours (Riley and Serieys unpubl.data). This shifted activity pattern may increase the risk of being struck by vehicles and vulnerability to other sources of mortality.

Though sample sizes are limited, our findings that AR transfers from mother to offspring suggests consequences



for reproduction in bobcats. Contaminant exposure that interferes with the reproductive success of wildlife populations can lead directly to population declines. We tested two bobcat fetuses, one from each study area and both were exposed to multiple AR compounds with one exposed to five compounds. Reproductive consequences associated with AR exposure in other species have included increased miscarriage, fetal toxicosis, fetal congenital deformities, and decreased sperm counts in humans (Ginsberg and Hirsh 1989), dogs (Munday and Thompson 2003), and sheep (Robinson et al. 2005). In humans, prenatal exposure to first-generation coumarin even at low, therapeutic doses has been associated with central nervous system abnormalities (Ginsberg and Hirsh 1989; Wesseling et al. 2001). Brodifacoum toxicosis was documented in neonatal puppies even though the mother was exposed 4 weeks prior to birth (Munday and Thompson 2003). AR exposure may be an important challenge for population viability in urban areas if chemical contamination causes detrimental effects on reproduction.

#### Conservation and management implications

Exposure of nontarget wildlife to ARs is increasingly recognized as a widespread conservation issue (Erickson and Urban 2004; US EPA 2008; California Department of Pesticide Regulation 2013) and numerous species have been exposed, sometimes causing direct mortalities (Scheuhammer 1987; Peakall 1992; Eason et al. 2002; Erickson and Urban 2004; Riley et al. 2007; Gabriel et al. 2012). Species that are exposed include federally listed endangered species such as San Joaquin kit foxes (McMillin et al. 2008), bald eagles (*Haliaeetus leucocephalus*, Stone et al. 2003; Salmon 2010), and the Northern spotted owl (*Strix occidentalis caurina*, Erickson and Urban 2004). Indirect mortalities associated with the poisons may also pose an important threat for wildlife populations, particularly those that are re-colonizing parts of their past range. For example, during a recent study of California fishers, which are candidates for protection under the US Endangered Species Act, a lactating female died of anticoagulant toxicosis, which most likely led indirectly to the death of her litter (Gabriel et al. 2012). For threatened populations, exposure to ARs may influence their reproductive success, lead to sublethal and lethal consequences and increase their vulnerability to other sources of mortality.

Although some U.S. States, such as California, are taking steps to increase regulation of the use and the availability of these poisons to consumers, the adequacy of these is unknown. Under current law, second-generation ARs are restricted to indoor use or within 30 m (100 ft) of buildings. In California, the Department of Pesticide

Regulation has reduced that distance to a 17 m (50 ft) radius from buildings. However, Tosh et al. (2012) found no relationship between distance from buildings and residue concentrations in two species of mice reflecting the high mobility of the small mammals even after ingestion of ARs. They also detected a contaminated wood mouse (*Apodemus sylvaticus*) 110 m from a building where usage occurred and another 160 m from a building where no usage occurred (Tosh et al. 2012). In residential areas within SMMNRA, residents have reported off-label use of ARs, and use of second-generation ARs up to 100 m from buildings (Bartos et al. 2012). We have observed containers of second-generation ARs in natural areas behind homes at greater than 30 m from a building. Residents who use ARs have also reported continued use of the compounds although they were aware of the threat that the compounds posed to nontarget wildlife (Morzillo and Mertig 2011a). If wildlife are especially likely to be exposed to ARs due to use of these compounds in residential areas, then measures that address residential use of ARs may be particularly effective in mitigating ecological risks associated with these compounds.

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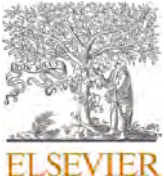
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# Road-crossings, vegetative cover, land use and poisons interact to influence corridor effectiveness

Laurel E.K. Serieys<sup>a,b,\*</sup>, Matthew S. Rogan<sup>b</sup>, Stephani S. Matsushima<sup>a</sup>, Christopher C. Wilmers<sup>a</sup>

<sup>a</sup> Environmental Studies Department, University of California, Santa Cruz, Santa Cruz, 95064, CA, USA

<sup>b</sup> Institute for Communities and Wildlife in Africa, University of Cape Town, Cape Town 7800, South Africa

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## ABSTRACT

Landscape connectivity is essential to conserving resilient wildlife populations in the Anthropocene. Maintaining connectivity requires preserving or restoring patches of habitat, accounting for the behavioral factors that determine movement between patches and mitigating threats. We measured natural and anthropogenic features that influence movement and mortality for bobcats (*Lynx rufus*) in a system threatened with complete isolation by urbanization. Our overarching objective was to inform local land acquisition and restoration to maintain two last-chance wildlife corridors. We collected five-minute movement data from 36 bobcats in central California to assess features of road-crossing hotspots and model habitat selection, including functional responses to housing densities and vegetation. We collected opportunistic mortalities and assessed rat poison exposure to evaluate edge effects as acute threats. Bobcats strongly selected for natural vegetation, evident at the level of a single tree or shrub. Individuals selected low-density housing (<5 houses/ha) yet avoided high-density housing development and monoculture agriculture. Narrow (<25 m wide) riparian strips were critical to connectivity. Bobcats successfully crossed the busiest highway in the landscape but frequently died when crossing a less-trafficked road with a high median barrier. Vehicles and disease were dominant sources of mortality, while 94% of bobcats were exposed to rat poisons despite California's 2014 regulations implemented to reduced wildlife exposure. Maintaining landscape connectivity requires conserving key habitats, mitigating the effects of infrastructure, and sustaining populations of highly mobile, healthy individuals. Our findings have driven conservation action through land acquisition. We demonstrate how robust, rapid data collection can facilitate real-world conservation outcomes.

## 1. Introduction

The movement of individuals and their genes across landscapes is vital to population persistence (Fletcher et al., 2016), the adaptability of species to environmental change (Thomas et al., 2004), and ecosystem resilience (Sgrò et al., 2011). Landscape connectivity is a fundamental underpinning of diverse ecological processes including predator-prey interactions, nutrient cycling, and disease dynamics (Fletcher et al., 2016). The global expansion of human populations, however, is drastically changing the ability of organisms to move across landscapes. Seventy-five percent of the planet's terrestrial surface is impacted by numerous anthropogenic activities collectively referred to as the "human footprint" (Sanderson et al., 2002). This footprint has reduced terrestrial mammal vagility by 30–50% (Tucker et al., 2018) and correlates with anthropogenic mortality (Hill et al., 2019). Understanding

factors that influence animal vagility and associated risk is increasingly elemental to biodiversity conservation in the Anthropocene (Fletcher et al., 2016).

Humans transform landscapes and inhibit wildlife movement in two fundamental ways. First, destruction of natural habitat fragments landscapes and reduces connectivity (Foley et al., 2005). Second, humans create infrastructure and linear barriers when building cities, paving roads, erecting fences, or damming rivers. Yet the effects of infrastructure and barriers can be complex and sometimes counterintuitive. Roads, for example, may facilitate movement in areas with low human footprint (Whittington et al., 2011) while in areas with high human footprint, roads can act as a critical impediment to movement (Riley et al., 2014a). Overall, however, roads may act as an important source of mortality (Hill et al., 2019) and suppress animal population abundance (Fahrig and Rytwinski, 2009) irrespective of their effects on

\* Corresponding author at: Environmental Studies Department, University of California, Santa Cruz, Santa Cruz, 95064, CA, USA.

E-mail address: [Laurel@fwob.org](mailto:Laurel@fwob.org) (L.E.K. Serieys).

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animal movement.

Edge effects around habitat also disrupt population dynamics and persistence (Benson et al., 2016; Fagan et al., 1999; Watling et al., 2011). Thus, the qualities of matrices (i.e., developed portions of the landscape in which habitat patches are embedded) themselves can fundamentally influence ecological connectivity (Watling et al., 2011). For example, dispersal routes obstructed by human infrastructure can increase mortality, especially for subadult individuals, and isolate populations (Riley et al., 2014b; Kramer-Schadt et al., 2004). Isolation erodes genetic variation (Benson et al., 2016), increasing vulnerability to other stressors (Keller and Waller, 2002). Disease dynamics can shift in transformed landscapes while pesticide exposure kills wildlife, may increase disease susceptibility (Riley et al., 2014c), and can cause population declines (Riley et al., 2007). When retaining or restoring connectivity, an appraisal of the acute edge effect threats to populations is essential to implementing robust mitigation measures.

Corridors that facilitate wildlife movement between habitat patches can mitigate barriers caused by fragmentation (Beier, 2018; Beier et al., 2008). Identifying effective corridors is challenging because landscape connectivity is a complex combination of structural features and functional processes, and consequently, corridors based on expert opinion can substantially deviate from animal-defined corridors (LaPoint et al., 2013). Structural connectivity, the presence of habitat linking sub-populations, may be a function of a suite of variables including land cover type, patch size, isolation, mortality risk, and whether linear features facilitate or disrupt movement (Fletcher et al., 2016). Functional connectivity is assessed via the behavioral response of individuals to those landscape features and other factors and movement rates between sub-populations (Carvalho et al., 2016; Kramer-Schadt et al., 2004). Because observing functional movement is difficult due to the need to monitor select individuals at precise times moving long distances, structural connectivity often becomes a proxy for functional movement. Yet, accounting for actual behavior, and in particular varying choice among individuals, provides essential insight into how animals move through the landscape (LaPoint et al., 2013).

Fortunately, we have entered a “golden age” of bio-logging with technological advances that can record extremely fine-grain movement of tagged animals (Wilmers et al., 2015). Using high-resolution data to define movement corridors is more reliable than expert-opinion and cost-based models that ignore unique interactions between animal behaviors and structural features (Abouelezz et al., 2018; LaPoint et al., 2013). Technological advancements improve rapid assessments to inform mitigation and restoration measures via land acquisition and retro-fitting infrastructure to reduce barrier effects (e.g., Serieys and Wilmers, 2019). Additionally, we can pair precise animal locations with high-resolution remote monitoring of extensive landscapes to better match fine-scale movement with fine-scale landscape features down to individual trees.

Here, we use high-resolution movement (5 min) and remote sensing (0.6 m [0.36 m<sup>2</sup> pixels]) data to determine the presence of two “last-chance” wildlife linkages (the only remaining corridors that connect habitat patches) in landscapes threatened by imminent anthropogenic development in central California. We used a landscape-species approach (Sanderson et al., 2002) to identify natural and human-derived features that influence connectivity. Additionally, we wanted to understand factors that reduce functional connectivity by increasing mortality. We chose a mesocarnivore, the bobcat (*Lynx rufus*), because its scale of movement is congruous with the scale of the study areas, while their resource requirements translate into an inherent need to navigate hostile matrices to move among habitat patches (Crooks, 2002). As a mammalian carnivore, bobcats exist at low densities and are thus genetically sensitive to habitat fragmentation and inbreeding (Ruiz-López et al., 2012). Their trophic status leaves them vulnerable to the bioaccumulation of urban pathogens and pesticides (Carver et al., 2016; Serieys et al., 2015). Overall, these ecological traits make them intrinsically vulnerable to extinction associated with habitat degradation

(Cardillo et al., 2005), and excellent proxies for sympatric species (e.g. puma, *Puma concolor*; badger, *Taxidea taxus*; coyote, *Canis latrans*) that have similar extinction risk (Cardillo et al., 2005) and may also contribute to ecosystem processes (Zavaleta et al., 2009) in the study areas.

Our overarching goal was to make management recommendations to local conservation agencies before more extensive habitat loss leads to irreversible population fragmentation and decline. Our specific objectives included: i) intensive monitoring of bobcat movement complemented with movement-explicit step selection functions to identify the relative importance of natural and human-modified landscape features that influence bobcat movement through the last-chance corridors; ii) evaluate the barrier and mortality effects of roads to characterize safe and dangerous road-crossing hotspots so that potentially needed retro-fitting of roads can facilitate connectivity and mitigate threats; and iii) assess the role of vehicles, ubiquitous rat poisons, and an urban-associated disease (notoedric mange, *Notoedres cati*; Serieys et al., 2015) in driving bobcat mortality thereby potentially inhibiting functional connectivity. Given the severity of fragmentation in the region, these high-resolution data are essential to designing mitigation measures to preserve and restore landscape connectivity amidst ongoing development and habitat loss.

## 2. Methods

### 2.1. Study area

We conducted this study within the San Francisco Bay Region and adjacent southern counties (Fig. 1) in the California Floristic Province, the sixth most important biodiverse conservation region within the U.S. (Stein et al., 2000). The region is characterized by a series of mountain ranges with anthropogenic development concentrated in the interlinking valleys.

Our study sites comprised two stretches of fragmented habitat that remain as the only two viable linkages between the Santa Cruz Mountains and the eastern ranges — the Coyote Valley to the east, and the Aromas Hills to the southeast. Local conservation stakeholders describe these areas as the “last-chance” wildlife corridors for Santa Cruz Mountains faunal populations because they constitute the last remaining potential linkages between the Santa Cruz Mountains and adjacent mountain ranges (Fig. 1, Supplemental Fig. S1). Both areas are imminently threatened by intense commercial development. Conservation organizations seek mitigation measures that would preserve remaining natural habitat of greatest importance to wildlife and maintain biological connectivity between the mountain ranges (Serieys and Wilmers, 2019).

Each study area encompasses roughly 30 km<sup>2</sup> (Supplemental Fig. S1). Land uses include orchards, row crops, commercial development, residential neighborhoods, and altered open areas (i.e., golf courses and school yards). Remaining natural areas are a mix of riparian strips, mixed oak and shrub savannah, and serpentine grassland.

### 2.2. Sampling, movement, and mortality data

We used standard cage-trapping techniques to capture bobcats during three trapping sessions between June 2017 and December 2018. In Coyote Valley, dry season trapping occurred June 1–July 30, 2017 while wet season trapping occurred November 10, 2017–February 28, 2018 because one on-the-ground objective in Coyote Valley was to test for potential seasonal differences in bobcat habitat selection. In Aromas Hills, we trapped during one trapping session between June 1, 2018 and December 31, 2018. We used cage traps (Tru-catch traps, Bell Fourche, South Dakota or CamTrip cages, Caging Bobcats, Barstow, California) that were checked a minimum of every 12 h. Individuals were chemically immobilized with a mixture of ketamine HCl (5 mg/kg) and medetomidine HCl (0.1 mg/kg). We recorded age class, sex, weight, and



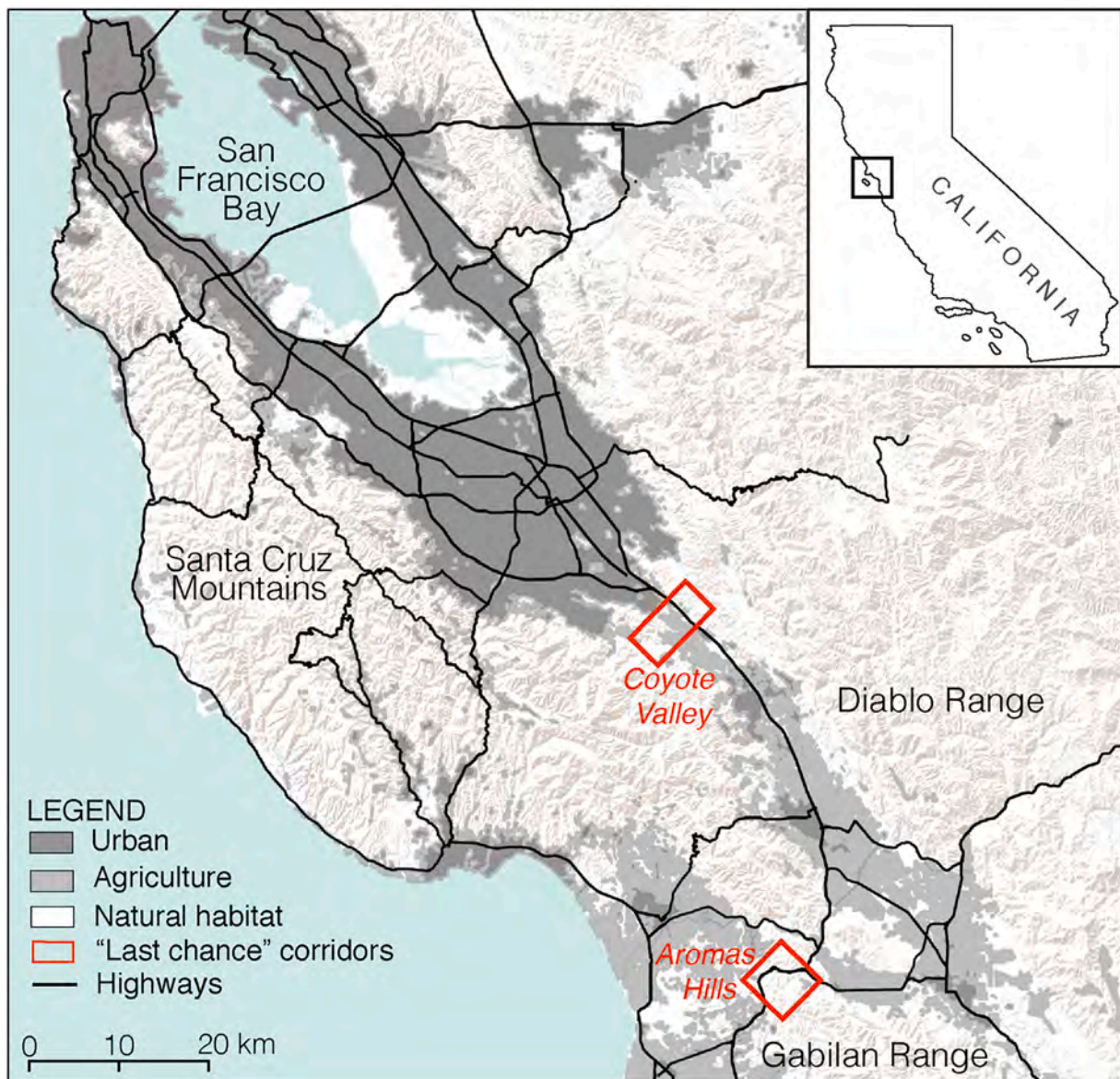


Fig. 1. A map of the Santa Cruz Mountains and neighboring ranges.

morphological measurements. We classified as juveniles (<2 years) or adults ( $\geq 2$  years) based on body size, weight, tooth wear and eruption, and reproductive status (Serieys et al., 2015).

Individuals were collared, and their movements monitored using GPS and triaxial accelerometers (Eobs GmbH; Grünwald, Germany) that sampled locations at 5-min intervals when the animal was moving, and at 3-h intervals when the animal was at rest (Supplemental Methods 1, collar programming file). Collars were set to record data for a minimum of three-months for each individual.

We performed mortality surveys for GPS-collared individuals on a weekly-monthly basis, depending on the ease of locating each individual, particularly given that we were unable to obtain entry access to various regions of the study areas. We opportunistically collected carcasses from untagged bobcats to increase our understanding of factors contributing to mortality in the study areas. We necropsied all carcasses and recorded cause of mortality, collection date and location, sex, age class, and presence of notoedric mange (*Notoedres cati*; Riley et al., 2007).

All animal capture, handling, collaring, and sample collection was approved by the Institutional Animal Care and Use Committee (IACUC) of the authors' institution (Protocol numbers). Scientific collecting

permits were authorized by the California Department of Fish and Wildlife (Aromas, SCP-11968; Coyote Valley, SCP-13565).

### 2.3. Anticoagulant rodenticide exposure

To further assess contributors to mortality, we tested for a standard panel of commercially available anticoagulant rodenticide (AR) compounds (brodifacoum, bromadiolone, difethialone, difenacoum, chlorophacinone, diphacinone, warfarin, and coumachlor) when it was possible to recover the liver of animals that died. The detection of ARs in liver reflects the history of exposure for the individual (Serieys et al., 2015). We assessed the presence and concentrations of each compound using HPLC and LCMS/MS as has been previously described (e.g. Serieys et al., 2015). The threshold of detection required for quantitation by LCMS/MS for our panel of ARs was 0.05 ppm for brodifacoum, chlorophacinone, and diphacinone, and 0.02 ppm for bromadiolone, coumachlor, difethialone, warfarin, and difenacoum. When compounds were detected by HPLC, but at concentrations too low to be quantitated by LCMS/MS, we report the compound as "level of detection" (LOD). For compounds that were LOD, when calculating mean concentrations across individuals, we assigned the smallest non-zero value (0.01) given



our level of detection precision.

#### 2.4. Landscape covariates

We tested the influence of topography (SLOPE), vegetation (TREES, SHRUBS, GRASS, EUCALYPTUS), distance from water (streams, lakes, ponds; WATER), monoculture agriculture (CROPS, ORCHARDS), and anthropogenic landscape features including distance from arterial roads (ROADS) and housing density within a 100-meter radius around each GPS location (HOUSE; see Section 2.6 below for radius selection) on bobcat movement. For additional GIS layer source details, see Supplemental Table S1.

To assess the influence of vegetation on bobcat movement across the study areas, we first conducted a supervised maximum likelihood land cover classification in ArcGIS 10.5 (ESRI, Redlands, CA) from US Department of Agriculture National Agricultural Imagery Program high-resolution (0.6 m [0.36 m<sup>2</sup> pixels]) remotely sensed imagery (USDA 2016) recorded at spectral bands corresponding to blue, green, red, and near-infrared wavelengths. We classified land cover as trees, shrubs, grass, non-vegetation (i.e., urban or rock), and water (Supplemental Table S1). We resampled the land cover raster at 1.2 m resolution to account for errant pixels. We subsequently used the California Department of Conservation agricultural layers for Santa Clara, Monterey, San Benito, and Santa Cruz Counties (California Department of Conservation; [consrv.ca.gov](http://consrv.ca.gov)) to identify monoculture agricultural areas that we classified as either row crops or orchard. Informal quality assessment showed high correspondence between the agricultural layers and row crops and orchards visible in the NAIP imagery. However, informal quality assessment revealed shaded vegetation classified as water; we corrected for this by masking out water bodies using the USGS Natural Hydrography Dataset (NHDH\_CA\_92v200; [usgs.gov](http://usgs.gov)) and reclassifying remaining water pixels (initially classified as water) as TREES. We transformed bobcat locations from WGS84 into the 1983 North American Datum and reprojected them into the Universal Transverse Mercator Zone 10 N coordinate reference system. For each location, we sampled the presence or absence of trees, shrubs, grass, row crops, and orchards such that each category had a binary designation of 0 or 1. To account for GPS error in observed locations, points were classified as trees and shrubs if trees or shrubs were within a 5-meter radius of each location and, if either class was present within the buffer, assumed the true location of the bobcat was within the nearer of the two vegetation classes (though such instances were rare).

We estimated other natural landscape features including the minimum distance from the nearest stream, pond, or reservoir (WATER; USGS Natural Hydrography Dataset [NHDH\_CA\_92v200]; [usgs.gov](http://usgs.gov)) and topographical features, elevation (ELEVATION) and slope (SLOPE), extracted from the USGS 1/9 arc-second Digital Elevation Model ([sciencebase.gov](http://sciencebase.gov)).

We measured four types of disturbed landscapes on bobcat movement—monoculture agriculture, eucalyptus, housing density, and roads. We identified locations within monoculture agricultural areas that included orchards and row crops (ORCHARDS or CROPS, California Department of Conservation; [consrv.ca.gov](http://consrv.ca.gov)). To determine the effect of a dense 4 km<sup>2</sup> eucalyptus grove (in Aromas Hills) on bobcat movement and habitat selection, we used QGIS (QGIS Development Team, 2019) to manually map the eucalyptus grove from the high-resolution NAIP imagery. We tested the effect of housing density within a 100-meter buffer (see ‘Section 2.6. Housing density scale’ below for more details about buffer size determination) surrounding each location (HOUSE, based on Microsoft’s Building Footprints; Open Data Commons Database License). Finally, we calculated the distance of each location from the nearest arterial (primary or secondary) road (ROADS; ESRI Roads [DataMaps10.2]). Primary arterial roads are highways or freeways with high traffic volumes, while secondary arterial roads comprise smaller, less-trafficked roads that feed directly into primary roads (Riley et al., 2014a). Arterial roads in our study included US Route 101 found in both

study areas, as well as six secondary roads of particular interest in the study areas (described further below, Section 2.8).

#### 2.5. Movement-explicit habitat selection

We analyzed movement-explicit habitat selection using step-selection functions (SSFs; Thurfjell et al., 2014) because we wanted to characterize habitat that specifically influenced decision-making while individuals were moving across the landscape. Because the collars collected both 5-min movement, and 3-hour resting locations, we isolated movement locations by removing resting locations. We implemented a standard 1:20 match-case control empirical design by creating strata where each individual’s end ‘used’ location ( $t$ ) was paired with 20 ‘available’ locations (Duchesne et al., 2010; Fortin et al., 2005). We investigated selection in response to topography, vegetation, streams and lakes, monoculture agriculture, distance from arterial roads and housing density.

Habitat selection analyses are sensitive to the spatiotemporal scale at which available habitat is characterized (Boyce, 2006; Wilmers et al., 2015; Thurfjell et al., 2014; Suraci et al., 2019) and fix intervals determine the strength and order of habitat selection (Thurfjell et al., 2014; Suraci et al., 2019). For example, at fine temporal scales (<20 min), movement decisions reflect options within a maximum of several hundred meters (Thurfjell et al., 2014; Suraci et al., 2019). Thus, at fine scales, the selection for natural vegetation within an individual’s immediate vicinity will obscure potential avoidance of risky anthropogenic features on the landscape (e.g. Suraci et al., 2019). A primary objective of this study was to assess the relative influence of both anthropogenic and natural landscape features on movement decision making. Therefore, we subsampled our 5-min movement data to an intermediate (3 h) fix interval following Suraci et al. (2019). At intermediate fix intervals, the relative importance of anthropogenic landscape features is best captured in SSF habitat selection studies in human-dominated landscapes (Suraci et al., 2019).

We simulated ‘available’ locations to match each observed location  $t$  by sampling, with replacement, random vectors originating from the immediately preceding ‘used’ location (i.e., location  $t-1$ ). Random vectors were drawn based on the empirical distribution of turn angles and step lengths between consecutive locations derived from data on all individuals that were the same sex as the focal individual. However, while drawing the random vectors, we excluded the focal individual’s data to avoid circularity (Fortin et al., 2005). We included three resource-independent behavioral parameters in the models to control for inherent biases in animal movement that may also affect habitat use. Step length (STEP, calculated between  $t$  and  $t-1$ ) and log-transformed step length (LOG.STEP) controlled for potential habitat selection biases arising from the ability of individuals to travel to available locations (Forester et al., 2009; Nicosia et al., 2017). Directional persistence (DIR.PERSIST) controlled for the inherent tendency of individuals to move in a constant direction and was calculated between  $t$ ,  $t-1$ , and  $t-2$  (following (Duchesne et al., 2010; Nicosia et al., 2017; Suraci et al., 2019) as:

$$\cos(\theta_t - \theta_{t-1})$$

where  $\theta_t$  is the absolute (angle relative to North) of the vector resulting in the current step  $t$ , and  $\theta_{t-1}$  is the absolute angle of the preceding vector resulting in step  $t-1$ .

We estimated selection ( $\beta$ ) coefficients using conditional logistic regression (CLR) via cox proportional hazards models in package ‘survival’ 2.43-3 (Therneau, 2018) for R statistics software (R Core Team, 2019). Successive strata were not independent due to temporal autocorrelation (Craiu et al., 2008), thus deflating standard errors associated with  $\beta$  coefficients. Therefore, we calculated robust standard errors using generalized estimating equations (GEE; Prima et al., 2017) by specifying intra-group (‘cluster’) correlation. We classified clusters by collaring events following a recommendation to use one cluster per

individual when the number of individuals exceeds 30 (Prima et al., 2017). Two individuals were opportunistically recollared in Coyote Valley. Clusters represented 38 collaring events across 36 bobcat individuals (total  $n_{strata} = 35,701$ ).

Next, we modeled the relative probability of a bobcat selecting a particular location as a function of all natural and disturbance landscape variables described above. All covariates were standardized (mean = 0, standard deviation = 2; Gelman and Hill, 2007). We performed pairwise Pearson correlations to ensure that covariates were not strongly collinear ( $|r| \leq 0.40$  for all pairwise relationships). We first independently modeled the two topographic covariates (ELEVATION, SLOPE) to determine which covariate performed best. We identified the best fit topographical model as that with the lowest quasi-likelihood under independence (QIC) score, a criterion indicated by Craiu et al., 2008 for use in GEE-based analyses. SLOPE performed best, and thus was included in all downstream modeling. Next, we fit a set of 20 candidate models (Supplemental Table S2) representing hypotheses regarding the potential influence of 10 landscape covariates (SLOPE, CROPS, ORCHARD, GRASS, TREES, SHRUBS, EUCALYPTUS, WATER, ROADS, and HOUSE) on bobcat movement. We selected the top model as that with the lowest QIC. We provide parameter estimates and 95% confidence intervals (derived from robust standard errors) on the logit scale, as estimated by CLR.

## 2.6. Housing density scale

To assess the scale at which housing density exerted the strongest influence on bobcat habitat selection, we calculated housing density individually at 16 different scales between 50 and 1000 m radius (at 50–100 m increments) buffers surrounding each used and available location. We tested the relative effects of these 16 different buffer sizes individually while controlling for directional persistence and step length using the CCLR framework. We identified the most parsimonious model (100 m buffer size) by comparing the QIC as described above.

## 2.7. Functional responses: housing density and vegetation cover

We wanted to determine whether bobcats exhibit a functional response to changes in low- to medium-housing density. We considered a functional response for both study areas collectively, but we also considered distinct functional responses within Aromas Hills and Coyote Valley because the two study areas have differing spectra of housing densities. In Aromas Hills, bobcats regularly moved through low-density neighborhoods (<5 houses/ha). In contrast, Coyote Valley residential development is largely high-density (>5 houses/ha) that bobcats rarely permeated. We tested for functional responses using a piecewise linear spline regression model that split housing density into two or three covariates with different slopes on either side of a breakpoint (Kohl et al., 2018; Smith et al., 2019b). We selected optimal breakpoints using a grid search approach of the breakpoint by comparing the QIC values of candidate spline models against models with a simple linear effect (on the log link scale) for housing density.

Next, because land acquisition, primarily of agricultural parcels, is active in both study sites, we considered a functional response to varying degrees of composite vegetation cover (i.e., trees and shrubs). Our aim was to calculate recommended vegetation restoration guidelines for parcels. We specifically tested for the functional response on the scale of one acre (a common management unit) by extracting the composite value for proportion cover by trees and shrubs in a one-acre circular buffer around each location. We performed the same grid search method described above.

## 2.8. Road crossings

We used 5-minute relocation data to identify the date, time, and location of road-crossing events for each individual that crossed one of

seven arterial primary or secondary roads. We focused this analysis only on major arterial roads with noted high traffic volume and road mortalities in the study areas (e.g. Serieys and Wilmers, 2019). Highway 101 was the only primary road in both study areas and is an 8–10 lane freeway with numerous culverts and underpasses. Average daily traffic is roughly 84,000 vehicles/day in Coyote Valley, and 52,000 vehicles/day in Aromas Hills (dot.ca.gov). All other roads were secondary (Supplemental Fig. S1) and average all daily average traffic volumes exceeded 2000 vehicles/day (Monterey Road: 9000; Route 129: 10,200; Route 25: 2400; Route 156: 3100; Bailey Road: 5525; Santa Theresa Road: 7500 vehicles/day). We defined a road-crossing location as any intersection of a line segment between two consecutive 5-minute bobcat locations and a line feature representing the arterial road. These locations were thus rough approximations of actual crossing locations. We classified road-crossings as occurring during the day or night based on local sunrise and sunset times.

We calculated the expected number of road crossings per hectare using a two-dimensional kernel density estimator (KDE) with a 250 m search radius of identified road-crossings in ArcGIS 10.3. The expected number of crossings ranged from 0 to 11.31, which we reclassified according to easily interpretable categories of areas of infrequent crossings (<1/ha), regular crossing areas (1–2/ha), and road-crossing hotspots (>2/ha).

## 3. Results

### 3.1. Movement sampling

We captured 38 bobcats (22 adults, 16 juveniles; 21 males, 17 females; Supplemental Table S3) across both study areas (Coyote Valley: 26; Aromas Hills: 12). One juvenile's collar fell off within two days, and we did not collar one juvenile. Therefore, we collected 652,700 5-min GPS-collar locations from 36 individuals (22 adults, 14 juveniles; 20 males, 16 females; Supplementary Table S3) filtered to 32,373 three-hour observations for habitat selection analyses. We monitored GPS-collared bobcats for an average of 143.8 tracking days (range: 16–369; median = 131 days).

### 3.2. Movement-explicit habitat selection

Both natural and anthropogenic landscape features strongly influenced bobcat habitat selection while individuals were moving (Table 1). Alternative models exhibited  $\Delta QIC > 17$  (Supplemental Table S2). Their

**Table 1**

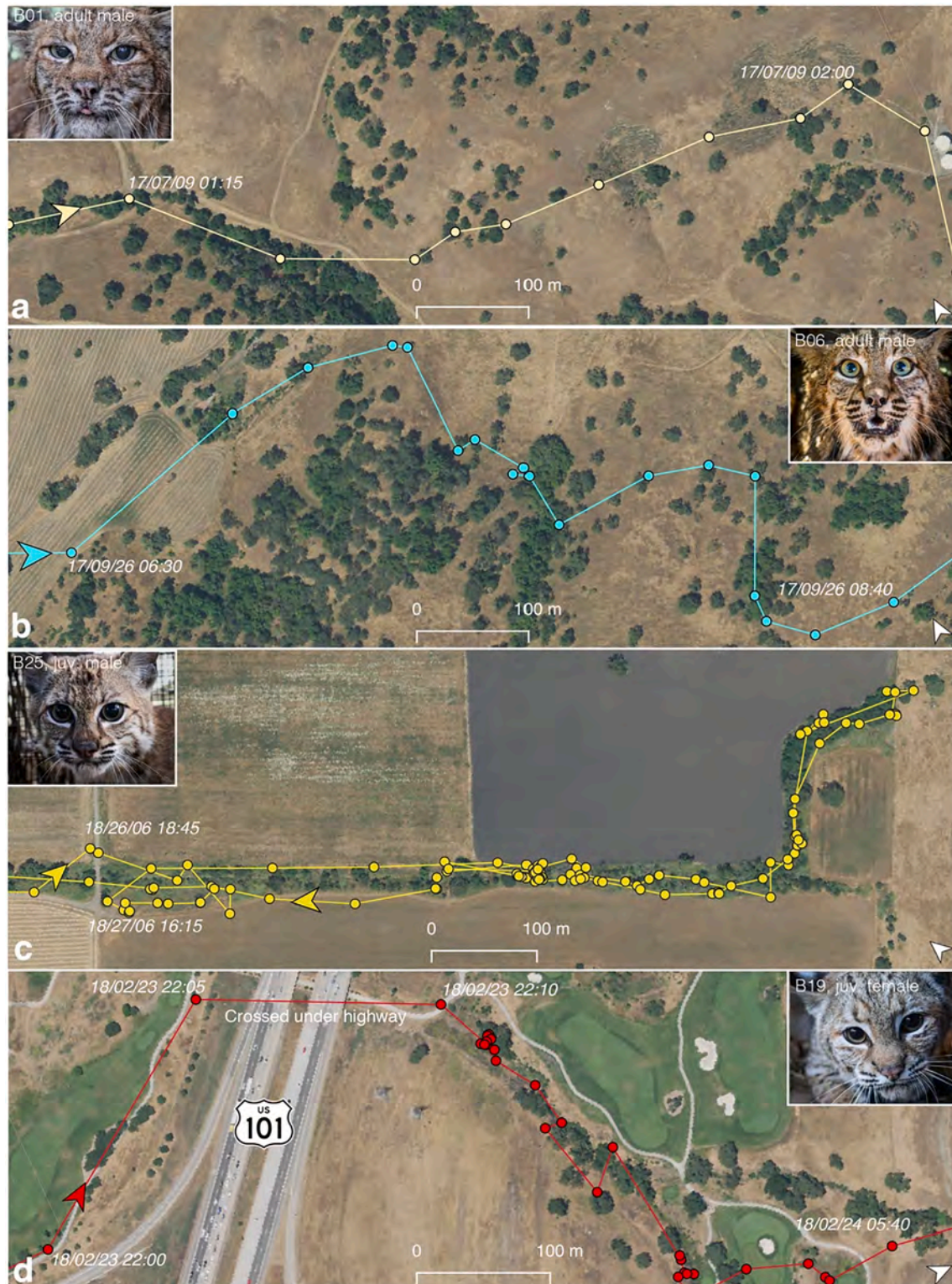
The top habitat selection model comprising landscape covariates and three resource-independent behavioral parameters. Water is measured as the distance from the nearest water source, and thus a negative selection coefficient represents a positive association. Behavioral parameters controlled for inherent biases in animal movement that influence habitat use. Directional persistence (DIR.PERSIST) controlled for the inherent tendency of individuals to move in a constant direction. Step length (STEP) and log-transformed step length (LOG.STEP) controlled for the habitat selection biases arising from the ability of individuals to travel to available locations.

Covariate	Assoc.	$\beta$ estimate	Robust SE	Lower 95% CI	Upper 95% CI	p- Value
TREE	+	1.43	0.08	1.27	1.60	<0.001
SHRUB	+	1.30	0.10	1.09	1.51	<0.001
CROP	–	–0.55	0.08	–0.71	–0.40	<0.001
ORCHARD	–	–0.15	0.03	–0.21	–0.09	<0.001
HOUSE	–	–0.18	0.04	–0.25	–0.10	<0.001
EUCALYPTUS	–	–0.26	0.07	–0.41	–0.12	<0.001
WATER	+	–0.49	0.19	–0.87	–0.12	0.010
SLOPE	+	0.18	0.06	0.07	0.28	0.002
DIR.PERSIST		0.15	0.05	0.05	0.24	0.003
STEP		–0.07	0.18	–0.43	0.30	0.724
LOG(STEP)		0.40	0.13	0.14	0.65	0.003



strong selection for trees ( $\beta = 1.43$ ) and shrubs ( $\beta = 1.30$ ) was remarkably apparent even when mapping each individual's movement data over satellite imagery (Fig. 2). Bobcats strongly avoided highly transformed landscapes — even those that remained largely vegetated. Specifically, bobcats avoided row crops ( $\beta = -0.55$ ), eucalyptus ( $\beta = -0.26$ ), and orchards ( $\beta = -0.15$ ). Bobcats selected for proximity to

water ( $\beta = -0.49$  [the coefficient is negative because the covariate is calculated as the distance from water]) and steeper slopes ( $\beta = 0.18$ ). Bobcats selected against high density housing ( $\geq 5$  houses/ha;  $\beta = -0.18$ ).



**Fig. 2.** Bobcat movement is evident at the scale of a single tree or shrub. A–B) Approximately 1 h of 5-min interval data for adult males. C) Approximately 22 h of 5-min data for a juvenile male. D) Juvenile female crosses under Highway 101 following sparse vegetation.

### 3.3. Functional responses: housing and vegetation

For the combined study areas, and for Coyote Valley specifically, we found no support for a functional response to housing. Coyote Valley's dense, multifamily residential development was impermeable to bobcats with the exception of three juveniles that took single forays into these areas. In Aromas Hills, a clear functional response emerged (Fig. 3a). Probability of selection increased from 0 to 0.95 houses/ha (i.e. between 2 and 3 houses within 100 m; knot = 0.4 standard deviations above the mean;  $\Delta$ QIC of  $-8.15$ ), after which the probability of avoidance increased as housing density increased.

Bobcats across both study areas exhibited a strong functional response to vegetation ( $\Delta$ QIC =  $-1216.0$ ; Fig. 3b). The relative probability of selection increased for vegetation cover (on the scale of one acre) as the proportion of vegetation increased, saturating at 69% (0.47 standard deviations above the mean), and thereafter, declining gently.

### 3.4. Roads: permeability and features of hotspots and barriers

We documented 29 bobcats (22 adults, 13 juveniles, 19 males, 16 females) cross arterial roads 3333 times (Supplemental Tables S4–S5). The majority (80%) of crossings occurred at night. Adults crossed more frequently than juveniles (adults: 0.85 crossings/day; juveniles: 0.52 crossings/day), while females crossed more frequently than males (females: 0.86 crossings/day; males: 0.58 crossings/day). Seventy-nine percent of crossings were across secondary roads, while 21% were across Highway 101. We did not detect road avoidance using habitat selection models. We identified 14 road-crossing hotspots: 10 in Coyote Valley and four in Aromas Hills. Five hotspots crossed Highway 101. Nine crossed secondary roads. All crossing hotspots (Fig. 4a–c) shared certain features. They were in topographical depressions, often in drainages or stream beds (12/14), and in every case, trees or shrubs flanked both sides of the road. Four crossing hotspots across Highway 101 were characterized by extensive overpasses across riparian areas (that bobcats could cross under). In the remaining hotspot, a large culvert was present.

While biologists did not specifically record whether cats passed under or over roads, we assume animals used this infrastructure in the majority of cases (e.g. Fig. 2d). Along stretches of Highway 101 that did not have crossing infrastructure, particularly an 8 km stretch in Aromas Hills, we did not document attempted crossings by collared bobcats and rarely road mortalities. Two Aromas Hills bobcats moved directly adjacent to the highway along the stretch absent of crossing infrastructure, but the highway delineated the boundary of their movements.

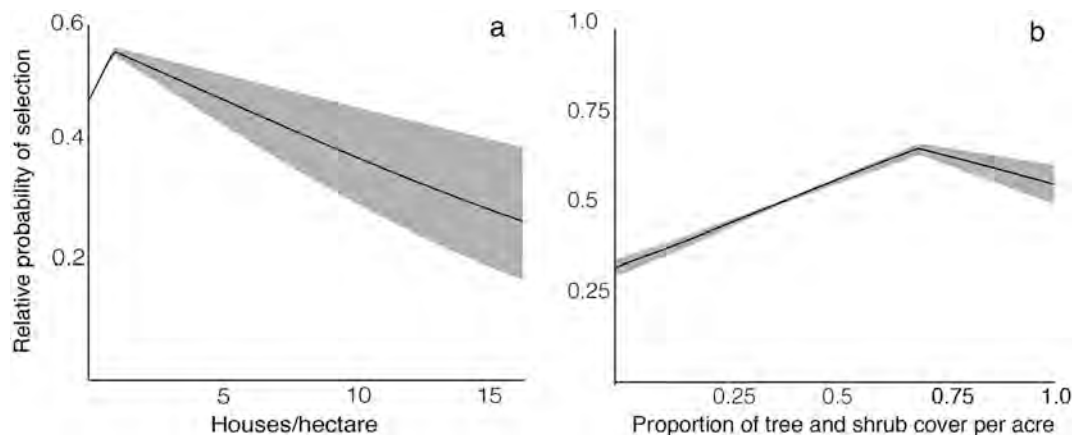
The deadliest and least-crossed arterial road was Monterey Road

(Fig. 4d) although this road had only 10.7% the average daily traffic volume as the adjacent primary road, Highway 101. However, Monterey Road characterized by a lack of potential crossing infrastructure, frequent wildlife road mortalities, and a prominent concrete median topped with mesh wire fencing ( $\sim 1.5$  m tall). Crossing Monterey Road accounted for only 1.6% of total successful crossing events, but seven of thirteen road mortalities in Coyote Valley. Of the twenty-five Coyote Valley bobcats, all were captured  $< 3.2$  km from Monterey Road (median = 792 m). Yet we observed only five individuals successfully cross the road, three of which were eventually killed on the road. Unexpectedly, Monterey Road formed a stronger movement barrier for bobcats than Highway 101.

### 3.5. Mortality and poisons

We documented 28 bobcat mortalities (18 Coyote Valley, 10 Aromas Hills; 9 GPS-collared, 19 opportunistic; Supplemental Tables S3, S5). Of the nine GPS-collared bobcats, four were hit by cars, two died of notoedric mange, two were predated, and one was attacked by domestic dogs. Of the opportunistic mortalities, 13 were hit by cars and four died of mange. Although the majority (68%) of the mortalities were detected opportunistically (and thus source of mortality potentially skewed by detection bias), in Coyote Valley, vehicle collision was the leading source of mortality ( $n = 12$ ) while in Aromas Hills, mange was the leading source of mortality ( $n = 5$ ).

Bobcat death due to notoedric mange has previously been linked with secondary anticoagulant rodenticide (AR) exposure (Riley et al., 2007). Therefore, we assessed AR exposure in bobcats when possible. We recovered livers from 18 individuals and detected exposure to ARs in 17 (94.4%) of these individuals tested. Bobcats, like other predatory species, are secondarily exposed to these globally ubiquitous poisons via consuming poisoned prey (Hindmarch et al., 2018; Riley et al., 2007; Serieys et al., 2015). Five different commercial compounds were detected — second-generation brodifacoum, bromadiolone, and difethialone, and first-generation diphacinone and chlorophacinone. Individuals were exposed to 1–5 compounds (median = 3.5; Supplementary Table S4), indicating repeat exposure events because AR baits are formulated with single compounds. The total concentrations detected ranged from “level of detection” (LOD)—1.82 ppm, with a mean concentration of 0.37 ppm (median = 0.15, SD = 0.52). In contrast to previous liver-based bobcat studies (Riley et al., 2007; Serieys et al., 2015), we most frequently detected first-generation compounds diphacinone and chlorophacinone, and diphacinone specifically was present in every AR-positive bobcat, while chlorophacinone was detected in 78% of individuals ( $n = 14$ ; mean = 0.02 ppm). The mean concentration



**Fig. 3.** Functional responses to housing density and vegetation. a) Relative probability of selecting low housing density increases steeply up to one house/ha. The relative probability of selecting for areas without housing is approximately equivalent to the relative probability of selecting for housing densities of 5 houses/ha. b) Relative probability of selecting habitat with cover (composite tree and shrub) increases as vegetation increases.





**Fig. 4.** Road-crossing hotspots (a–c) and Monterey Road (d). Individual road-crossing events documented from unique bobcats are represented by a yellow circle. High resolution (5-min) relocation data were used to identify the date, time, and location of road-crossing events for each individual that crossed arterial roads. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

of diphacinone (mean = 0.15 ppm) was also relatively high compared with other compounds. With respect to second-generation compounds, 11 bobcats were exposed to brodifacoum (mean = 0.03 ppm), nine to bromadiolone (mean = 0.17 ppm), and three to difethialone (all 'LOD'). For six bobcats that died of mange, we detected 36% greater total concentration of ARs (mean = 0.42 ppm) as for bobcats that died of other causes (mean = 0.31 ppm).

#### 4. Discussion

We used advanced bio-logging technology to collect high-resolution bobcat movement observations in a human-modified landscape to provide rapid data-based recommendations for preserving “last-chance” corridors linking the Santa Cruz Mountains wildlife community with those in adjacent ranges. By using both 5-min and 3-h resolution movement data, we identified unexpected trends, such as the critical importance of individual trees and shrubs in promoting structural connectivity, whether within habitat patches or over roads. We observed varying degrees of permeability in matrices in the study area, where, for example, high-density housing development was impermeable and avoided, while low-density housing was not only permeable to bobcats, but even attractive and positively selected. Yet, complementing our movement data with mortality data demonstrated a pervasive, but an easily overlooked edge effect—nontarget rat poison exposure. Indiscriminate poisoning of nontarget wildlife is likely important

impediment to functional connectivity for numerous species beyond our focal bobcats. By integrating these diverse data on habitat selection, road interactions, and edge effects, this study reinforces that the maintenance of structural connectivity alone is insufficient for preserving corridors that abet wildlife conservation in fragmented landscapes.

##### 4.1. Selection for complex vegetation

In coastal sage scrub and oak woodland savannah habitat, native vegetation that adds complexity to the landscape was the most critical natural component of structural connectivity. Bobcat selection for natural vegetation was evident at the scale of a single tree or shrub. As previously observed in bobcats (Abouelezz et al., 2018; Litvaitis et al., 2015; Reed et al., 2016) and other ecologically-similar carnivores such as Eurasian lynx (*Lynx lynx*; Bouyer et al., 2015), leopards (*Panthera pardus*; Fattedbert et al., 2015), and pumas (*Puma concolor*; Burdett et al., 2010), bobcats strongly avoided areas simplified by monoculture (row crops and orchards) and opted instead for the more complex structure of natural vegetation. More complex vegetation offers better cover for stalking prey (Hopcraft et al., 2005; Smith et al., 2019a). Unexpectedly, vegetated riparian corridors <25 m wide provided sufficient cover for bobcats (of all demographics) to move through otherwise barren, row crop fields, an essential element to landscape connectivity in the fragmented landscape. We detected multiple juveniles residing exclusively in these narrow swaths of vegetation (Fig. 2c), suggesting that these



linear sections of vegetation are important to functional connectivity.

#### 4.2. Contrasting permeability of matrix infrastructure

Studies have repeatedly found that large felids will move through low-density housing (Burdett et al., 2010; Lewis et al., 2015; Smith et al., 2019b) but in Aromas Hills, such conditions actually proved preferential to bobcats. In contrast, high-density residential areas were impermeable with exception to three juveniles that took single forays into densely developed areas. Possible explanations for selection of low-density residential areas could be that landscaping creates more complex, better-irrigated habitat, or that bobcats are attracted to synanthropic prey near houses. In southern California, bobcats selected urban areas for nighttime foraging of rabbits (*Sylvilagus* spp.; Dunagan et al., 2019). While low-density residential areas can offer increased resources, these areas may represent ecological traps (Battin, 2004) because bobcats are more likely to be exposed to rodenticides in residential areas than in unaltered habitat (Serieys et al., 2015). The characteristics of matrices can thus have dichotomous effects on habitat selection with repercussions for functional connectivity if the resources bobcats seek are poisoned.

The influence of roads revealed the nuanced effects of matrix infrastructure versus activity in mediating connectivity. Roads are ubiquitous and affect the ability of all wildlife species to live and move within human-dominated landscapes (Clark et al., 2015; Kramer-Schadt et al., 2004; Poessel et al., 2014). However, it is often impossible to disentangle the barrier effects of the structural features of roads from those associated with traffic on those roads (Riley et al., 2014a). We found that crossing hotspots occurred where complex vegetation (trees or shrubs) intersected the road rather than where traffic was light. Highway 101 was a strong impediment to movement in Aromas Hills (particularly along an 8 km stretch that did not have any available safe-crossing infrastructure) while Coyote Valley bobcats readily crossed the freeway. In Aromas Hills, only two collared individuals found two safe-crossing areas. In Coyote Valley, 11 bobcats found at least nine culverts or underpasses that provided safe-crossing locations (three of which were crossing hotspots) without encountering vehicles. The Highway 101 bridges and culverts in Coyote Valley typically occur where riparian strips intersect the highway, such that natural vegetation funneled bobcats toward features that offer safe crossing for numerous species (Grilo et al., 2008; Smith et al., 2015).

In contrast, Monterey Road bears substantially less traffic but was a stronger barrier to movement and killed more bobcats. We identified a single culvert that was always flooded, which discourages carnivores from passing through (Tigas et al., 2002). When wildlife attempt to cross over the road, they encounter a concrete median topped with chain-link fencing. The combination of forcing bobcats to cross through traffic and erecting an obstacle half-way across proved particularly deadly.

#### 4.3. Edge effects as threats to functional connectivity

The impacts of habitat fragmentation extend beyond the boundaries of anthropogenic development and can cryptically reduce fitness (Flesch, 2017) and increase mortality (Benson et al., 2019) thereby constraining functional connectivity. As previously documented elsewhere for bobcats and wildlife in North America generally, human activities, and specifically vehicles, were the predominant source of mortality we documented (Hill et al., 2019; Serieys et al., 2015). Secondly, notoedric mange, which has been linked with AR exposure in 99% of investigated cases in California bobcats (Serieys et al., 2015), was another prominent source of mortality; in Aromas Hills, it even eclipsed vehicle collisions as the leading source of mortality. We were unable to statistically model cause-specific mortality and survival on our mortality data given that: i) our sample size of tagged mortalities was low, and ii) untagged opportunistic mortalities may bias our findings.

Bobcat deaths from vehicles and mange in our study areas attest to

the multiple harmful edge effects wildlife experience in human-dominated landscapes (Hill et al., 2019). The prevalence of mortality due to notoedric mange associated with rodenticide exposure was unexpected and demonstrates that in vulnerable landscapes, cryptic threats to functional connectivity cannot be overlooked. The deadly spillover of common pesticides into natural populations is more prevalent than frequently recognized because it can easily go undetected (Berny, 2007). Rodenticide exposure for sampled bobcats was high (94%) even though the California Department of Pesticide Regulation restricted the use of second-generation anticoagulant rodenticides in 2014 to reduce harm to wildlife (section 6471, Title 3, California Code of Regulations, [www.cdpr.ca.gov](http://www.cdpr.ca.gov)). The observed prevalence was consistent with that found in a more extensive study of bobcats (88% of livers, n = 172) in southern California prior to these new regulations (Serieys et al., 2015). Clearly, these restrictions were insufficient to protect our study population from ongoing harm. While overall exposure rates were similar between the two studies, one critical difference is that we detected first-generation ARs (diphacinone) in every sample while the prior study recorded first-generation ARs in fewer than half of all exposed bobcats. This suggests that end users reacted to the new regulations not by reducing the use of ARs but by substituting first-generation ARs for the restricted ones. Exposure was likely higher in Aromas Hills than in Coyote Valley due to intensive application of ARs in agricultural areas, which are far more extensive in the former. Even if bobcats avoid crop fields and orchards areas specifically, poisoned prey can travel to adjacent natural areas or riparian corridors that bobcats favor.

Anticoagulants, and diphacinone in particular, have been linked with immune dysfunction and altered gene expression in bobcats (Fraser et al., 2018; Serieys et al., 2018), and these consequences explain increased mange vulnerability. The altered immune function and gene expression associated with ARs highlights the complex nature of edge effects, and that certain edge effects can indirectly kill wildlife through altered immunity and disease dynamics. Yet negative effects of ARs are not limited to bobcats. Just in California, ARs have directly killed predators that include bobcats, pumas (Benson et al., 2019), coyotes (Riley et al., 2003), gray foxes (*Urocyon cinereoargenteus*, Riley, NPS Unpubl. data), San Joaquin kit foxes (*Vulpes macrotis*; Cypher et al., 2014), fishers (*Pekania pennanti*; Gabriel et al., 2012), barn owls (*Tyto alba*), Cooper's hawks (*Accipiter cooperii*), great horned owls (*Bubo virginianus*), red-shouldered hawks (*Buteo lineatus*), striped skunks (*Mephitis mephitis*), and Turkey vultures (*Cathartes aura*; California Fish and Wildlife Unpubl. data). Wildlife exposure to pesticides demands intervention if managers want to maintain or restore ecological connectivity near the wildland-urban or wildland-agricultural interface.

#### 4.4. Conservation and management implications

Our movement data have already guided parcel acquisition of a key habitat patch in Coyote Valley, thus successfully aiding in restoring one "last-chance" corridor. Our functional response and habitat selection analyses for vegetation indicates that in barren agricultural fields that undergo rehabilitation, faster growing shrubs (as opposed to slow-growing oak trees) can be used to more quickly add complex vegetation to the landscape and thus rapidly restore a matrix component to natural habitat. Our study thus offers a compelling example of how rigorous data collection and analysis of animal behavior can focus highly targeted conservation actions. Moving forward, by recognizing the effects of vegetation and infrastructure on connectivity, considerable capacity exists to reduce mortality and to restore and preserve movement corridors, and corresponding gene flow within Coyote Valley and Aromas Hills. The lessons learned here apply more broadly to bobcats and other highly mobile terrestrial predators across the urban-wildland interface of North America.

The findings that anthropogenic and natural landscape features can exert strong influence on bobcat movement are a cause for both concern and optimism. Although matrix components that include crops, roads,

and medium-high-density housing impede bobcat movement, culverts, low-density housing, and the restoration of trees and shrubs can mitigate these effects even in broadly-transformed landscapes. Corridors can be very narrow so long as they contain shrubs and trees in addition to grass. Yet preserving structural connectivity alone will not conserve Santa Cruz Mountains wildlife. Functional connectivity requires healthy, abundant populations to generate fit dispersers (Pulliam, 1988). Exposure to people is poisoning wildlife and bobcat preferential selection of low-density housing and narrow corridors in agricultural fields is potentially luring them into toxic ecological traps. We investigated AR exposure in a single species, but repeatedly, research has found that where one species is affected, others are too (Gabriel et al., 2018; Riley et al., 2007). Further, these poisons threaten numerous endangered species (Benson et al., 2019; Cypher et al., 2014; Gabriel et al., 2012, 2018). Ongoing monitoring, local outreach to encourage reduced AR use, and alternative interventions, such as integrated pest management approaches, are needed to maintain functional connectivity for Santa Cruz Mountains wildlife populations.

Similarly, more must be done to reduce vehicle collisions. Our hot-spot analyses elucidate where road-crossing attempts are most likely, facilitating a targeted mitigation approach when prioritizing which culverts to retrofit or maintain as viable crossing structures. Retrofitting or maintaining culverts to prevent standing water could be a relatively simple solution to mitigate mortality. High median barriers were associated with increased mortality; the same barriers on the freeway edges could funnel animals toward available culverts. By bookending “safe-crossing” culverts with natural vegetation, some species may be encouraged to use them (Smith et al., 2015) while clearing vegetation along the roadside at dangerous crossing locations could deter crossing attempts.

Overall, we found substantial scope to reduce edge effects and preserve connectivity between the Santa Cruz Mountains and neighboring ranges even in the face of ongoing development. Specific actions to preserve these links beyond restoration of “last-chance” corridors are needed however; passivity will not succeed.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

Tracking data are available via the Movebank Data Repository (<http://www.movebank.org>).

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.biocon.2020.108930>.

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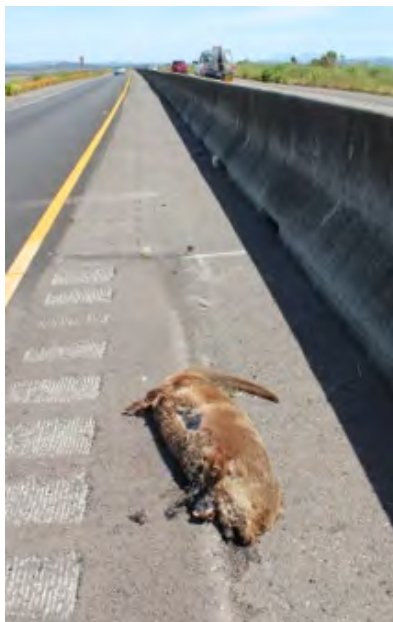
# 2017

## Road Ecology Center, UC Davis

Fraser Shilling, Ph.D., Co-Director

David Waetjen, Ph.D., Programmer

Kathryn Harrold, Consultant



## Impact of Wildlife-Vehicle Conflict on California Drivers and Animals

Using observations of reported traffic incidents and carcasses the Road Ecology Center estimates the total annual cost of wildlife-vehicle conflict (WVC) in California to be at least \$276 million, up 20% from the year before. This report includes maps of WVC hotspots, discusses impacts to wildlife and people from WVC, and ranks highways in each Caltrans District for financial cost of WVC (spoiler, I-280 in District 4 is the costliest). Projects to reduce WVC can be the most effective of any safety project, with effectiveness often >90%. In addition, only 1-2% of California's transportation budget, including the new Senate Bill 1 funds, would be required to carry out these safety projects.

This report provides an overview of wildlife-vehicle conflict (WVC) hotspots on California highways in 2015 and 2016, based on a combination of traffic incidents involving wildlife that were recorded by the California Highway Patrol (CHP) and carcass observations reported to the California Roadkill Observation System (<http://wildlifecrossing.net/california>). Because Caltrans does not systematically record where they pick up the tens of thousands of wildlife carcasses per year they dispose of from state highways, these data are not included. Analytical details are available from Fraser Shilling ([fmshilling@ucdavis.edu](mailto:fmshilling@ucdavis.edu)) upon request.

## **Photo acknowledgements**

Mule deer – Kathryn Harrold

Otter – Fraser Shilling

## **Data collection acknowledgements**

This and previous reports and the analyses contained within would not have been possible without the concerted and coordinated efforts of hundreds of volunteer roadkill observers over the last 9 years who contribute to the California Roadkill Observation System (CROS, <http://wildlifecrossing.net/california>). Through their endeavors, they have collected >53,000 observations of >420 species, representing one of the largest and most comprehensive wildlife monitoring programs in California. Their accuracy rates for species identification are >97% and have measurably high locational accuracy (median  $\leq \pm 13$  meters). For scientific papers describing our roadkill/WVC work, see our published work cited below and at the end of this report (you can paste the “doi” value into a browser and access the papers). The report also benefited from the efforts of many unknown law enforcement personnel who described traffic incidents in enough detail that we can use their observations to help plan for reduced wildlife-vehicle conflict.

## **CROS is 9-Years Old, Published, & Globally Linked**

The Road Ecology Center at UCD is happy to announce that CROS is now 9 years old, and during this period, the volunteers have assembled an (ongoing) important dataset which can benefit California wildlife and drivers in the decades to come. We have also released a new journal article on CROS, published in the peer-reviewed journal *Frontiers of Ecology and Evolution*, covering the technical details of the project, including the accuracy of volunteer observations. The paper also covers details of our other project in Maine, called the Maine Audubon Wildlife Road Watch (<http://wildlifecrossing.net/maine>). Finally, we have partnered with other similar systems around the world in the Globalroadkill.net project (<http://globalroadkill.net>).

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## The Authors

Fraser Shilling is the Co-Director of the UC Davis Road Ecology Center (<http://roadecology.ucdavis.edu>). He actively investigates the impacts of transportation systems on natural systems and human communities. He received his PhD in 1991 from the University of Southern California in the Division of Biological Sciences. Dr. Shilling directs the California Roadkill Observation System, the largest system in the world for volunteer observations of roadkill. David Waetjen is lead programmer and web guru for the Road Ecology Center. He received his PhD from UC Davis (Geography) in 2011. He develops web-systems and spatial analyses for wildlife, water, and sustainability applications. Kathryn Harrold is an independent wildlife consultant who is expert in how wildlife interact with roadways and how we can improve roads/highways to protect drivers and wildlife from conflict.

Contact: Fraser Shilling, Co-Director, Road Ecology Center, UC Davis; [fmshilling@ucdavis.edu](mailto:fmshilling@ucdavis.edu), 530-752-7859; [@roadecology](#)

# UC Davis Road Ecology Center

## Fourth Annual Special Report on the Impact of Wildlife-Vehicle Conflict (WVC) on California Drivers and Animals

### Top 5 Recommendations

1) Systematically collect data. The state data assembled here were not collected with the purpose of studying wildlife-vehicle conflict, the volunteer data were. California agencies should up their wildlife game and collect data about wildlife-vehicle conflict. This is especially true for Caltrans, which already collects and disposes of tens of thousands of wildlife carcasses annually, but does not record or report the data.

2) Require collection and analysis of wildlife-vehicle conflict data for highway/road projects, before they are approved and funded. Transportation and wildlife agency biologists have very little data upon which to base decisions for projects impacting wildlife and their habitat. Highway projects that are likely to increase WVC can be approved and built because these data are not required.

3) Protect driver safety and wildlife by building WVC-reduction projects. Very few driver safety projects have the overall effectiveness that WVC reduction projects do. There are hundreds of places on state highways and major roads where WVC is a priority, but statewide only 2-3 projects are built per year. We need ten times that rate in order to reduce risk to both drivers and wildlife.

4) Use our vast transportation resources to support this critical need. New funds from Senate Bill 1, \$5.3 billion annually, along with existing transportation project funds mean that we could easily build 10 times as many large WVC reduction projects per year, but we choose not to.

5) Systematically evaluate how well we are doing with WVC reduction so that we can keep improving. As we plan and build WVC reduction, we should transparently monitor reduced driver injuries and death and use of the structures by wildlife.

### Introduction

Using California state data on traffic incidents, the Road Ecology Center has mapped stretches of California highway that are likely to be hotspots for wildlife-vehicle conflicts (WVC). Animals entering roadways are often killed and pose a hazard to drivers, who may collide with the animal, or try to avoid the animal and have an accident suffering vehicle damage, injury, and even death. We estimated the total annual cost to society from >7,400 WVC incidents in

California on state highways and a small proportion of major roads to be ~\$276 million for 2016, which is a 20% increase over 2015. **It is important to note that this report does not cover ALL incidents in California, just the ones reported by the CHP and California Roadkill Observation System (CROS).** Allstate Insurance Co. estimates that California had >23,000 claims/year for collisions with wildlife in 2015-2016, which is >3 times the rate we describe here and if included, would result in a total cost to society of >\$500 million/year. Wildlife populations may suffer significant losses due to collisions and highways with high rates of WVC may cause ripple effects into surrounding ecosystems. In addition, animals are injured during collisions, which is damaging to the animal and potentially traumatic and life threatening to drivers.

By identifying stretches of highway where WVC are more likely, the Road Ecology Center is assisting Caltrans and other responsible entities in developing mitigation to protect drivers and wildlife populations. Measures with proven effectiveness include building fencing and over/under-passes along priority highways to allow the safe passage of wildlife across highways and reducing speed limits in protected wildlife habitat. According to Caltrans and California Highway Patrol statistics, there are >7,000 reported accidents per year on California highways involving deer and other wildlife. We estimate that there are another few thousand with horses, cows, sheep and goats.

For the second year analyzing CHIPs data, we have determined rates and locations of both animal carcasses and reported traffic incidents. These incidents could be reports of animals running across the road, collisions with animals (primarily deer), or accidents resulting from people swerving to avoid a collision with an animal in the road. Our analyses include identification of geographical hotspots and calculated costs to the public from vehicle damage, injury and even death. This information shows where there are problems and should help in developing safety projects to fix these known problem areas.

The following sections include maps of the distribution of WVC densities, projected costs of WVC and hotspots along state highways and other roadways. The densities of WVC reported are the minimum for each highway segment and do not represent actual rates, which are likely to be much higher. By significantly increasing the systematic treatment of these hotspots and stretches of highway with high rates of collisions, Caltrans and other entities can contribute cost-effectively to driver safety and improve the environmental sustainability of state highways.

## Methods

### Traffic Incidents

Records of traffic incidents between February 2015 and February 2017 were obtained from state databases of traffic incidents (e.g., emergency responses to crashes), included in our customized “California Highways Incident Processing system” (CHIPs), and coded according to severity of the incident for the drivers/vehicles and for the animals. We separated the ~13,000 records of wildlife-vehicle collisions from the ~1.4 million traffic incidents using customized term queries (e.g., for “deer” AND “buck” AND “doe” AND “fawn”). We reviewed each record for information about fate of the animal, fate of the driver, type of accident (collision vs. swerve), and vehicle damage. Location and date/time information were from the record.

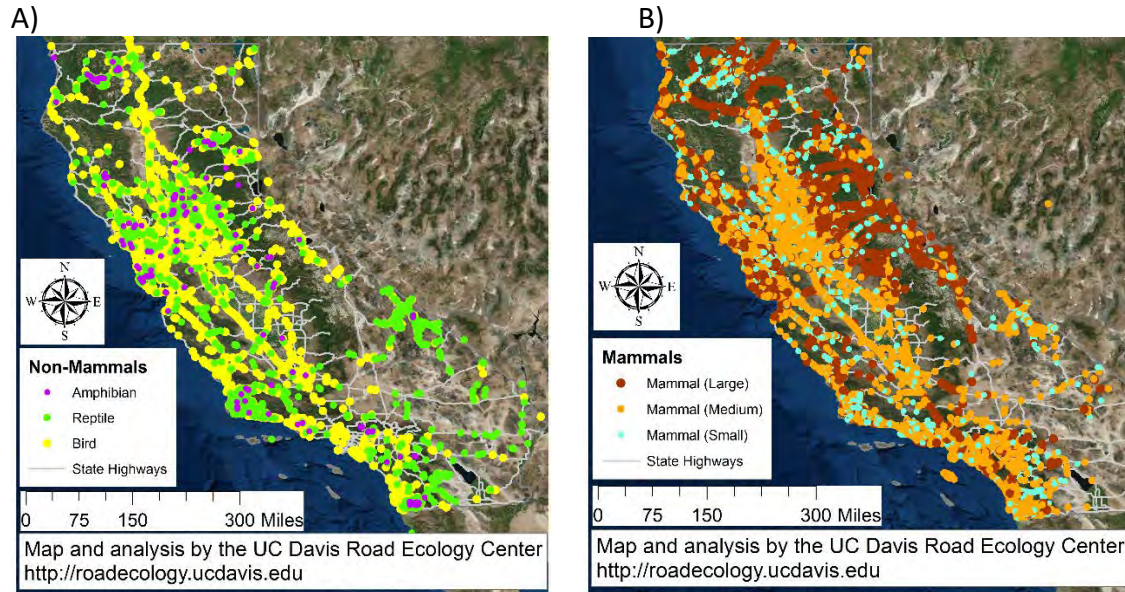
The California Roadkill Observation System project (<http://wildlifecrossing.net/california>) includes past and current participation by over 1,000 volunteer-scientists, including several hundred academic, agency, and NGO biologists and natural historians (Shilling and Waetjen, 2017). More than 53,000 WVC observations were contributed to the website by volunteers between August 2009 and the end of 2016 and by Caltrans Maintenance staff for the period 1987 to 2007. We selected recent observations of large-animal carcasses (last two years) and combined these observations with the CHP crash data.

The carcass observations and traffic incidents were used in a geographic information system (GIS) to identify stretches of highway where WVC occur more frequently (high density) and places where there are statistically-significant clusters of WVC (hotspots; Shilling and Waetjen, 2015). Density was calculated as number of incidents/mile and by using the Kernel Density Estimator (KDE) tool in ArcGIS. Hotspots were identified using spatial autocorrelation tests (Morans I, Getis-Ord, and KDE plus). Estimates of costs to society of incidents were calculated using the nature of the incident (e.g., “minor injury”) and coefficients for the average cost of these types of incidents used by the US Department of Transportation (USDOT, 2013).

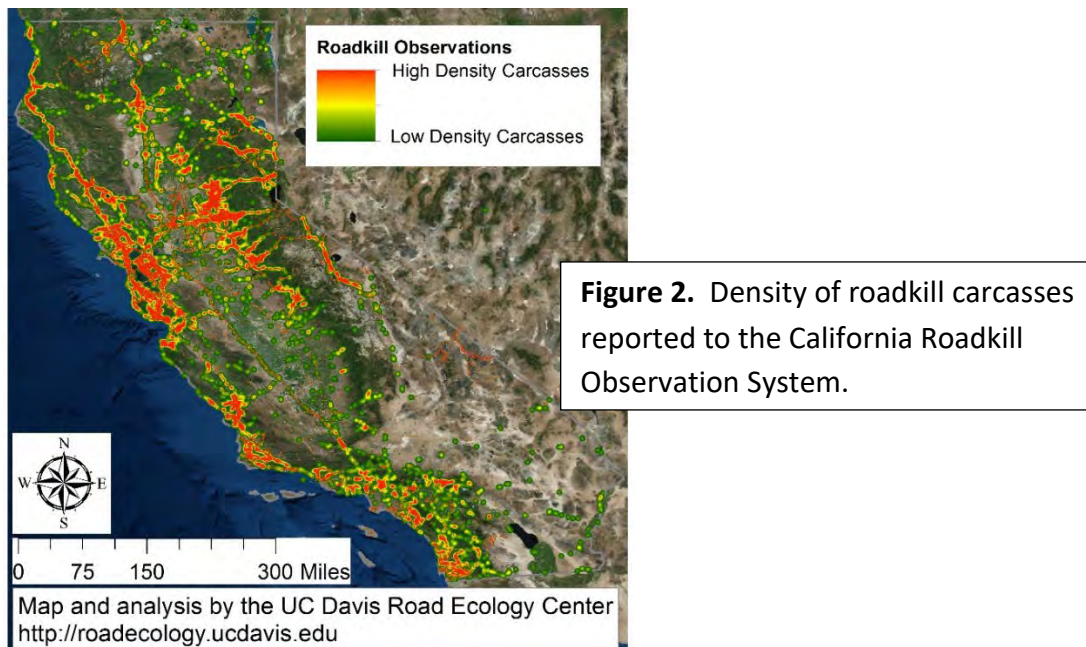
## Major Findings

### Statewide Carcass Observations

The maps below show >53,000 observations of animal carcasses on local roads and state highways (Figure 1) and the density of carcasses across the state (Figure 2). These are not the total roadkill that occurred, just the ones that people saw and reported to the California Roadkill Observation System (CROS) between 2009 and 2016.



**Figure 1.** Carcass observations for (A) amphibians, reptiles, and birds; and (B) mammals of various sizes.

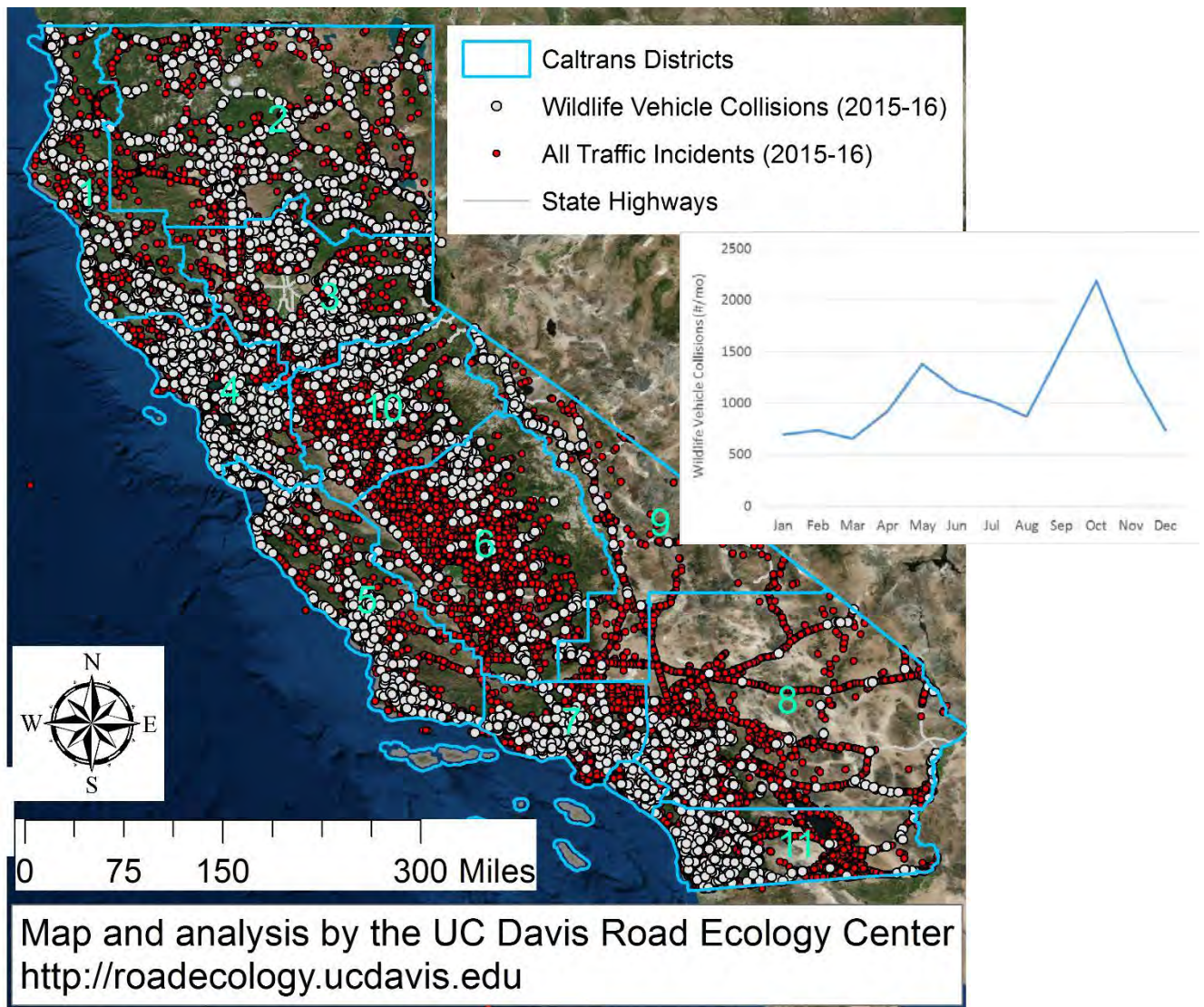


**Figure 2.** Density of roadkill carcasses reported to the California Roadkill Observation System.



## Statewide Highway Traffic Incidents

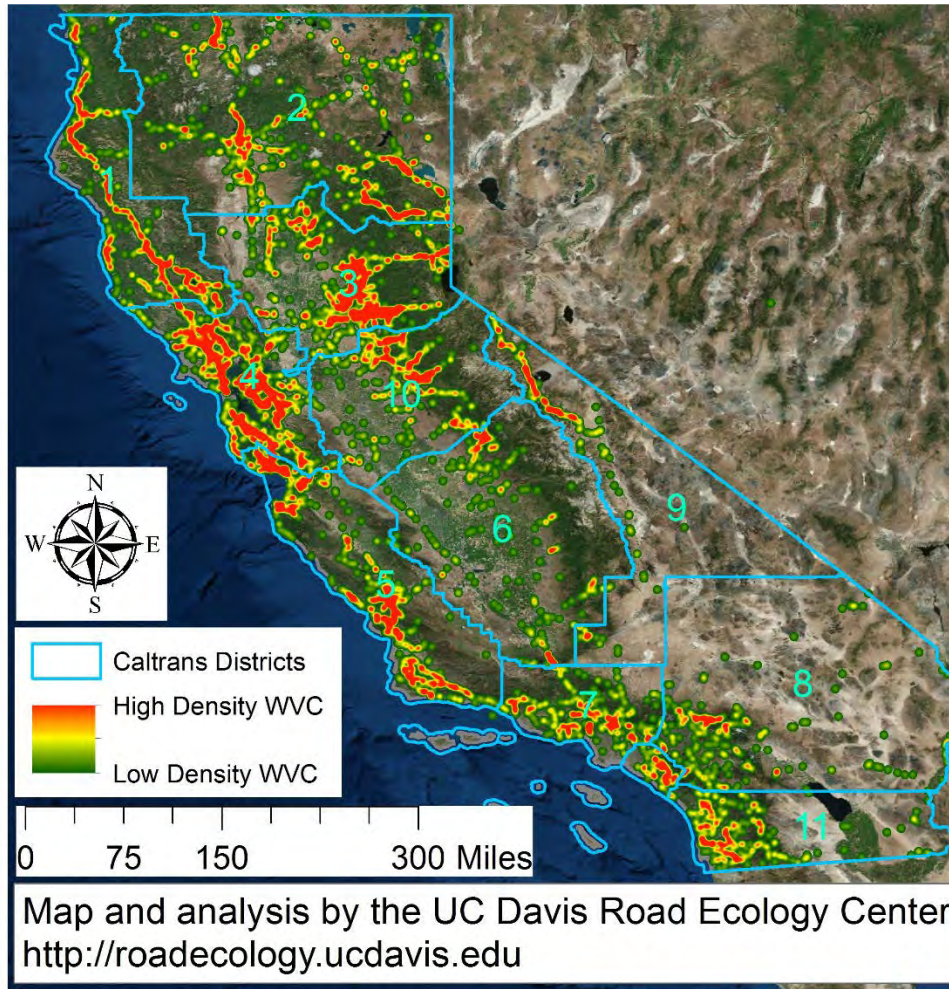
There were at least 1.4 million traffic incidents (of all types) across California reported to the California Highway Patrol in 2015 and 2016 (Figure 3, All Traffic Incidents). Of these, about half were collisions and more than 13,000 involved wildlife, including reports of animals standing next to, standing in, or running across roadway lanes, collisions with large animals, and swerving to avoid collisions, resulting in a crash (Figure 3, Wildlife Vehicle Collisions). October was the most dangerous month for conflict, with about twice as many incidents as other months (inset graph). This may be because of increased movement related to mating season and seasonal migration.



**Figure 3.** All traffic incidents (dark symbols) and those involving wildlife (white symbols) in the California Highways Incident Processing system (CHIPS) for 2015 and 2016. Caltrans districts are numbered and outlined in blue. Inset graph: number of WVC per month for 2015 - 2016.

## Statewide Wildlife-Vehicle Conflict Hotspots

Although WVC occur everywhere in California, the highest densities were reported in the San Francisco Bay Area (Caltrans District 4), Sierra Nevada Foothills (Caltrans Districts 3 & 10), North Coast (Caltrans District 1), and parts of the Central/South Coast (Caltrans Districts 5, 7, 11 & 12). These high-density areas are most likely where traffic volumes and wildlife populations are greatest, leading to more conflict. The map below shows the density of collisions with large wildlife in California (Figure 4).

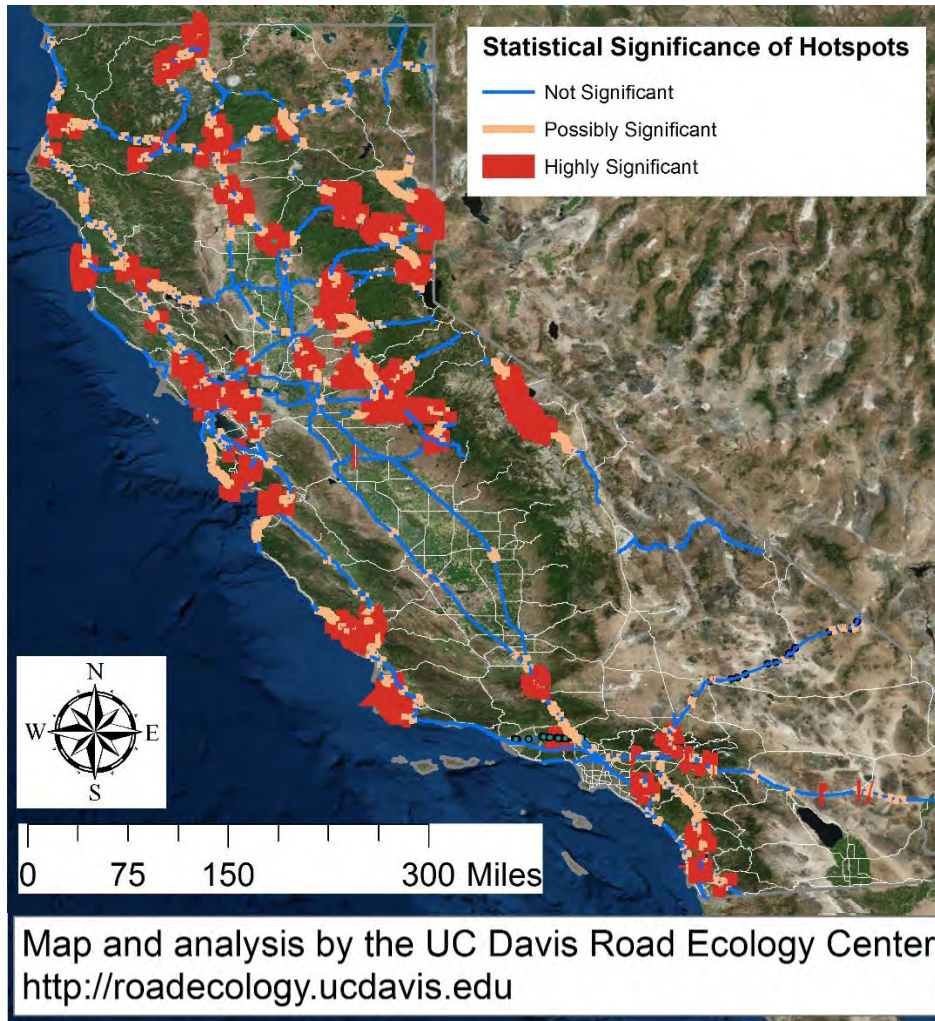


**Figure 4.** A) Density of all WVC for 2015 and 2016.

In order to inform statewide decision-making about resource-distribution to reduce WVC, we mapped the density of WVC across all highways/roadways (Figure 4). In order to inform decision-making about specific highways, we also mapped statistically-significant clusters of points along highways with the highest rates of WVC (Figure 5, below). For many highways,



there are back-to-back clusters of WVC, resulting in entire stretches of highway being highlighted as a hotspot (e.g., highway 395 on the east-side of the Sierra Nevada).



**Figure 5.** Statistically-significant hotspots for collisions of vehicles with large mammals on certain highways.

### Consequences of Collisions to Drivers and Society

Records analyzed show some individual drivers involved in collisions with animals, or who drive by injured animals and report them, experience emotional trauma and if the animal is larger, also face damage to their vehicle and injury (or even death) to themselves. Drivers may either collide with the animal, or swerve to avoid the animal and become involved in a collision with another vehicle or object (Table 1). We estimated the total cost of all WVC incidents to society, using summaries of types of accident (e.g., property damage only, major injury), the loss of

wildlife, and coefficients for each of these types of loss. Equivalent costs for accident types were obtained from the US Department of Transportation (USDOT, 2013) and a related project in South Dakota (Cramer et al., 2016). Because the number of fatalities may not be accurately reported in data obtained from state resources, we used an average value for California in 2015 (5.3/year, average 2005-2014) of the number of fatalities per year from collisions with wildlife, obtained from the Insurance Institute for Highway Safety (<http://www.iihs.org/iihs/topics/t/roadway-and-environment/fatalityfacts/fixed-object-crashes>, accessed 9/13/2016). In 2016, 5 fatalities were reported in crashes with wildlife.

The rates of property damage, injury and death reported here are probably underestimates and may be superseded by more detailed information from state sources. For example, Allstate Insurance Co. estimates that there were >23,000 claims/year for collisions with deer in 2015-2016, whereas our calculations are based on >7,000 reported collisions during this time period. If these additional 16,000 collisions resulted in the same average property-damage-only cost as used below (USDOT, 2013), there would be an additional >\$312 million cost to society (16,000 times \$17,343/crash), resulting in a total estimated cost to society from WVC of ~\$588 million/year.

From 2015 to 2016, we found an increase of ~20% in cost to society from WVC. This does not reflect a change in how the calculation was conducted, but instead an increase in the number of collisions. For example, there was a 25% increase in injury accidents from 2015 to 2016.

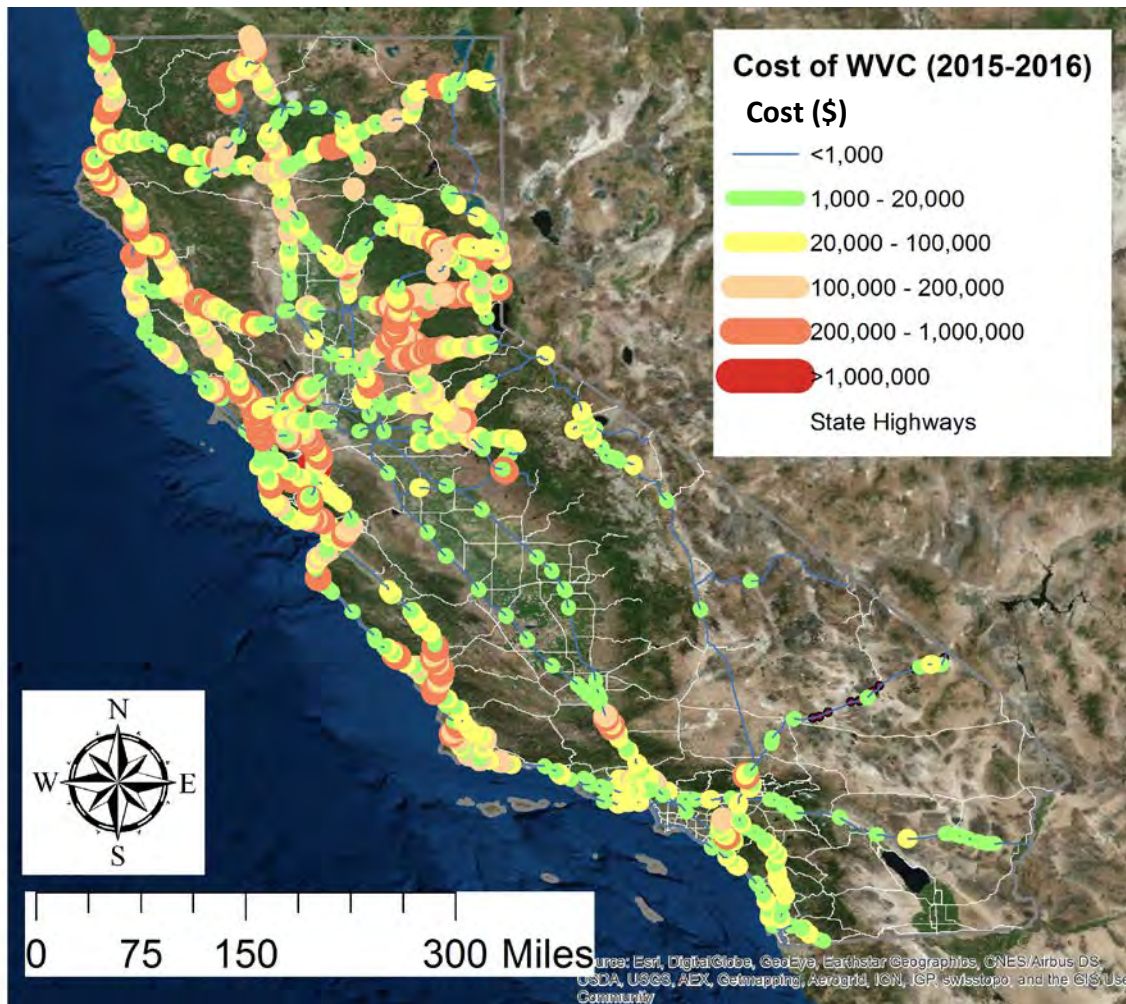
**Table 1.** Impact to drivers and estimated cost to society of reported collisions with animals on California highways and certain major roads. Equivalent costs for accident types were obtained from the US Department of Transportation (2013).

Type of Accident	Coefficient (cost as \$/event)	Number (2015/2016)	Cost 2015	Cost 2016
Lost animal value (all animals)*			\$36,165,000	\$37,733,000
Collision/Swerve (property damage)	\$17,343	5,368/7,479	\$94,467,321	\$130,055,157
Injury (minor)	\$105,228	235/285	\$24,771,329	\$30,011,602
Injury (major)	\$506,217	44/62	\$22,067,897	\$31,281,437
Fatality	\$9,395,247	5.3*/5	\$49,794,809	\$46,976,235
<b>Total</b>			<b>\$224,619,659</b>	<b>\$276,057,431</b>

\* This value includes both reported and estimated un-reported carcasses. Others have reported under-reporting rates for carcasses from collisions of 5-10 fold (e.g., Olson et al., 2014).

\*\* Average CA fatality rate from collisions with animals for 2005-2014

To aid Caltrans and county transportation agencies in mitigating costly WVC incidents, we mapped the cost per mile of WVC for select highways (Figure 6). To put the costs and corresponding colors into perspective, fencing of any highway segment in light orange to red would pay for itself within 1 to 4 years through reduced collisions. Fencing highway segments in yellow would pay for itself in 4 to 20 years. In both cases, the fencing would stretch from one logical end-point (e.g., bridge) to another, so actual costs would vary. Previous research has shown that fencing and crossing structures can reduce collisions >90% when fencing is maintained. In the Bay Area, long stretches of I-280, I-680, and US-101 could be fenced and significant cost-reductions (and reduced injury and death for people and animals) realized through reductions in WVC.



**Figure 6.** Cost of WVC per mile for select highways in California.



## Consequences of Collisions to Large Mammals, Animal Populations & Individual Animals

The majority of reported traffic incidents involving an animal (Figure 3) were with Mule deer (*Odocoileus hemionus*, 89%, Table 2), though at least 5 other mammals were also reported. In addition, these are just species and number of animals that were included in a CHP incident report. Others have reported under-reporting rates of collisions with ungulates (e.g., deer) of 5 to 10 fold (Donaldson and Lafon, 2008; Olson et al., 2014). This suggests that as many as 25,000 to 50,000 mule deer were killed during collisions in 2015 and an unknown number of other species. This is supported by the Allstate Insurance Co estimate of >23,000 claims/year for collisions with deer in California, where collisions are likely to occur more often than claims.

**Table 2.** The types and number of each type of wildlife involved in traffic incidents reported to CHP in 2016.

Wildlife type	Number	% of Total
Mule deer	6,119	89%
Coyote	377	9%
Black bear	135	2%
Elk	44	<1%
Mountain lion	43	<1%
Wild pig	21	<1%

For people who have collided with an animal, some will have observed that the animal does not always die immediately. We found that 21% (n=1,431) of animals involved in incidents were reported as injured by responding law enforcement (Table 3). There were an additional 30% (n=2,048) with an unknown fate after being involved in a traffic incident. We have found previously that as many as 40% of all animals could have been injured during the traffic incident. Only 131 animals were reported as dispatched by responding law enforcement officers, meaning that the remaining injured and some portion of the “unknown fate” animals stayed injured following the collision. This may still be an under-estimate of the total as there has been shown to be chronic under-reporting of collisions with ungulates, such as deer, in the US (Donaldson and Lafon, 2008; Olson et al., 2014).

**Table 3.** Animal outcomes following collisions with vehicles in 2016.

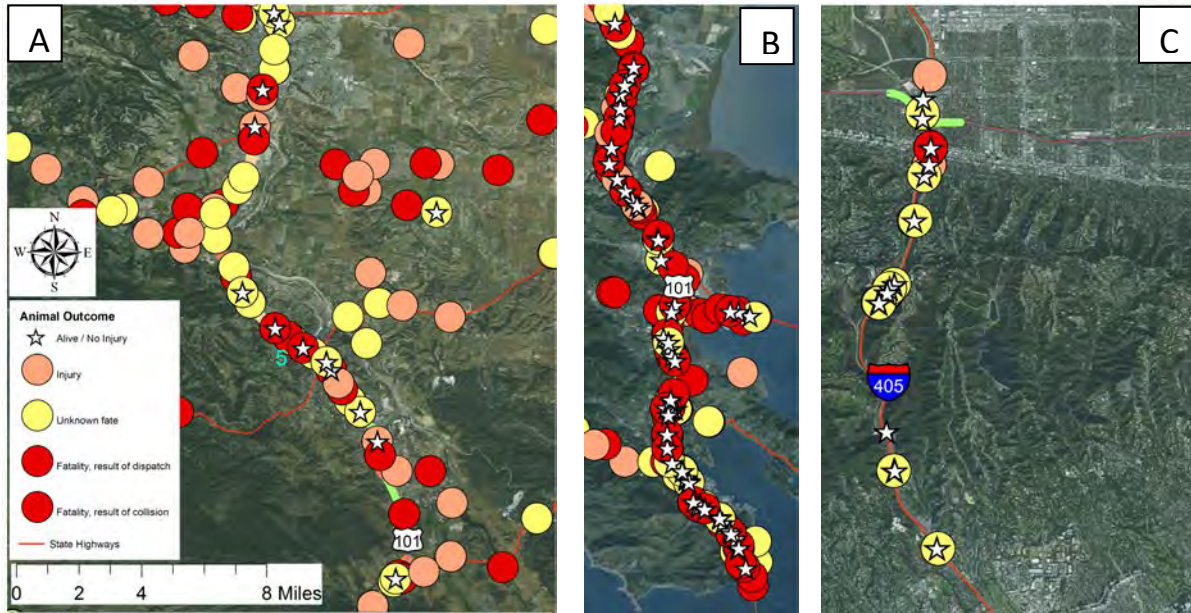
<b>Animal Outcome</b>	<b>#</b>	<b>%</b>
Unknown fate	2,048	30%
Alive / No Injury	500	7%
Injury	1,431	21%
Fatality, result of collision	2,618	39%
Fatality, result of dispatch	131	1.9%
Total	6,728	

These findings raise the question of whether these incidents where animals are injured in a collision are covered by California’s statutory definition of animal cruelty (California Penal Code, Sec. 597) which defines cruelty as including where animals are “mutilated, or cruelly killed” or where any animal is subject to “needless suffering”. Typically, wildlife are exempted from these statutes because they may be otherwise hunted and killed. However, the cruelty exemptions (Sec. 599c) cover permitted/licensed killing of game animals (e.g., for food) and not killing in general. Drivers are not being accused of being cruel, but it will help them as much as animals to do everything possible to prevent the collision and therefore stop the resulting cruelty.

A possible solution to this problem would be for the state to create a hotline where drivers can report an injured animal for potential rehabilitation, or in extreme cases, dispatch by CHP.

### **Where There is Smoke, There is Fire**

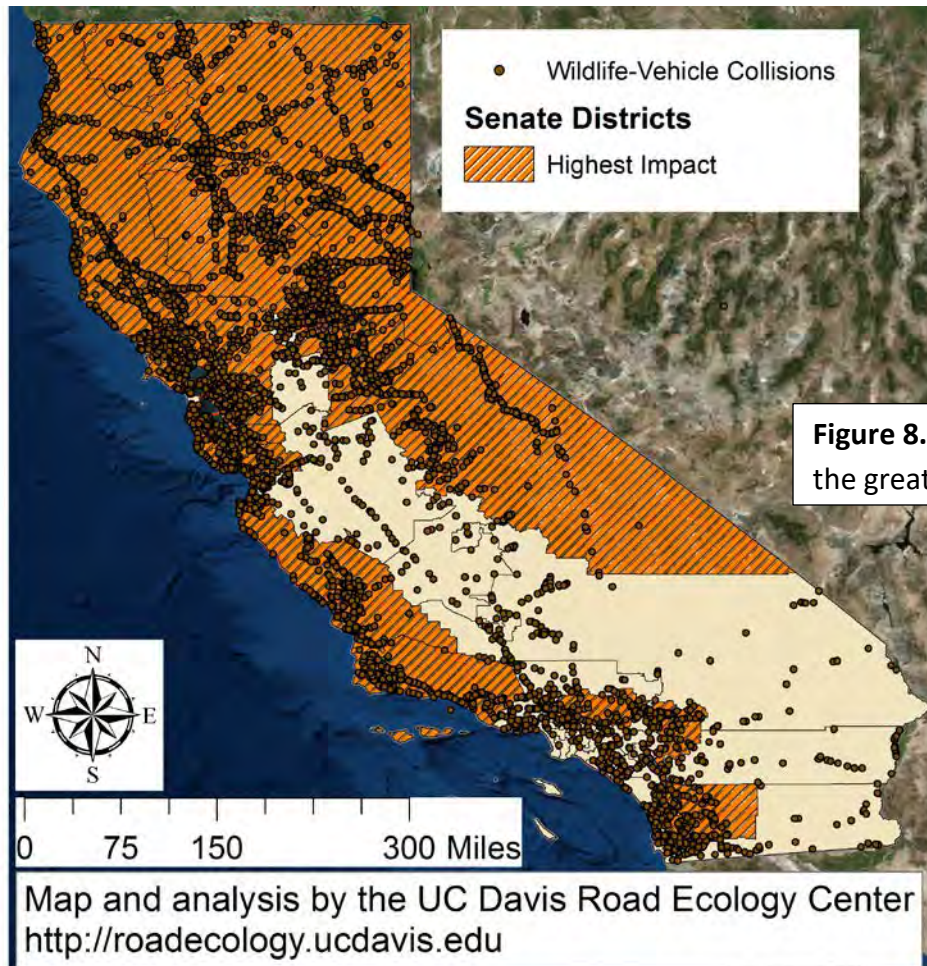
One way to predict where WVC might occur in the future, and therefore prevent it, is to record collisions and the presence of dead animals. Another possibility is to investigate where live animals occur near highways, before they are hit. We compared the observations by CHP officers of live animals (primarily deer) with reports of dead animals and collisions of vehicles with animals. In many cases, if a live animal was reported present and adjacent to traffic lanes, collisions occurred later in the same area (Figure 7). This suggests that after a live animal is observed on the roadside, there is a risk that the animal may try to cross the road and become involved in a collision with a vehicle. This relationship seems weakest in rural areas (Figure 7A) and strongest near urban centers (Figure 7B,C).



**Figure 7.** Comparison of observations of live (stars) and injured/dead (circles) animals on or adjacent to highways. A) US 101 north of San Luis Obispo. B) US 101 immediately north of Golden Gate Bridge (Marin County). C) I-405 south of Sherman Oaks in the Los Angeles area.

## Regional Focus

The need for projects that reduce the risk to driver safety and lives, property damage, and impacts to wildlife is critical. Building these projects will require a combination of Caltrans, county, regional, and legislative action and funding. From this point of view, it is important to understand where these impacts and costs are greatest. In general, anywhere drivers and wildlife habitat are near each other, there is some risk of WVC. This risk is greatest when there are more drivers driving fast through or near wildlife habitat, such as the San Francisco peninsula, the Sierra Nevada foothills and the hills surrounding the Los Angeles basin. The map below shows the 15 California Senate districts where 90% of the cost and impact are located (Figure 8). Five of these districts have Republican senators and 10 have Democrat senators, suggesting that the problem and funding solutions are both bipartisan.



**Figure 8.** Senate Districts with the greatest impact from WVC.

The following sections highlight 3 regions in California, showing the top highway segments in each region for WVC and providing an estimate of how quickly projects designed to reduce WVC would pay for themselves.



## San Francisco Bay Area, Regional Highway Hotspots

This map shows the cost and clustering of WVC traffic incidents on select highways in the San Francisco Bay region (Figure 9). There are segments of highways that have rates and costs of WVC that mean if safety projects, such as fencing and wildlife crossings, were undertaken, they would pay for themselves through reduced WVC (Table 4). This is especially true for I-280, the fencing of which would pay for itself in less than 1 year due to reduced WVC.

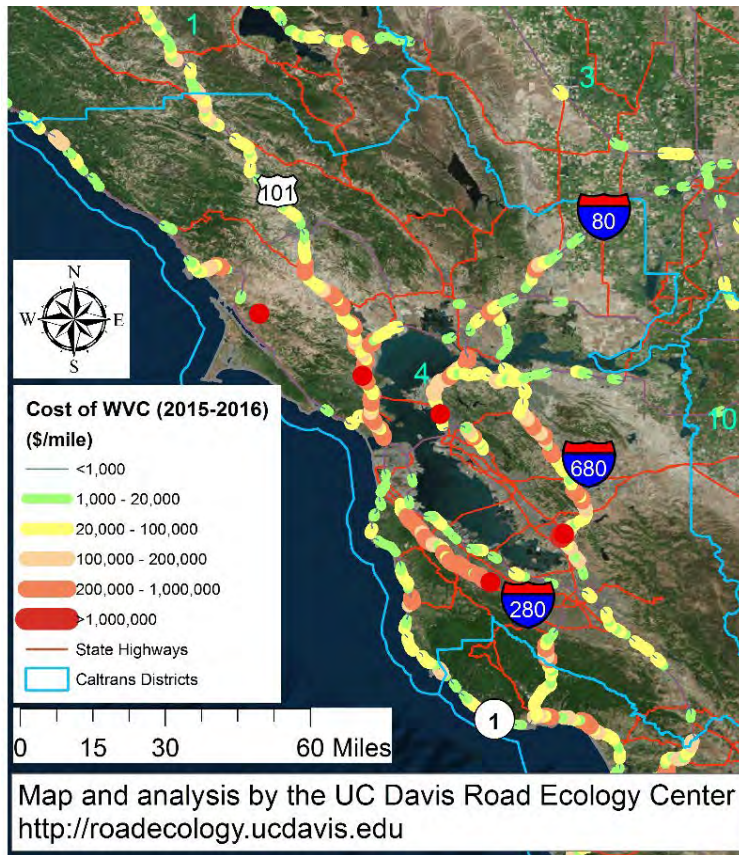


Figure 9. Cost (\$/mile) of WVC for select highways in the San Francisco Bay Area/Caltrans District 4.

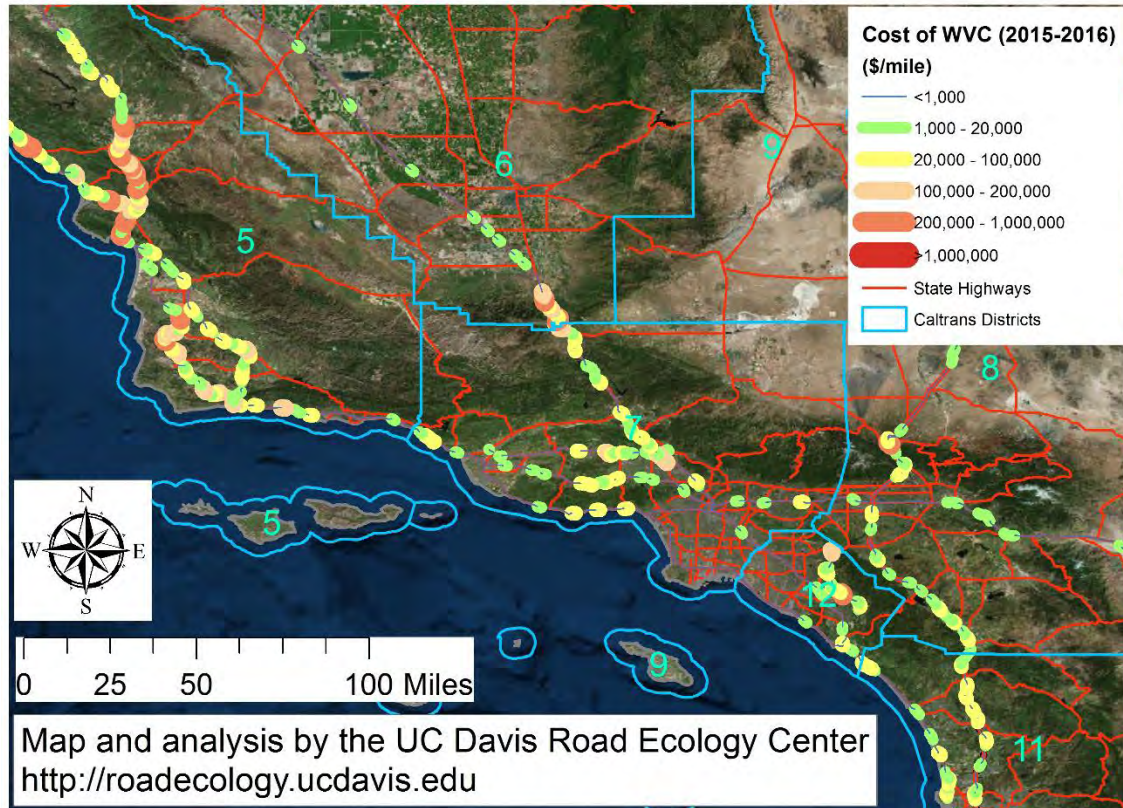
Table 4. Cost-effectiveness of WVC mitigation action on Bay Area highways, fencing only. New crossing structures would cost an additional 2-10 million for most highways in list. Enhancing existing structures would cost less.

Highway	Injury/Property Damage (#)	Injury/Fatal (#)	Two-year cost (\$)	Length (miles)	Cost/mile	Years to Pay Off (Fence)
I-280	386	26	\$20,113,971	23	\$874,520	0.5
SR101 (Marin Co)	225	11	\$14,700,264	28	\$525,009	0.8
SR13	81	4	\$1,996,915	6.5	\$307,218	1.3
SR24	114	4	\$2,569,234	11	\$233,567	1.7
I-680	221	6	\$13,950,875	72	\$193,762	2.1
SR9	119	7	\$3,039,900	20	\$151,995	2.6
SR17	62	2	\$1,712,173	27	\$63,414	6.3
I-80	129	5	\$2,977,412	57	\$52,235	7.7
I-580	55	4	\$1,545,997	30	\$51,533	7.8
SR1	142	6	\$3,290,756	85	\$38,715	10.3



## Southern California, Regional Highway Hotspots

This map shows the cost and clustering of WVC traffic incidents on select highways in Southern California (Figure 10). There are segments of highways that have rates and costs of WVC that mean if safety projects, such as fencing and wildlife crossings, were undertaken, they would pay for themselves through reduced WVC (Table 5).



**Figure 10.** Cost (\$/mile) of WVC for select highways in the Southern California region/Caltrans Districts 5, 6, 7, 8, 11 & 12.

Table 5. Cost-effectiveness of WVC mitigation action on Bay Area highways, fencing only. New crossing structures would cost an additional 2-10 million for most highways in list. Enhancing existing structures would cost less.

Area/Highway	Injury/Property Damage (#)	Injury/Fatal (#)	Two-year cost (\$)	Length (miles)	Cost/mile	Years to Pay Off (Fence)
SR2	33	2	\$868,385	6	\$144,731	2.8
US101	13	11	\$3,581,108	26	\$137,735	2.9
I-405	38	0	\$659,034	8	\$82,379	4.9
I-5	49	1	\$997,840	15	\$66,523	6.0
SR134	18	1	\$460,207	7	\$65,744	6.1
SR154	38	3	\$1,103,133	19	\$58,060	6.9
SR33	17	1	\$442,864	8	\$55,358	7.2
SR118	19	1	\$417,402	8	\$52,175	7.7
SR74	31	4	\$1,129,765	23	\$49,120	8.1
SR1	75	4	\$1,892,857	47	\$40,274	9.9

## Sierra Nevada Foothills, Regional Highway Hotspots

This map shows the cost and clustering of WVC traffic incidents on select highways in the Sierra Nevada foothills (Figure 11). There are segments of highways that have rates and costs of WVC that mean if safety projects, such as fencing and wildlife crossings, were undertaken, they would pay for themselves through reduced WVC (Table 6).

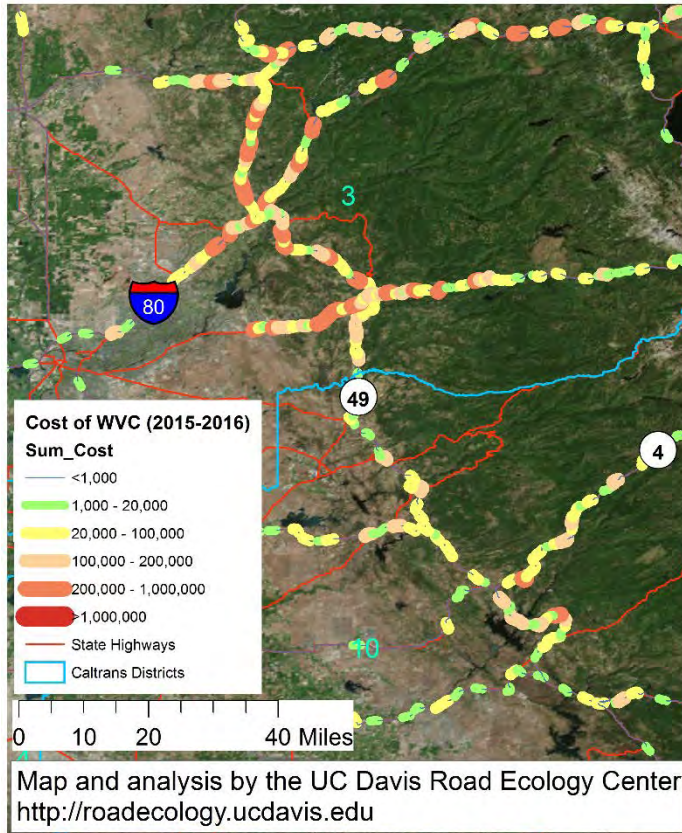


Figure 11. Cost (\$/mile) of WVC for select highways in the Sierra Nevada foothills/Caltrans Districts 3 & 10.

Table 6. Cost-effectiveness of WVC mitigation action on Sierra Nevada Foothill highways, fencing only. New crossing structures would cost an additional 0.5 to 1 million for most highways in list. Enhancing existing structures would cost less.

Highway	Injury/Property Damage (#)	Injury/Fatal (#)	Two-year cost (\$)	Length (miles)	Cost/mile	Years to Pay Off (Fence)
SR174	75	5	\$2,381,731	11	\$216,521	1.8
SR50 (West)	245	15	\$6,409,382	54	\$118,692	3.4
SR108	107	3	\$2,179,504	22	\$99,068	4.0
I-80	154	12	\$4,266,774	49	\$87,077	4.6
SR44	67	4	\$1,693,965	25	\$67,759	5.9
SR49	310	22	\$8,452,612	133	\$63,553	6.3
SR20	82	8	\$2,486,094	45	\$55,247	7.2
SR88	49	3	\$1,380,621	25	\$55,225	7.2
SR41	74	3	\$1,607,185	35	\$45,920	8.7
SR4	54	3	\$1,380,621	38	\$36,332	11.0

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2018

# Impact of Wildlife-Vehicle Conflict on California Drivers and Animals



Fraser Shilling, Ph.D., Co-Director;  
Cameron Denney, Graduate  
Student Researcher; David  
Waetjen, Ph.D., Programmer;  
Kathryn Harrold, Consultant;  
Parisa Farman and Paola Perez,  
Students



**UC DAVIS**  
**ROAD ECOLOGY CENTER**

9/15/2018

# Impact of Wildlife-Vehicle Conflict on California Drivers and Animals

Using observations of reported traffic incidents and carcasses the Road Ecology Center estimates the total annual cost (2017) of wildlife-vehicle conflict (WVC) in California to be at least \$307 million, up 11% from 2016. The estimated cost could be as high as \$600 million if accidents that are claimed to insurance companies (but un-reported to police) were included. This report includes maps of WVC hotspots, discusses impacts to wildlife and people from WVC, and presents new tools to help organizations and individuals use this information. Projects to reduce WVC can be the most effective of any safety project, with effectiveness often >90%.

Data Sharing/Collaboration: We are always happy to share data and map outputs for people interested in reducing wildlife-vehicle conflict for driver safety and/or wildlife conservation. We receive requests from highway planners, fish and wildlife scientists, students, and non-governmental organizations on a weekly basis. We can typically meet data requests for specific highways, counties, etc., but please keep in mind that this is an unfunded effort of the Road Ecology Center, so we will try to get back to you within a few days.

We have developed a globally-unique web-tool to visualize WVC incidents in CA. It shows WVC hotspot areas throughout CA and a real-time display of WVC events. You can find the website here: <https://roadecology.ucdavis.edu/hotspots>.



This report provides an overview of wildlife-vehicle conflict (WVC) hotspots on California highways between 2015 and 2017, inclusive, based on a combination of traffic incidents involving wildlife that were recorded by the California Highway Patrol (CHP) and carcass observations reported to the California Roadkill Observation System (<http://wildlifecrossing.net/california>). Analytical details are provided here and are also available from Fraser Shilling ([fmshilling@ucdavis.edu](mailto:fmshilling@ucdavis.edu)) upon request. This report also introduces a new, public web-system that allows the public and transportation agencies to view our scientific results for both legacy/long-term hotspots analysis and real-time tracking of WVC incidents.

## **Photo acknowledgement**

Bighorn Sheep – BighornSheep Institute

## **Data collection acknowledgements**

We appreciate the support from the National Center for Sustainable Transportation (using USDOT funding) for development of the automated wildlife-vehicle conflict hotspot tool described here and elsewhere. This and previous reports and the analyses contained within would not have been possible without the concerted and coordinated efforts of hundreds of volunteer roadkill observers over the last 9 years who contribute to the California Roadkill Observation System (CROS, <http://wildlifecrossing.net/california>). Through their endeavors, they have so far (9/2018) collected >58,000 observations of >420 species, representing one of the largest and most comprehensive wildlife monitoring programs in California. Their accuracy rates for species identification are >97% and have measurably high locational accuracy (median <±13 meters). For scientific papers describing our roadkill/WVC work, see our published work cited below and at the end of this report (you can paste the “doi” value into a browser and access the papers). The report also benefited from the efforts of many unknown law enforcement personnel who described traffic incidents in enough detail that we can use their observations to help plan for reduced wildlife-vehicle conflict.

## **CROS is 9-Years Old, Published, & Globally Linked**

The Road Ecology Center at UCD is happy to announce that CROS passed its 9<sup>th</sup> birthday, and during this period, the volunteers have assembled an (ongoing) important dataset which can benefit California wildlife and drivers in the decades to come. We have published our data and findings in the peer-reviewed journals Ecological Informatics, Nature Conservation, and Frontiers of Ecology and Evolution, covering the technical details of the project, including the accuracy of volunteer observations. Finally, we have partnered with other similar systems around the world in the Globalroadkill.net project (<http://globalroadkill.net>).

Citation for CROS: Waetjen DP and Shilling FM (2017) Large Extent Volunteer Roadkill and Wildlife Observation Systems as Sources of Reliable Data. *Front. Ecol. Evol.* 5:89. doi: 10.3389/fevo.2017.00089

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## The Authors

Fraser Shilling is the Co-Director of the UC Davis Road Ecology Center (<http://roadecology.ucdavis.edu>) and actively investigates the impacts of transportation systems on natural systems and human communities. He received his PhD in 1991 from the University of Southern California in the Division of Biological Sciences. Cameron Denney is a newly-graduated M.Sc. student in Geography at UC Davis and pioneered our new “automated hotspots” web-tool. David Waetjen is lead programmer and web guru for the Road Ecology Center. He received his PhD from UC Davis (Geography) in 2011. He develops web-systems and spatial analyses for wildlife, water, and sustainability applications. Kathryn Harrold is an independent wildlife consultant who is expert in how wildlife interact with roadways and how we can improve roads/highways to protect drivers and wildlife from conflict. Undergraduate and recently-graduated students Parisa Farman and Paola Perez are pursuing careers in wildlife biology and environmental policy.

Contact: Fraser Shilling, Co-Director, Road Ecology Center, UC Davis; [fmshilling@ucdavis.edu](mailto:fmshilling@ucdavis.edu), 530-752-7859; [@roadecology](#)

# UC Davis Road Ecology Center

## Fifth Annual Special Report on the Impact of Wildlife-Vehicle Conflict (WVC) on California Drivers and Animals

### Top 5 Recommendations

- 1) **Systematically collect and share data.** The state data assembled here were not collected with the purpose of studying wildlife-vehicle conflict, the volunteer data were. California agencies should collect and share data about wildlife-vehicle conflict to help inform decision-making about this important conservation and safety problem. We are open to partnering with Caltrans, California Department of Fish and Wildlife and others to accomplish this.
- 2) **Require collection and analysis of wildlife-vehicle conflict data for highway/road projects, before they are approved and funded.** Transportation and wildlife agency biologists have very little data upon which to base decisions for projects impacting wildlife. Highway projects that are likely to increase WVC can be built because these data are not required.
- 3) **Protect driver safety and wildlife by building WVC-reduction projects.** Very few driver safety projects have the overall effectiveness that WVC reduction projects do. There are hundreds of places on state highways and major roads where WVC is a priority, but statewide only 2-3 projects are built per year. Ten times that rate would make a dent in the apparent risk to both drivers and wildlife.
- 4) **Form new partnerships** among University and NGO scientists, citizen groups, and local agencies interested in reducing WVC impacts. Local and statewide partners can help advocate for diversion of transportation funds to improve ecological sustainability of transportation.
- 5) **Systematically evaluate how well we are doing with WVC reduction** so that we can keep improving. As we plan and build WVC reduction, we should transparently monitor reduced driver injuries and death and use of the structures by wildlife.

### Introduction

Using California state data on traffic incidents, the Road Ecology Center has mapped stretches of California highway that are likely to be continuing hotspots for wildlife-vehicle conflicts (WVC). Animals entering roadways are often killed and pose a hazard to drivers, who may collide with the animal, or try to avoid the animal and have an accident suffering vehicle damage, injury, and even death. We estimated the total annual cost to society from >6,600 WVC incidents in California on state highways and a small proportion of major roads to be ~\$307 million for 2017, which is an 11% increase compared to 2016. **It is important to note that this**

**report does not cover ALL incidents in California, just the ones reported by the CHP and California Roadkill Observation System (CROS).** State Farm Insurance Co. estimated that California had >23,000 claims/year for collisions with wildlife in 2015-2016 (<https://newsroom.statefarm.com/download/234883/allstates2015-16deerstats-finalpdf.pdf>), which is >3 times the rate we describe here and if included, would result in a total cost to society of ~\$600 million/year, which would be similar to costs in other states where total costs have been evaluated (e.g., VA, Donaldson, 2017). In addition, we counted 268 injury accidents in the CHP data we used, which is less than the 383 injury accidents Caltrans reported using CHP data in their press release for the 2018 press release (<http://www.dot.ca.gov/paffairs/pr/2018/prs/18pr072.html>). So, our study under-estimates the injury portion of the total cost of these types of accidents by ~1/3. This contrast also points to the need for a standardized system for California to collect and report these data. Wildlife populations may suffer significant losses due to collisions and highways with high rates of WVC may cause ripple effects into surrounding ecosystems. In addition, animals are injured during collisions, which is damaging to the animal and potentially traumatic and deadly to drivers.

By identifying stretches of highway where WVC are more likely, the Road Ecology Center is assisting Caltrans and other responsible entities in developing mitigation to protect drivers and wildlife populations. Measures with proven effectiveness include building fencing and over/under-passes along priority highways to allow the safe passage of wildlife across highways and reducing speed limits in protected wildlife habitat. Using CHP data, we have found records of >6,600 reported accidents per year on California highways involving deer and other wildlife. We estimate that there are another few thousand with horses, cows, sheep and goats.

For the third year analyzing CHP data, we have determined rates and locations of both animal carcasses and reported traffic incidents. These incidents could be reports of animals running across the road, collisions with animals (primarily deer), or accidents resulting from people swerving to avoid a collision with an animal in the road. Because deer activity adjacent to highways is correlated with rates of collisions with deer (Donaldson et al., 2015), we included reports of live animals on or near highways (~10% of all reports). Our analyses include identification of geographical hotspots and calculated costs to the public from vehicle damage, injury and even death. This information shows where there are problems and should help in developing safety projects to fix these known problem areas.

The following sections include maps of the distribution of WVC densities, projected costs of WVC and hotspots along state highways and other roadways. The densities of WVC reported are the minimum for each highway segment and do not represent actual rates, which are likely to be much higher. By significantly increasing the systematic treatment of these hotspots and stretches of highway with high rates of collisions, Caltrans and other entities can contribute cost-effectively to driver safety and improve the environmental sustainability of state highways.

## Methods

### Traffic Incidents

Records of traffic incidents between February 2015 and December 2017 were obtained from state databases of traffic incidents (e.g., emergency responses to crashes), included in our customized “California Highways Incident Processing system” (CHIPs), and coded according to severity of the incident for the drivers/vehicles and for the animals. For this ~3 year period, we separated the ~19,800 records of wildlife-vehicle collisions from the ~2.5 million traffic incidents using customized term queries (e.g., for “deer” AND “buck” AND “doe” AND “fawn”). We reviewed each record for information about fate of the animal, fate of the driver, type of accident (collision vs. swerve), and vehicle damage. Location and date/time information were from the incident record.

The California Roadkill Observation System project (<http://wildlifecrossing.net/california>) includes past and current participation by over 1,000 volunteer-scientists, including several hundred academic, agency, and NGO biologists and natural historians (Waetjen and Shilling, 2017). More than 56,000 WVC observations were contributed to the website by volunteers between August 2009 and the end of 2017 and by Caltrans Maintenance staff for the period 1987 to 2007. We selected recent observations of large-animal carcasses (last three years) and combined these observations with the CHP crash data. We carefully controlled for duplicates, which were only rarely found because animal carcasses from crash incidents were usually collected fairly quickly by Caltrans.

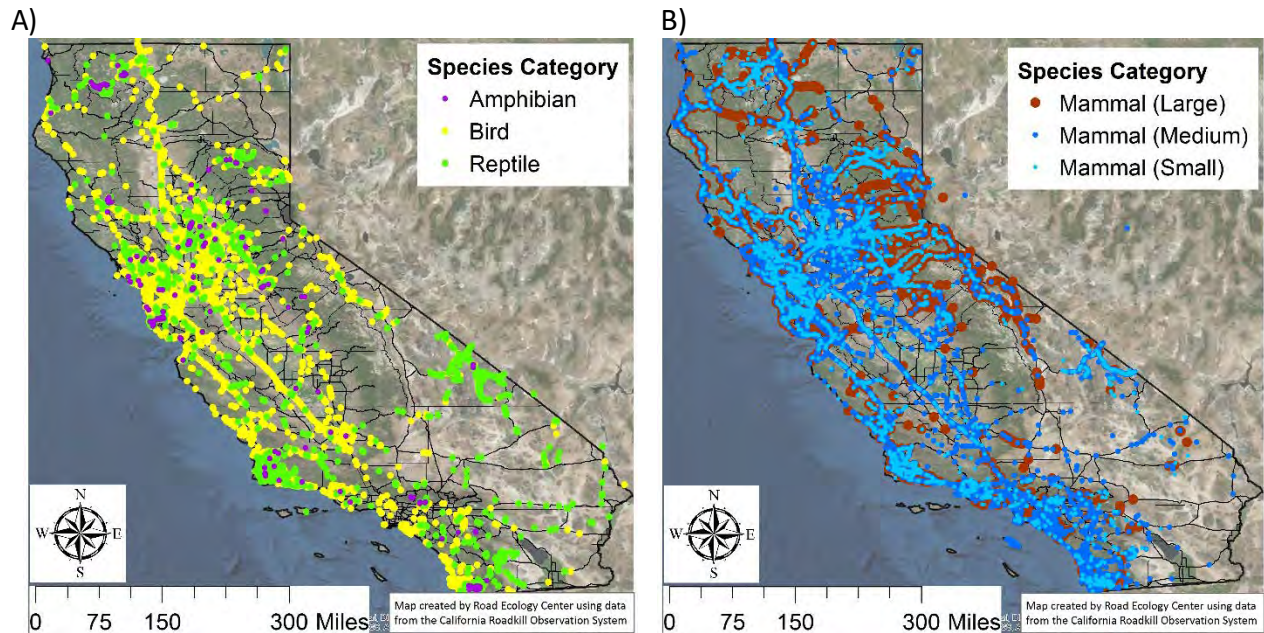
The carcass observations and traffic incidents were used in a geographic information system (GIS) to identify stretches of highway where WVC occur more frequently (high density) and places where there are statistically-significant clusters of WVC (hotspots; Shilling and Waetjen, 2015). Density was calculated as number of incidents/mile and by using the Kernel Density Estimator (KDE) tool in ArcGIS. Hotspots were identified using the spatial autocorrelation test Getis-Ord for 1 mile state highway segments. Specific methods are included in a methodology appendix. Estimates of costs to society of incidents were calculated using the nature of the incident (e.g., “minor injury”) and coefficients for the average cost of these types of incidents used by the US Department of Transportation (USDOT, 2013) and in published literature (Huijser et al., 2009) and technical reports (Cramer et al., 2016).



## Major Findings

### Statewide Carcass Observations

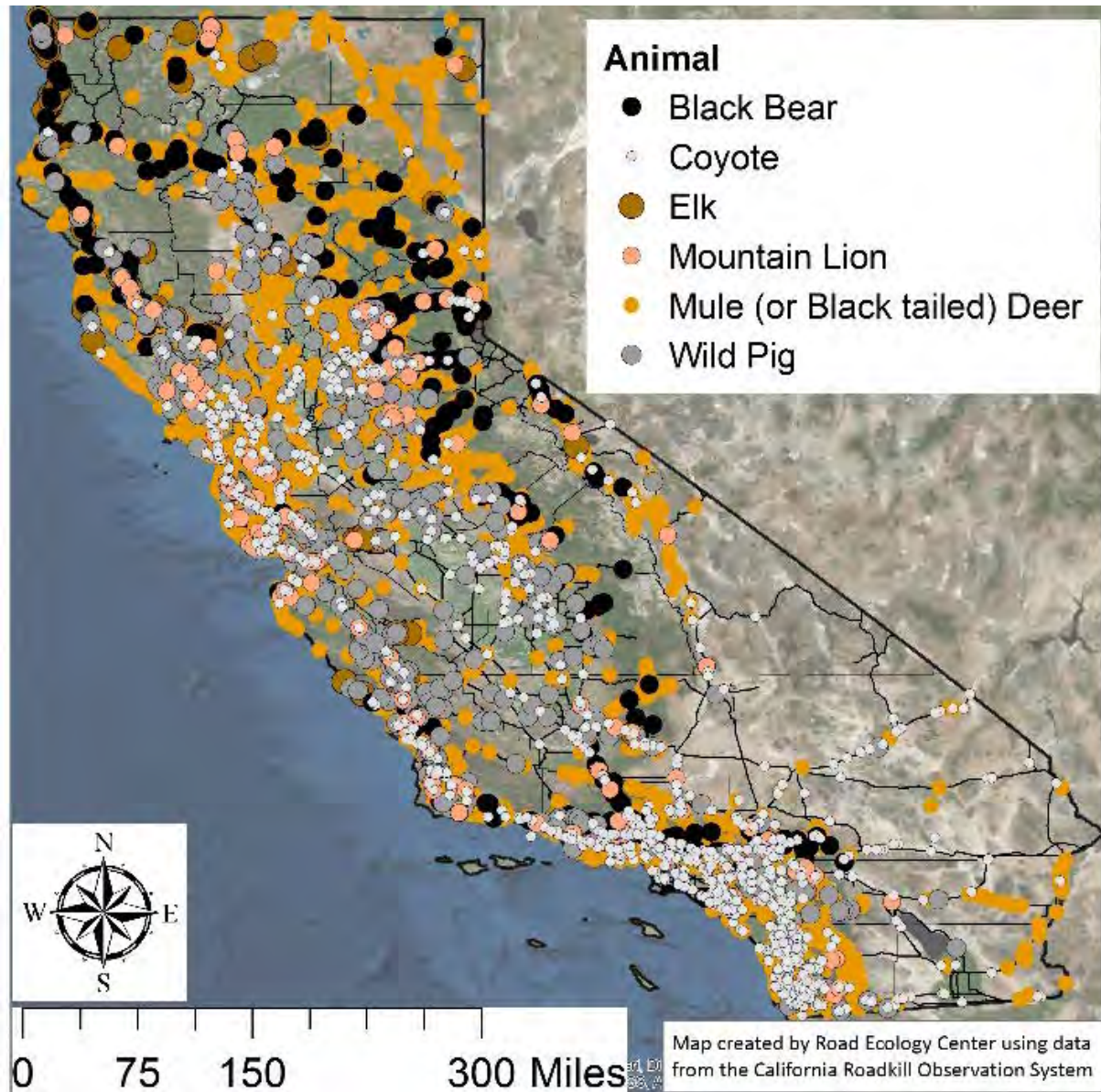
The maps below show >56,000 observations of animal carcasses on local roads and state highways (Figure 1). These are not the total roadkill that occurred, just the ones that people saw and reported to the California Roadkill Observation System (CROS) between 2009 and 2017.



**Figure 1.** Carcass observations for (A) amphibians, reptiles, and birds; and (B) mammals.

### Statewide Highway Traffic Incidents

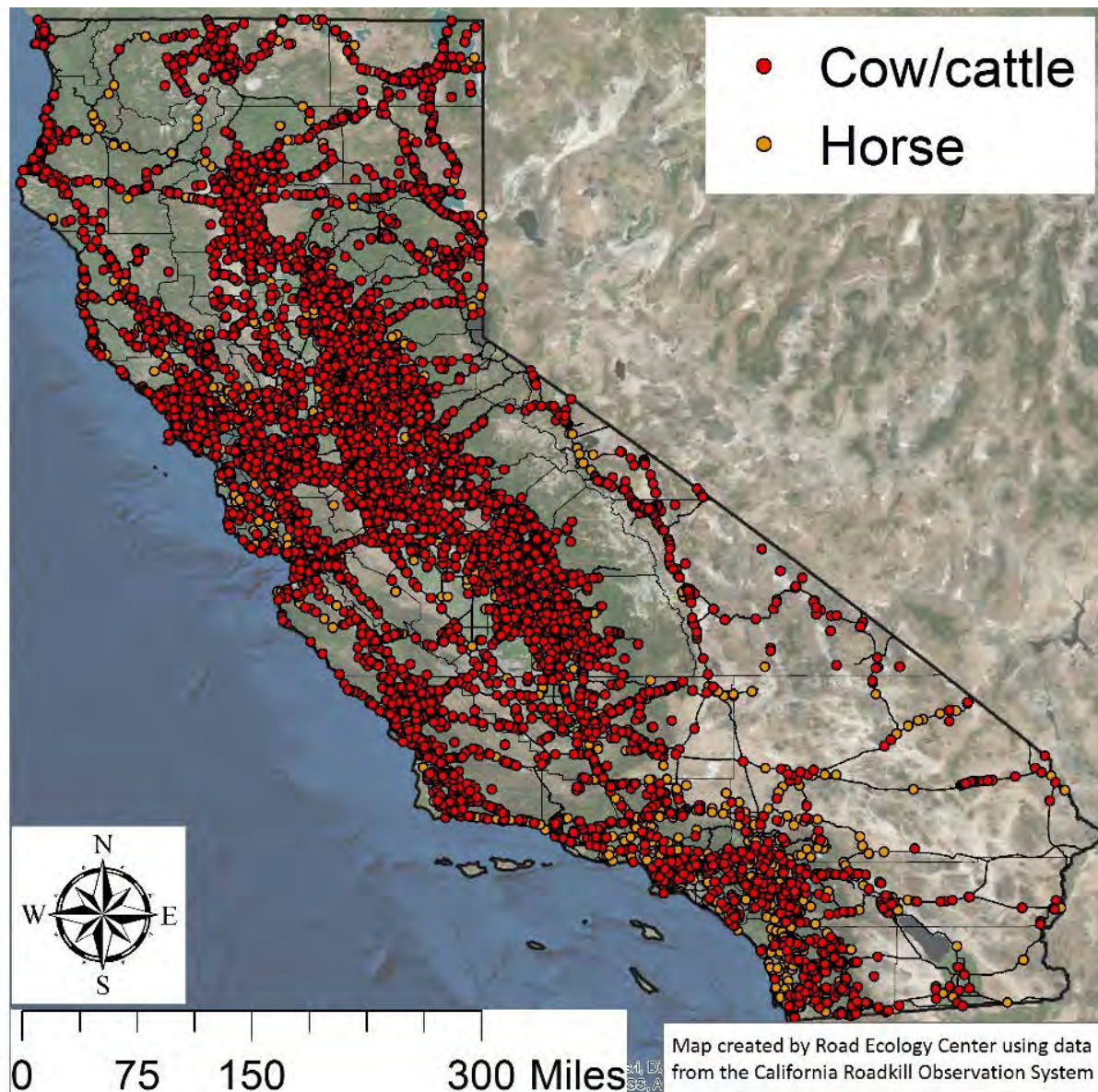
There were >2 million traffic incidents (of all types) across California reported to the California Highway Patrol in 2015-2017. Of these, about half were collisions and more than 19,800 involved wildlife, including reports of animals standing next to, standing in, or running across roadway lanes, collisions with large animals, and swerving to avoid collisions, resulting in a crash (Figure 2, Wildlife vehicle conflicts). The Fall is the most likely time for WVC, due to increased movement related to mating seasons and seasonal migration.



**Figure 2.** Wildlife-vehicle conflict (WVC) incidents on state highways (2015-2017)

For the first time, we also developed hotspot maps for animal-vehicle-conflict (AVC) involving domestic animals in free range areas, or that have escaped enclosures. Cattle, horse, sheep, pigs and goats can all become involved in conflict incidents with traffic. Because some of these animals can be quite large, larger than most wildlife (except elk and some bears), collisions with them can be particularly severe for the drivers. We found that AVC occurs everywhere in California (Figure 3) and at fairly high rates.



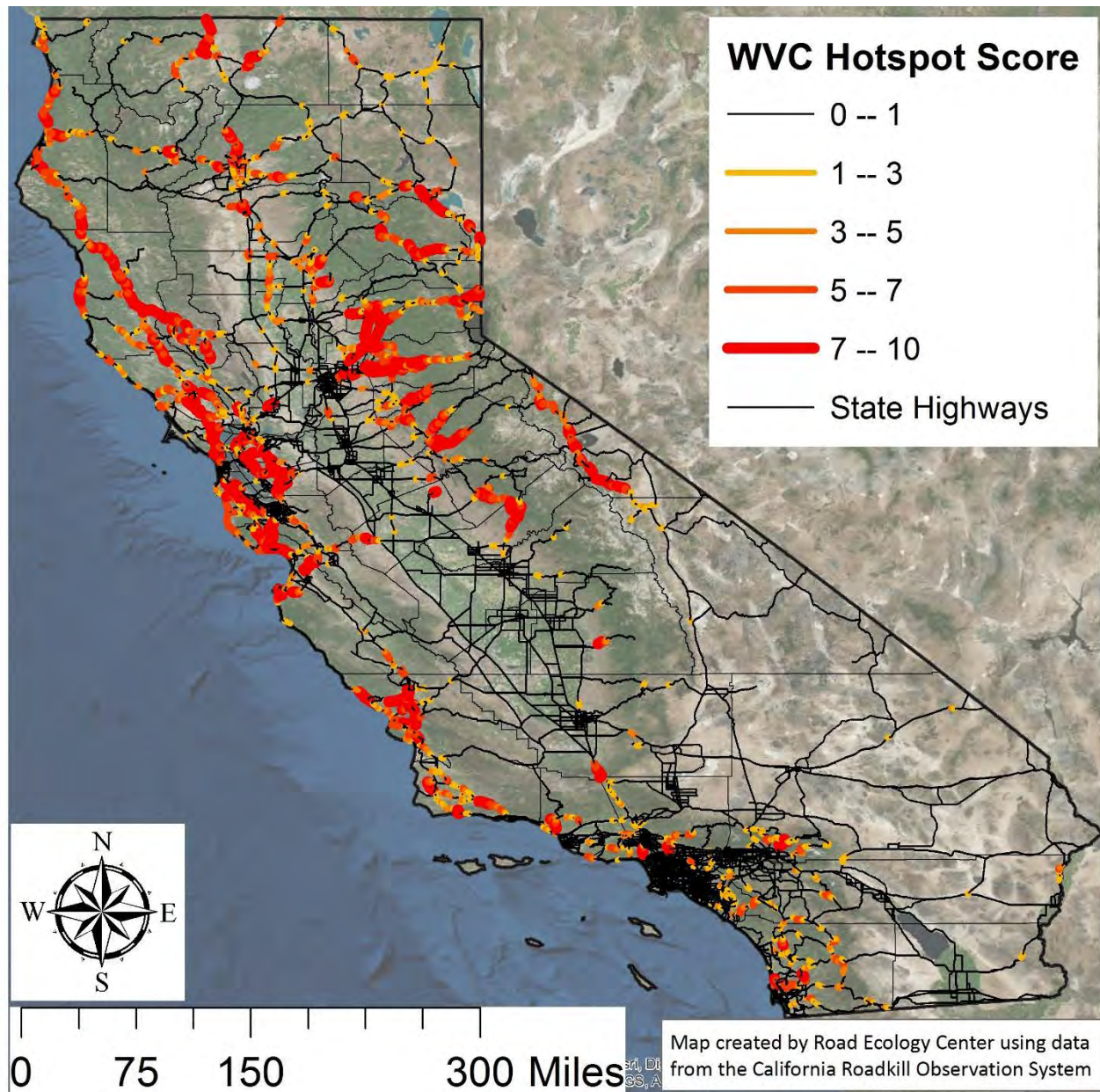


**Figure 3.** Animal-vehicle conflict involving domestic animals (cows/cattle and horses) for 2015 - 2017.

### Statewide Wildlife-Vehicle Conflict Hotspots

Although WVC occur everywhere in California, the highest densities were reported in the San Francisco Bay Area (Caltrans District 4), Sierra Nevada Foothills (Caltrans Districts 3 & 10), North Coast (Caltrans District 1), and parts of the Central/South Coast (Caltrans Districts 5, 7, 11 & 12). These high-density areas are most likely where traffic volumes and wildlife populations are greatest, leading to more conflict. The map below shows the high-density clusters of collisions with large wildlife in California (Figure 4).

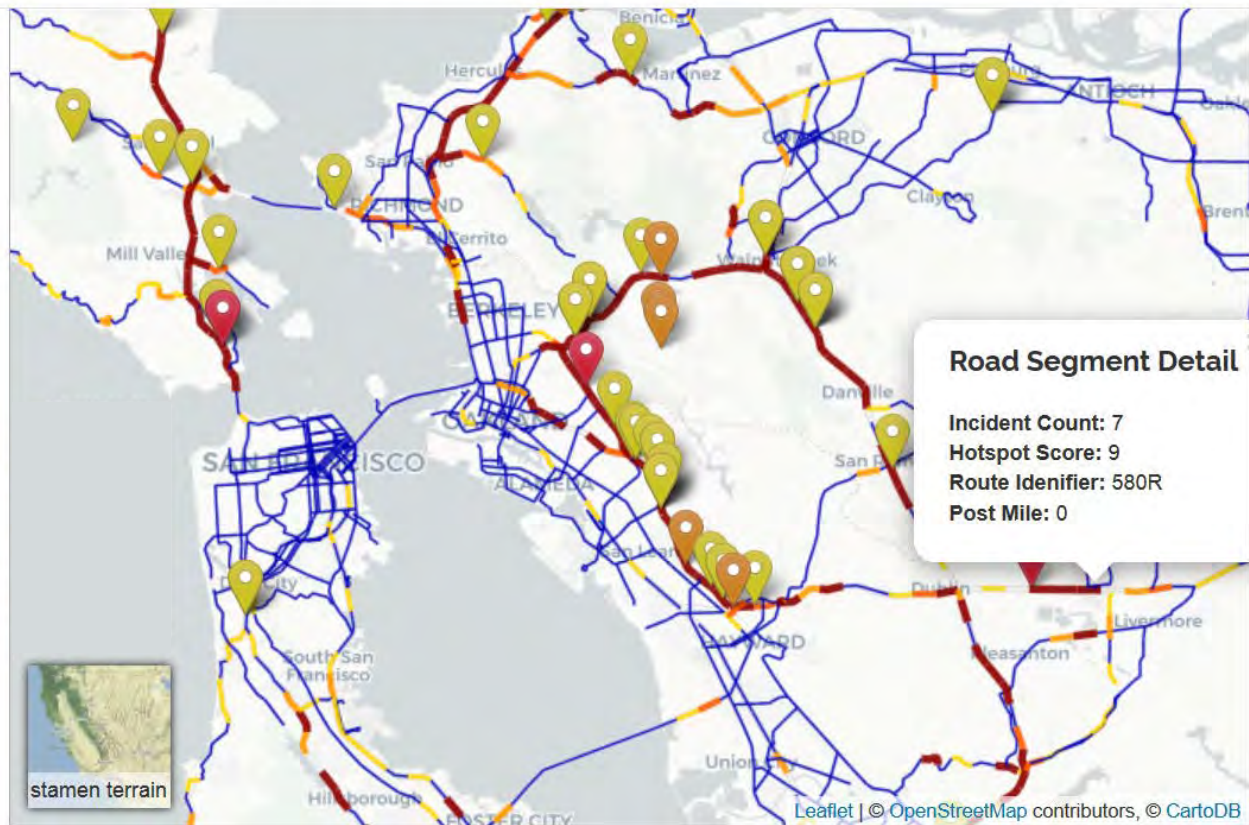




**Figure 4.** Statistically-significant, high-density WVC hotspots for 2015 to 2017. Hotspot score is a value that combines the total density of WVC incidents (#/mile) and the statistical significance of clusters of incidents. You can see these data here: <https://roadecology.ucdavis.edu/hotspots>.

### Real-Time, Automated Web-Map of WVC

To better inform the public and transportation agencies about highway segments with greater risk of WVC, we developed an easy-to-use, online system that provides two important sources of information: 1) mapped hotspots using legacy data (2015 to end of 2017); and 2) locations of recent (<1 week & <24 hours) locations of conflict with mule deer and other large mammals (Figure 5). You can find the website here: <https://roadecology.ucdavis.edu/hotspots>.



**Figure 5.** Zoomed in view of central San Francisco Bay Area showing incident densities and recent WVC incidents. The information box appears when the user clicks on a highway segment. <https://roadecology.ucdavis.edu/hotspots>.

We also developed the web-system so that it could be a continuous source of information for driver-assist, autonomous-vehicle, and app-based programs. For example, this information could be continuously fed into an app to inform drivers of locations of recent and long-term conflict, to inform their driving practice. It could also be used by driver-assist and autonomous vehicle systems to prioritize driver-warning and changes in sensitivity to the potential presence of large animals in the roadway.

### Consequences of Collisions to Drivers and Society

Records analyzed show some individual drivers involved in collisions with animals, or who drive by injured animals and report them, experience emotional trauma and if the animal is larger, also face damage to their vehicle and injury (or even death) to themselves. Drivers may either collide with the animal, or swerve to avoid the animal and become involved in a collision with another vehicle or object (Table 1). We estimated the total cost of all WVC incidents to society, using summaries of types of accident (e.g., property damage only, major injury), the loss of wildlife,



and coefficients for each of these types of loss. Equivalent costs for accident types were obtained from the US Department of Transportation (USDOT, 2013) and a related project in South Dakota (Cramer et al., 2016). We only counted 1 fatality in data from CHP, but Caltrans reported 12 fatalities from collisions with wildlife for 2017, using data from CHP (<http://www.dot.ca.gov/paffairs/pr/2018/prs/18pr072.html>), so we used this number.

The rates of property damage, injury and death reported here are probably underestimates and may be superseded by more detailed information from other sources. For example, State Farm Insurance Co. estimates that there were >23,000 claims/year for collisions with deer in 2015- 2016 (<https://newsroom.statefarm.com/download/234883/allstates2015-16deerstats-finalpdf.pdf>), whereas our calculations are based on >6,600 reported collisions during this time period. If these additional 16,000 collisions resulted in the same average property-damage-only cost as used below (USDOT, 2013), there would be an additional >\$277 million cost to society (16,000 times \$17,343/crash), resulting in a total estimated cost from WVC of ~\$584 million/year.

From 2016 to 2017, we found an increase of ~11% in cost to society from WVC, which was 20% higher than the year before. This does not reflect a change in how the calculation was conducted, but instead an increase in the number of fatal collisions.

**Table 1.** Impact to drivers and estimated cost to society of reported collisions with animals on California highways and certain major roads. Equivalent costs for accident types were obtained from the US Department of Transportation (2013).

Type of Accident	Coefficient (cost as \$/event)	Number (2017)	Cost (2017)
Lost animal value (all animals)*			\$37,377,000
Collision/Swerve (property damage)	\$17,343	6,411	\$111,185,973
Injury (minor)	\$105,228	224	\$23,665,146
Injury (major)	\$506,217	44	\$22,327,207
Fatality	\$9,395,247	12	\$112,742,964
<b>Total</b>			<b>\$307,298,290</b>

\* This value includes both reported and estimated un-reported carcasses. Others have reported under-reporting rates for carcasses from collisions of 5-10 fold (e.g., Olson et al., 2014).

### Consequences of Collisions to Large Mammals, Animal Populations & Individual Animals

The majority of reported traffic incidents involving an animal (Figure 2) were with Mule deer (*Odocoileus hemionus*, 88%, Table 2), though at least 5 other mammals were also reported. In addition, these are just species and number of animals that were included in a CHP incident report. Others have reported under-reporting rates of collisions with ungulates (e.g., deer) of 5

to 10 fold (Donaldson and Lafon, 2008; Olson et al., 2014). This suggests that as many as 25,000 to 50,000 mule deer were killed during collisions in 2015 and an unknown number of other species. This is supported by the State Farm Insurance Co estimate of >23,000 claims/year for collisions with deer in California

(<https://newsroom.statefarm.com/download/234883/allstates2015-16deerstats-finalpdf.pdf>), where collisions are likely to occur more often than claims.

One important observation was that almost twice as many black bears were reported involved in accidents in 2017 (170 animals) than in 2016 (89 animals), or 2015 (83 animals). In addition, there were more collisions with mountain lions in 2017 (64 animals) than in 2016 (44 animals), or 2015 (38 animals). It's not obvious why this occurred, but it is a disturbing trend for both wildlife and drivers

**Table 2.** The types and number of each type of wildlife involved in traffic incidents reported to CHP in 2016.

<b>Wildlife type</b>	<b>Number</b>	<b>% of Total</b>
Mule deer	5,862	88%
Coyote	353	5%
Black bear	165	2%
Wild Pig	145	<1%
Mountain lion	64	<1%
Elk	40	<1%

For people who have collided with an animal, some will have observed that the animal does not always die immediately. We found that 23% (n=1,495) of animals involved in incidents were reported as injured by responding law enforcement (Table 3). There were an additional 32% (n=2,119) with an unknown fate after being involved in a traffic incident. The rate of “unknown fate” for animals involved in a collision was much greater for elk, black bear and wild pig than mule deer, with the majority of these species having an unknown fate after collision. Only 149 animals were reported as dispatched by responding law enforcement officers, meaning that the remaining injured and some portion of the “unknown fate” animals stayed injured following the collision. This may still be an under-estimate of the total as there has been shown to be chronic under-reporting of collisions with ungulates, such as deer, in the US (Donaldson and Lafon, 2008; Olson et al., 2014).

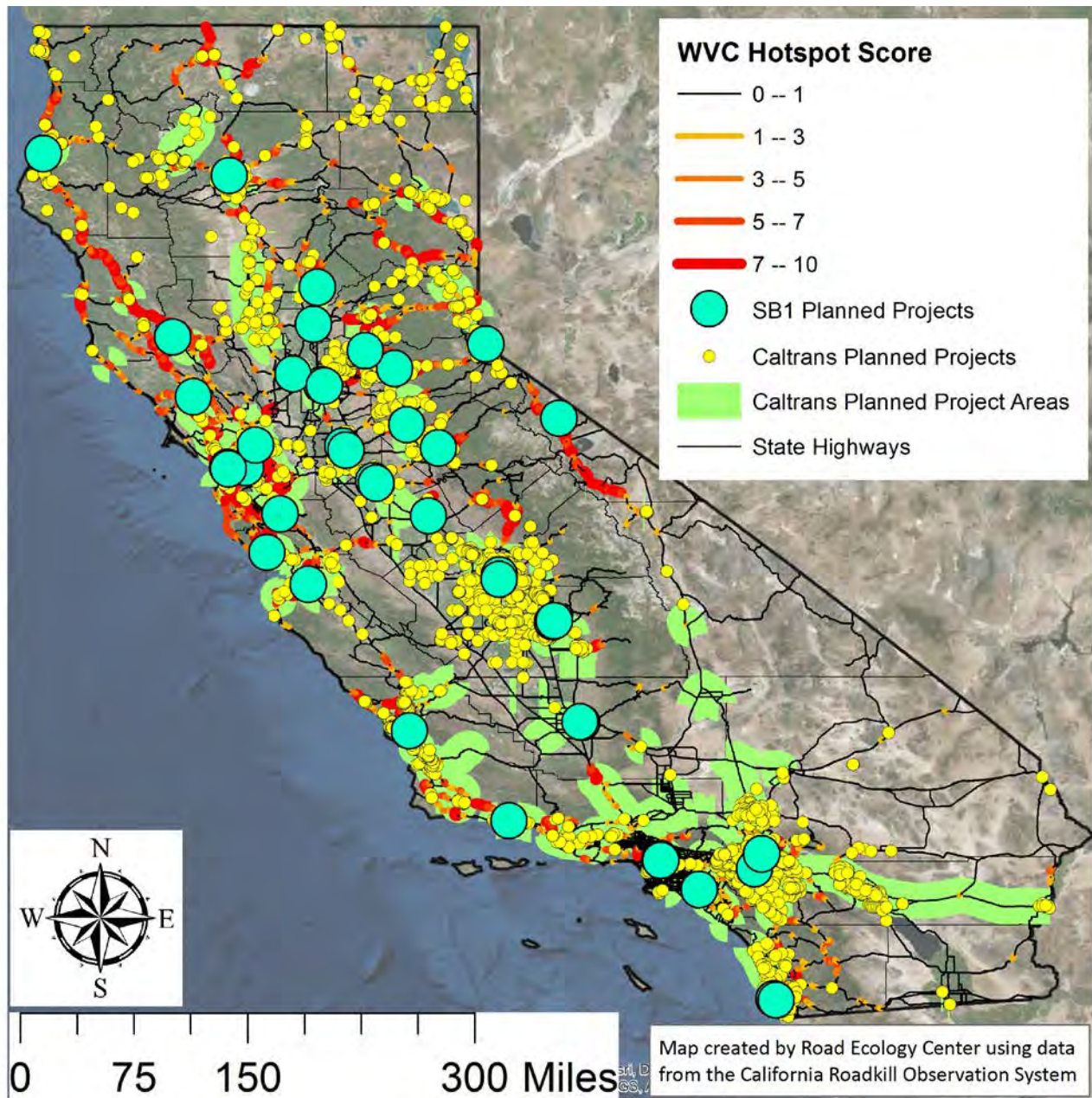
**Table 3.** Animal outcomes following collisions with vehicles in 2017.

<b>Animal Outcome</b>	<b>#</b>	<b>%</b>
Unknown fate	2,119	32%
Alive / No Injury	597	9%
Injury	1,495	23%
Fatality, result of collision	2,841	43%
Fatality, result of dispatch	149	2%
Total	6,604	

In last year’s report, we suggested that injuring animals in this manner could be considered cruelty. Although this may still be true, it makes sense to consider what solutions are available to reduce the unnecessary suffering of animals injured during collisions. A possible solution to this problem would be for the state to create a hotline where drivers can report an injured animal for potential rehabilitation, or in extreme cases, dispatch by CHP. Other countries (e.g., Germany, Sweden) have systems like this in place that could readily be adopted.

### **Regional/Local Focus**

The need for projects that reduce the risk to driver safety and lives, property damage, and impacts to wildlife is critical. Building these projects will require a combination of Caltrans, county, regional, and legislative action and funding. This risk is greatest when there are more drivers driving fast through or near wildlife habitat, such as the San Francisco peninsula, the Sierra Nevada foothills and portions of Southern California (see following pages). The map below (Figure 6) shows the location of planned, state-funded projects in California, which are potential locations for wildlife-vehicle collision mitigation. Unfortunately, there is not very good overlap between WVC hotspots and planned projects, including those planned under the Senate Bill 1 (SB1) fuel-tax funding source. This may not be surprising as neither the California Transportation Plan, nor SB1 mention widespread, adequate mitigation for this risk to driver safety and wildlife well-being. However, it is a problem that can be solved by spending SB 1 and other state funds on wildlife-crossing projects. There is an immediate and urgent need for leadership on this issue in California and widespread construction of wildlife crossings solutions to reduce harm to drivers and wildlife. We suggest an expenditure rate of “1% for wildlife”, which equates to ~\$500 million from transportation funds per year, coincidentally similar to the estimated cost per year of WVC.

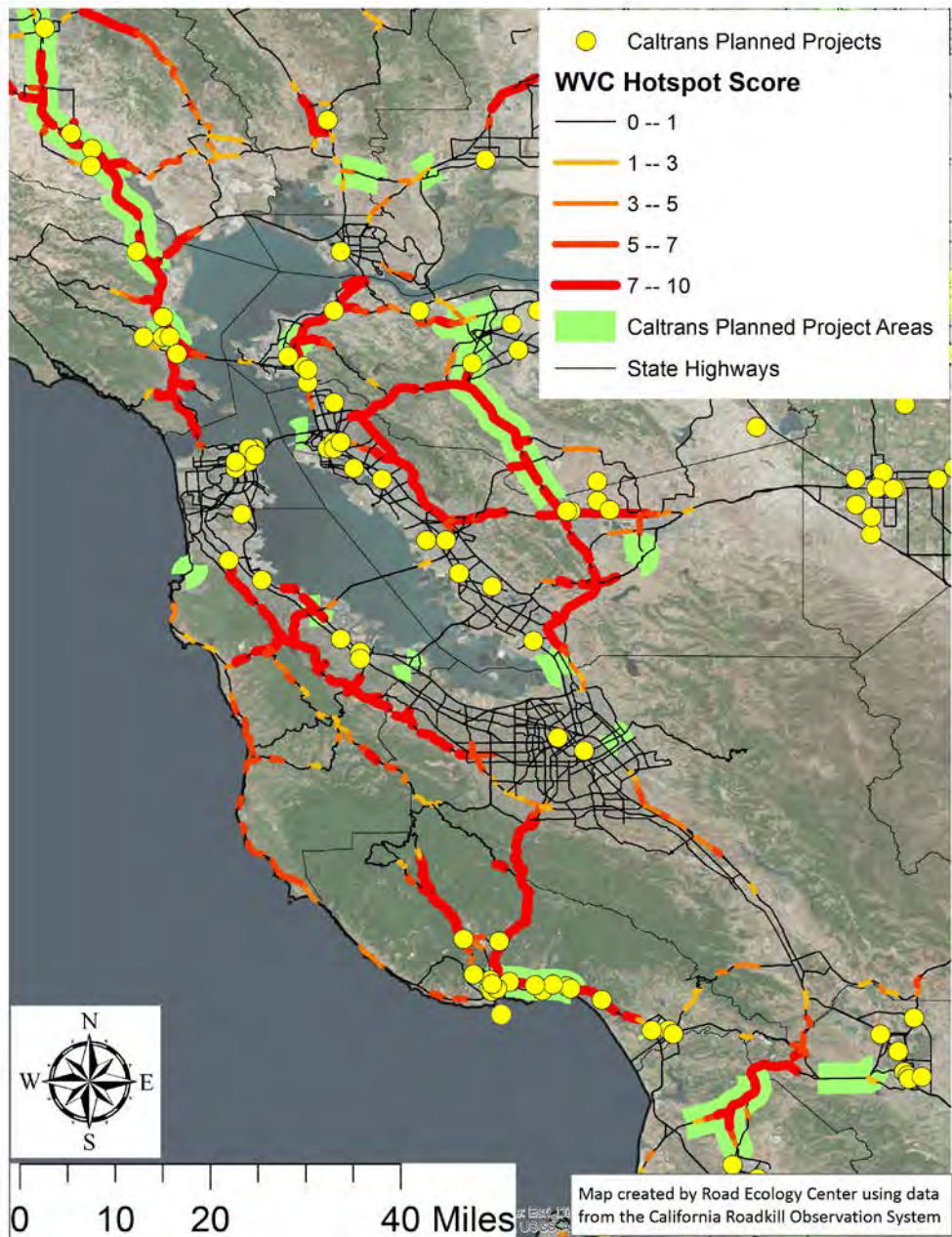


**Figure 6.** Locations of WVC hotspots and planned projects under the State Transportation Improvement Program (STIP) and Senate Bill 1, fuel-tax funding.



### San Francisco Bay Area, Regional Highway Hotspots

This map shows the hotspots of WVC incidents on select highways in the San Francisco Bay region (Figure 7). There are segments of highways that have high enough rates of WVC that if safety projects, such as fencing and wildlife crossings, were undertaken, they would pay for themselves through reduced WVC. This is especially true for I-280, the fencing of which would pay for itself in less than 1 year due to reduced WVC. Many major WVC hotspot areas have no planned highway projects, but projects should be planned to reduce risk and harm.

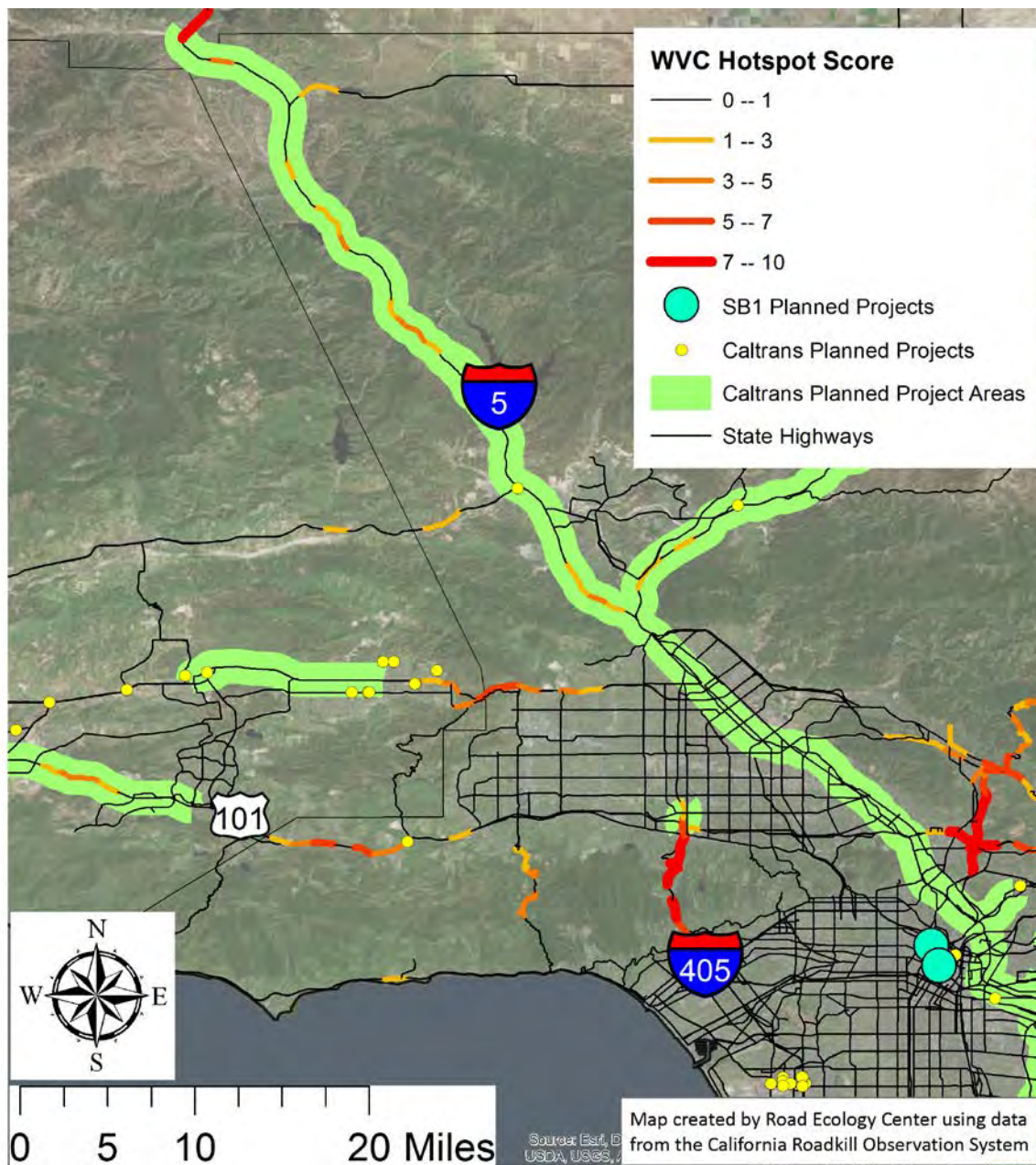


**Figure 7.** Overlap of WVC hotspot areas with state-planned/funded highway projects in the San Francisco Bay Area.



### Southern California, Regional Highway Hotspots

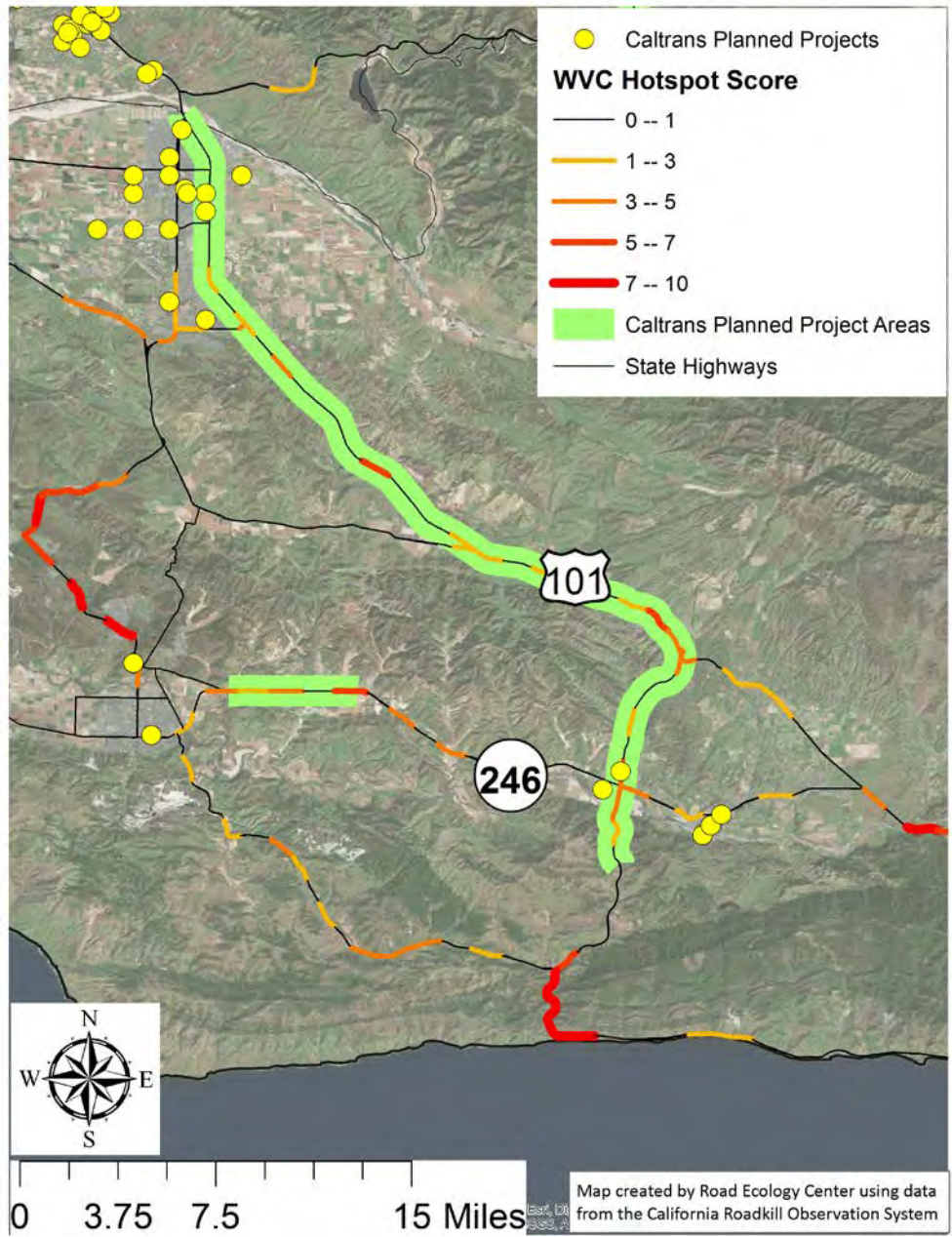
This map shows the clustering of WVC incidents on select highways in the northern Los Angeles basin and mountains (Figure 8). There are segments of highways that have high enough rates of WVC that mean if safety projects, such as fencing and wildlife crossings, were undertaken, they would pay for themselves through reduced WVC. There are several planned state-funded projects that could be used to build wildlife-crossing mitigation. There are also major hotspot areas with no planned highway projects, for which projects should be planned.



**Figure 8.** Overlap of WVC hotspot areas with state-planned/funded highway projects in the Southern California mountains north/west of Los Angeles.

### Central California, Regional Highway Hotspots

This map shows the clustering of WVC traffic incidents on select highways in central-coastal California (Figure 9). There are segments of highways that have high enough rates of WVC that if safety projects, such as fencing and wildlife crossings, were undertaken, they would pay for themselves through reduced WVC.

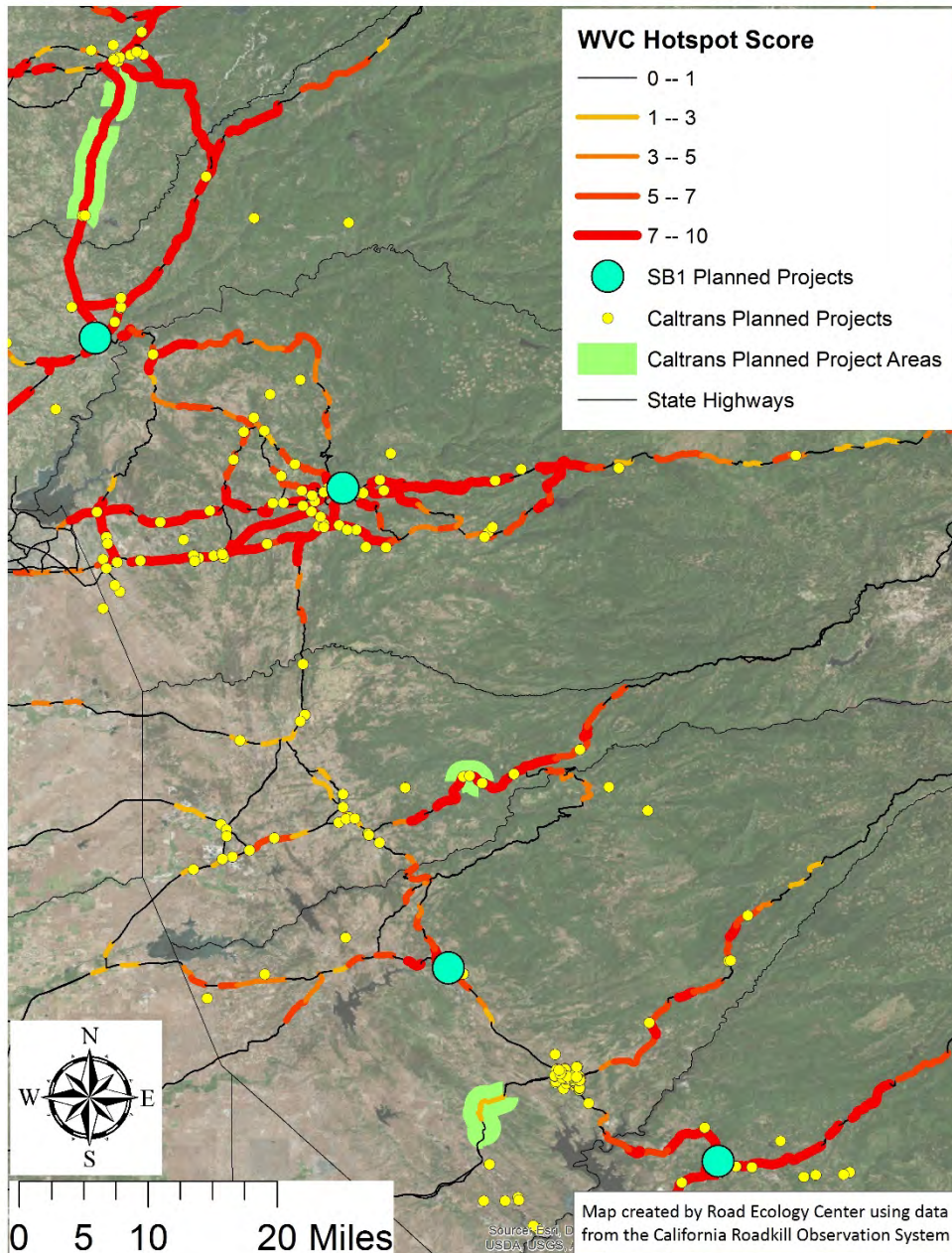


**Figure 9.** Overlap of WVC hotspot areas with state-planned/funded highway projects in the Central California coast near Lompoc.



### Sierra Nevada Foothills, Regional Highway Hotspots

This map shows the clustering of WVC incidents on select highways in the Sierra Nevada foothills (Figure 10). There are segments of highways that have high enough rates of WVC that mean if safety projects, such as fencing and wildlife crossings, were undertaken, they would pay for themselves through reduced WVC. There are several planned SB1-funded projects that could be used to build wildlife-crossing mitigation. There are also major hotspot areas with no planned highway projects, for which projects should be planned.



**Figure 10.** Overlap of WVC hotspot areas with state-planned/funded highway projects in the Sierra Nevada foothills east of Sacramento.

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## Appendix 1: (More) Detailed Methods

### Data Sources

State highway network (SHN) and post-mile (PM) spatial datasets were obtained from Caltrans (<http://www.dot.ca.gov/hq/tsip/gis/datalibrary/index.php#Highway>). All traffic incident data from California Highway Patrol (CHP) resources, beginning in 2/2017, were collected by the UC Davis Road Ecology Center's "California Highways Incident Processing System" (CHIPS) and ingested into a database. This database was then queried for incidents involving animals to create a dataset of Animal-Vehicle Conflict (AVC). The CHIPS AVC data includes collisions between vehicles and wildlife/domestic animals, carcasses found on highways, traffic hazards caused by animals, and other types of traffic incidents involving animals.

Each CHIPS data point contains several fields relating to the incident it represents. These fields include latitude, longitude, street or intersection name, animal species, and any details the CHP officer noted regarding the incident. Many points have multiple entries in the details field, meaning CHP documented updates to the incident as it progressed. These descriptions provide a thorough narrative of the incident, as well as details on the time that events occurred through the eyes of a CHP officer. Other fields in the AVC dataset are manually entered by the Road Ecology Center if they are included in the descriptions. Attributes include data like vehicle damage, driver and animal outcomes, and type of incident (e.g., swerve vs. collision).

CHIPS data represents incidents on California's state, interstate, and federal highways. CHP does respond and document incidents on some unincorporated roads near highways, but incidents more than 50 meters from a highway were excluded from this study.

It is important to note that CHIPS AVC data are a subset of reported incidents on California highways. Unreported incidents and incidents on roads falling outside of the jurisdictions of CHP are not included. CHP has jurisdiction on all federal, state, and interstate highways and public roads in certain unincorporated areas. Therefore, CHIPS incidents are not a record of all AVC in California, but events which induce a documented report within CHP jurisdiction.

Of the AVC incidents, ~90% of the incidents involved mule deer. It can be inferred that animals large enough to cause damage to a vehicle are more likely to be reported to CHP. A minimal number of incidents involve small animals, such as pigeons, geese, and dogs. These are included in the analysis dataset, but do not represent the entirety of incidents with those smaller animals. Thus, this analysis does not represent AVC with smaller species, since those incidents are unlikely to be reported.

Assuming CHP consistently and accurately documents incidents across the state highway network, CHIPS data provides a spatially unbiased dataset of AVC involving large animals on California highways.

### Geoprocessing

The datasets from the previous section were processed using the programming language R and ESRI ArcMap 10.6. The following geoprocessing steps were performed to create the automated hotspot analysis for AVC.



## **Network Segmentation**

The basis for the AVC network analysis is the highway network. In order to create a uniform unit for analysis, one-mile segments were created for highway networks. The Caltrans SHN was used for the AVC analysis of California. The highway lines were split at each one-mile PM. This created a fairly uniform set of segments, split at well-known locations.

## **Assigning Incidents to Segments**

A custom R script was written to assign AVC incident points to spatially corresponding road segments. The R script uses the `snapPointsToLines` function in the `maptools` library. Points >50 meters from any segment were filtered out. This approach did not attribute incidents to incorrect road segments. The number of AVC incidents for each segment was summed in an attribute field to the segment, which is the metric of primary importance in the WVC analysis. A maximum distance of 50 meters was chosen when snapping incident points to road segments. Since CHP often records data on road shoulders, and the highway network is often on the centerline of roads, or between separated highway lanes, and GPS receivers have an accuracy radius, point locations are usually a short distance away from network lines. However, incorporating points further than necessary would have included WVC points on roads not in the analysis, inaccurately inflating density distribution.

## **Clustering Statistics – Hotspot Score**

To provide a different view of the spatial distribution of AVC along the network, the `GetisOrd`  $G_i^*$  statistic was used to statistically analyze clusters and to contribute to a hotspot score for each one-mile road segment. An R script ran a local `Getis-Ord` calculation for each segment on the network, analyzing the number of incidents snapped to each segment. The default neighbor radius is one mile (1609 meters), and a binary weighted matrix including the value of the segment. The script adds a  $G_i^*$  z-score value to each segment, denoting if the segment is in a relative “hotspot” or “coldspot”.

The  $G_i^*$  statistic is well-suited to identify hot and cold locations in density distribution, the resulting z-score is not clearly understood by all audiences. Moreover, some additional nuances of WVC distribution should be incorporated into an easily shared “hotspot score”.

Using the  $G_i^*$  value, a “hotspot score” was created to more effectively communicate the results. First, segments with a) zero incident density or b) a negative  $G_i^*$  value are assigned a hotspot score of zero. This avoids over-smoothing the score, to reveal highway segments with no incidents in a region of high incidents. Then, a percentile of each  $G_i^*$  value within the distribution of remaining non-zero segments is calculated. Finally, an integer value from 1-10 is given to each segment by rounding up the percentiles. The hotspot score is a means of synthesizing incident density and spatial clustering, but presenting it in a way that is easily understood by all audiences. The process can be implemented on any network, and will categorize network segments into 10 equally sized categories, where each segment with a score greater than zero has incident densities and positive  $G_i^*$  values.

2019



# Impact of Wildlife-Vehicle Conflict on California Drivers and Animals

**ROAD ECOLOGY**  
Roadecology.ucdavis.edu **CENTER**  
**UCDAVIS**

Fraser Shilling, Ph.D., Co-Director; David Waetjen, Ph.D., Programmer; Kathryn Harrold, Consultant; Parisa Farman Student

8/1/2019

# Impact of Wildlife-Vehicle Conflict on California Drivers and Animals

Using observations of reported traffic incidents and carcasses the Road Ecology Center has estimated the **total annual cost** of reported (large) wildlife-vehicle collisions for 2018 in California to be **at least \$232 million** and the cost to society over the last 4 years to be **>\$1 billion**. The cost is calculated using California Highway Patrol (CHP) reports of crashes with wildlife and US Department of Transportation equivalent values for different types of crashes (e.g., property damage vs. major injury). When including accidents that are claimed to insurance companies but un-reported to police, the estimated cost could be as high as \$500 million/year (estimated for 2017). This report provides an overview of wildlife-vehicle conflict (WVC) in general, including collisions with small and large animals and accidents resulting from drivers swerving to avoid colliding with an animal. We highlight WVC hotspots on California highways between 2015 and 2018, inclusive, based on a combination of >26,000 traffic incidents involving wildlife that were recorded by the CHP and >42,000 carcass observations reported to the California Roadkill Observation System (CROS, <http://wildlifecrossing.net/california>) between 2009 and 2018, inclusive. This report includes **maps of WVC hotspots**, discusses impacts to wildlife and people from WVC, addresses whether mapped “wildlife corridors & linkages” help explain where WVC occurs, and presents new tools to help organizations, state agencies and individuals collect and use this information. Projects to **reduce WVC** can be the most effective of any safety project, with effectiveness often >90%.

For the first time, we **statistically compared the location of WVC** with various computer **predictions of wildlife corridors/linkages** in California. In general, we found no significant correlation between the locations of WVC and these linkages. This may not be surprising because wildlife generally do not follow narrow or predictable paths through their habitat. California agencies have been looking for predictability in wildlife movement to help reduce the **cost of mitigation**. Fortunately, there are ample data available on wildlife movement from WVC databases and studies involving GPS-collared wildlife to identify mitigation locations.

**Data Sharing/Collaboration:** We receive requests from highway planners, fish and wildlife scientists, academic faculty, students, and non-governmental organizations on a weekly basis. We can typically meet data requests within CA for specific highways, counties, etc., but please keep in mind that this is an unfunded effort of the Road Ecology Center, so give us a few days.

We have developed 2 globally-unique web-tools to collect and to visualize WVC incidents in CA: 1) A re-vamped California Roadkill Observation System to support “one-click” reporting (<https://wildlifecrossing.net/california>) –take a picture of a roadkilled animal with your smartphone and upload with one click (which automatically creates a database record); and 2) A WVC hotspot tool that shows hotspot areas throughout CA and has a real-time display of WVC events, <https://roadecology.ucdavis.edu/hotspots>.

Cover photo credit. Female mountain lion killed by a vehicle on a county road near San Luis Obispo, 8/1/2019. Photo taken and provided by Kelly Kephart, wildlife biologist with PGE.

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## UC Davis Road Ecology Center: Sixth Annual Special Report on the Impact of Wildlife-Vehicle Conflict (WVC) on California Drivers and Animals

### **Top 4 Talking Points**

- 1) **We can help the state systematically collect and share data.** The data assembled here from the CHP were not collected with the purpose of studying WVC, the volunteer data were. California agencies should collect and share data about WVC to help inform decision-making about this important conservation and safety problem. Using our extensive datasets and decade of experience collecting and analyzing WVC data, we are open to partnering with Caltrans, California Department of Fish and Wildlife and others to accomplish this.
- 2) **Legislated support is needed for highway/road projects that that have net WVC benefit.** In the past, WVC-reduction projects (like wildlife crossings) were only occasionally considered and as part of partial mitigation for transportation impacts. There is currently a state program to allow “advance mitigation credit” for WVC-reduction projects where impacts are reduced now, but balanced by doing more harm later. Transportation agency planners and biologists are increasingly discussing wildlife-crossing structures and other projects as stand-alone safety and sustainability projects, providing a net benefit to drivers and wildlife, without the need for the projects to mitigate for further harm later.
- 3) **Build WVC-reduction projects at known hotspots.** Very few driver safety projects have the overall effectiveness that WVC reduction projects do. There are hundreds of places on state highways and major roads where WVC is a priority. Unfortunately, we can’t use “wildlife corridor/linkage” computer models to tell us where these places are. Fortunately, we have the WVC and other wildlife movement data to help show us where to act.
- 4) **Allocate sufficient funds to build needed WVC-reduction projects.** With the passage of SB1, California voters provided state legislators and transportation agencies with an increase in funding (>\$5 billion/year!) to protect driver safety and the environment. We know that doing nothing, or very little to reduce WVC is costly – to drivers and to the environment (~\$300 million per year). There are myriad excuses for why “nothing can be done”, lack of funding is not one of them.

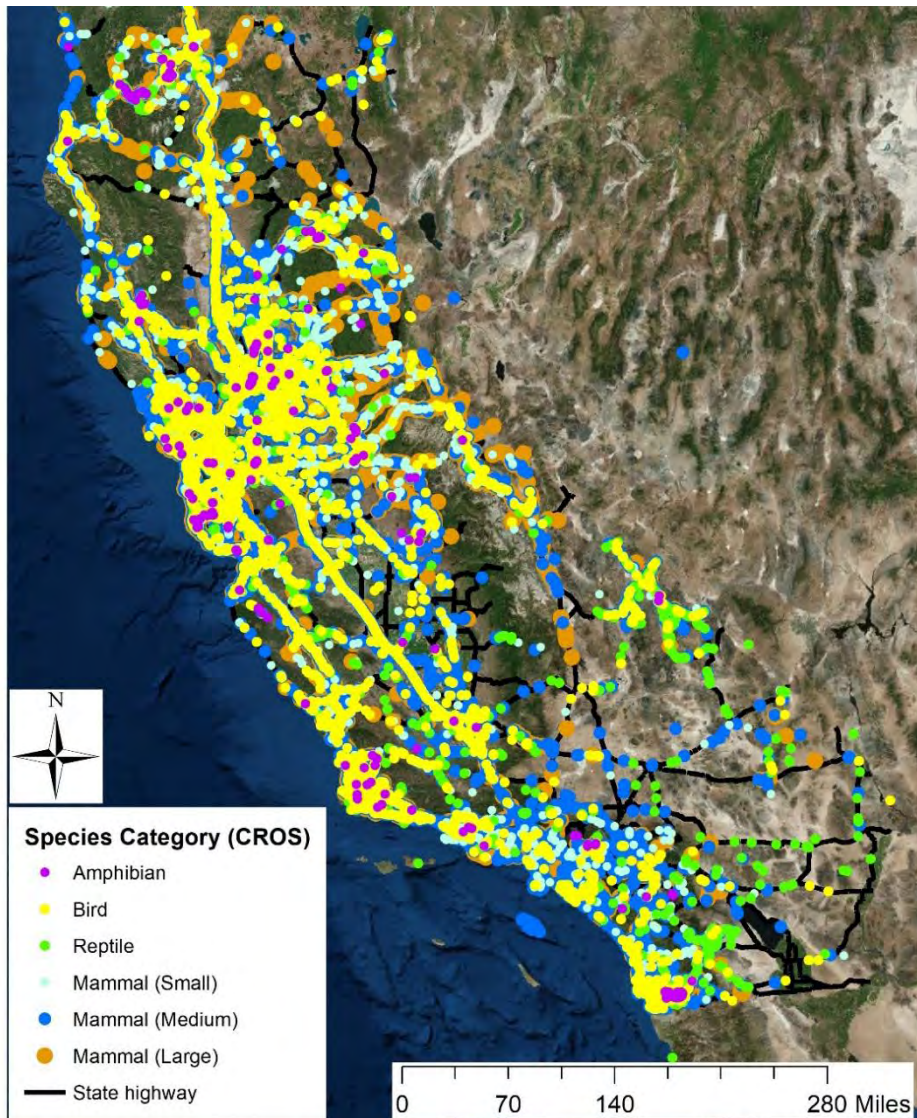
### **Introduction to Study**

Using California state data on traffic incidents and roadkill observations, the Road Ecology Center has mapped stretches of 15,160 miles of California highways that are likely to be continuing hotspots for wildlife-vehicle conflicts (WVC). Animals entering roadways are often killed and pose a hazard to drivers, who may collide with the animal, or try to avoid the animal



suffering vehicle damage, injury, and even death. Wildlife populations may suffer significant losses from highways with high rates of WVC, which may cause ripple effects into surrounding ecosystems up and down the food chain. In addition, animals are injured during collisions, which is damaging to the animal and traumatic and deadly to drivers.

By identifying stretches of highway where WVC are more likely to occur, the Road Ecology Center is assisting Caltrans and other responsible entities in developing mitigation to protect drivers and wildlife populations. Measures with proven effectiveness include 1) building fencing and over/under-passes along priority highways to allow the safe passage of wildlife across highways and 2) reducing speed limits in protected wildlife habitat. Using CHP data, we have found records of ~7,000 reported accidents per year on California highways involving deer and other large wildlife. We estimate that there are another few thousand with horses, cows, sheep and goats. Data from CROS allow state and local agencies to prioritize stretches of highway for mitigation of conflicts with particular species or groups (e.g., Ha and Shilling, 2017).



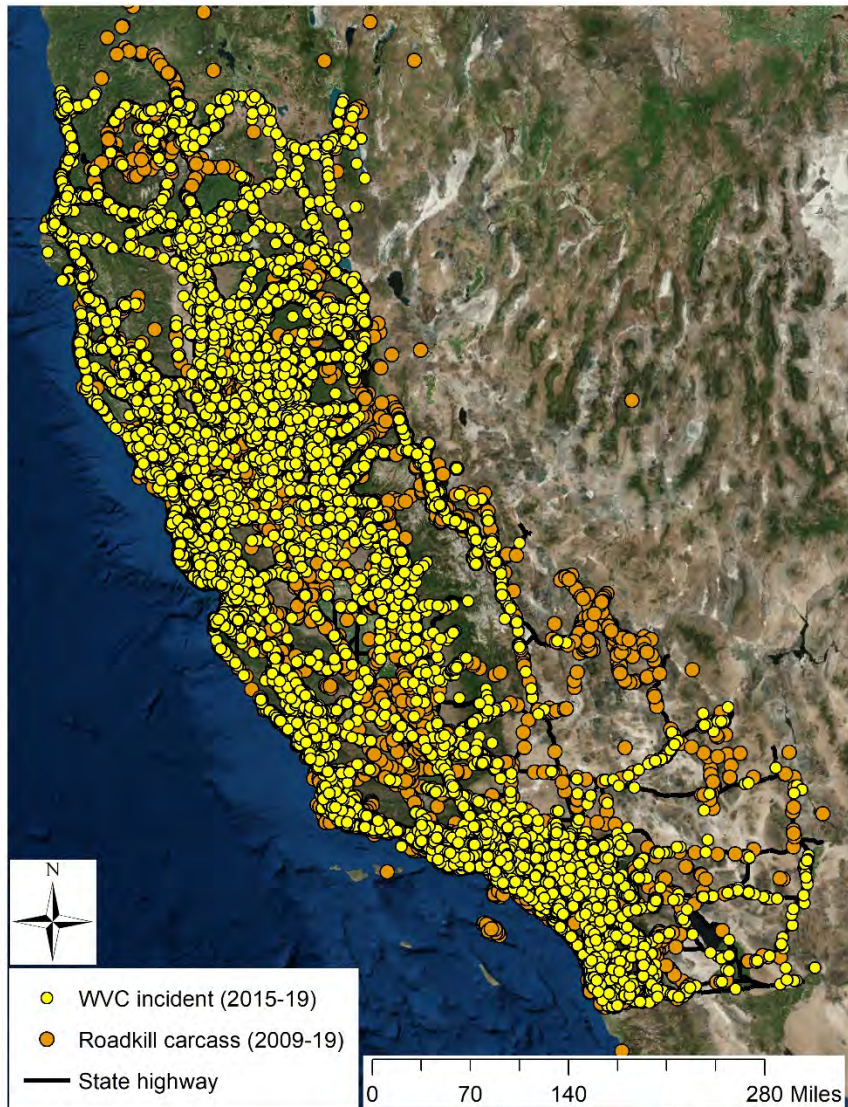
### Statewide Carcass Observations

Members of the public, agencies, and others made >60,000 observations of animal carcasses on local roads and state highways (Figure 1). These are not the total roadkill that occurred, just the ones that expert observers saw and reported to CROS.

**Figure 1.** Carcass observations for amphibians, reptiles, birds, and mammals.

## Statewide Highway WVC Incidents

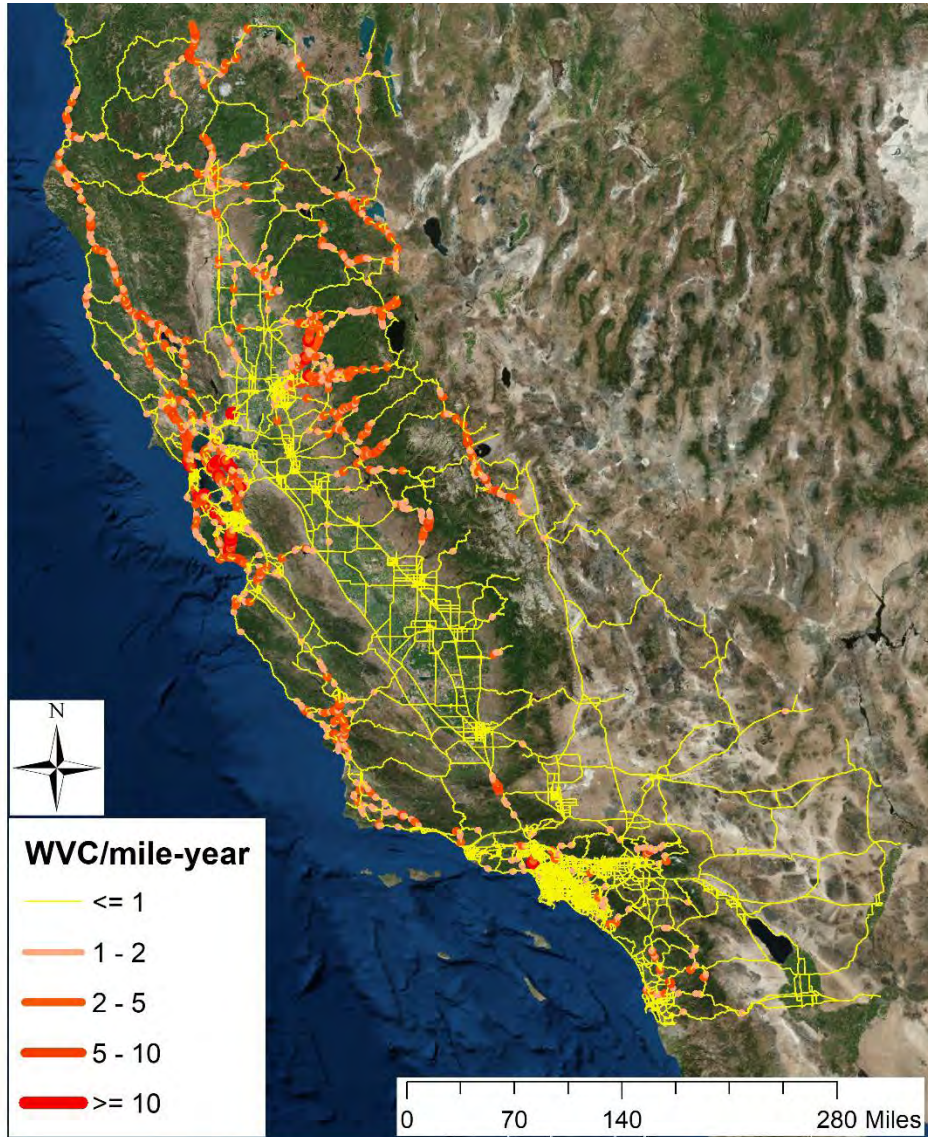
There were >2.5 million traffic incidents (of all types) across California reported to the CHP during 2015-2018. Of these, about half were collisions and 26,547 involved wildlife, including 1) reports of animals standing next to, standing in, or running across lanes (potential incidents); 2) collisions with large animals; and 3) swerving to avoid collisions, resulting in a crash (Figure 2).



**Figure 2.** Wildlife-vehicle conflict incidents on highways (2015-2018) and roadkilled animal observations on all roads (2009-2018).

Although WVC occurs on every major road and highway in California, the highest densities were reported in the San Francisco Bay Area (Caltrans District 4), Sierra Nevada Foothills (Caltrans Districts 3 & 10), North Coast (Caltrans District 1), and parts of the Central/South Coast (Caltrans Districts 5, 7, 11 & 12). These high-density areas are most likely where traffic volumes and wildlife populations are greatest, leading to more conflict. The map below shows the high-density clusters of collisions with large wildlife in California (Figure 3). There were 1,584 miles of state highway where  $\geq 4$  large animals were involved per mile per year in WVC incidents and 3,138 miles where  $\geq 2$  large animals were involved in WVC per year.



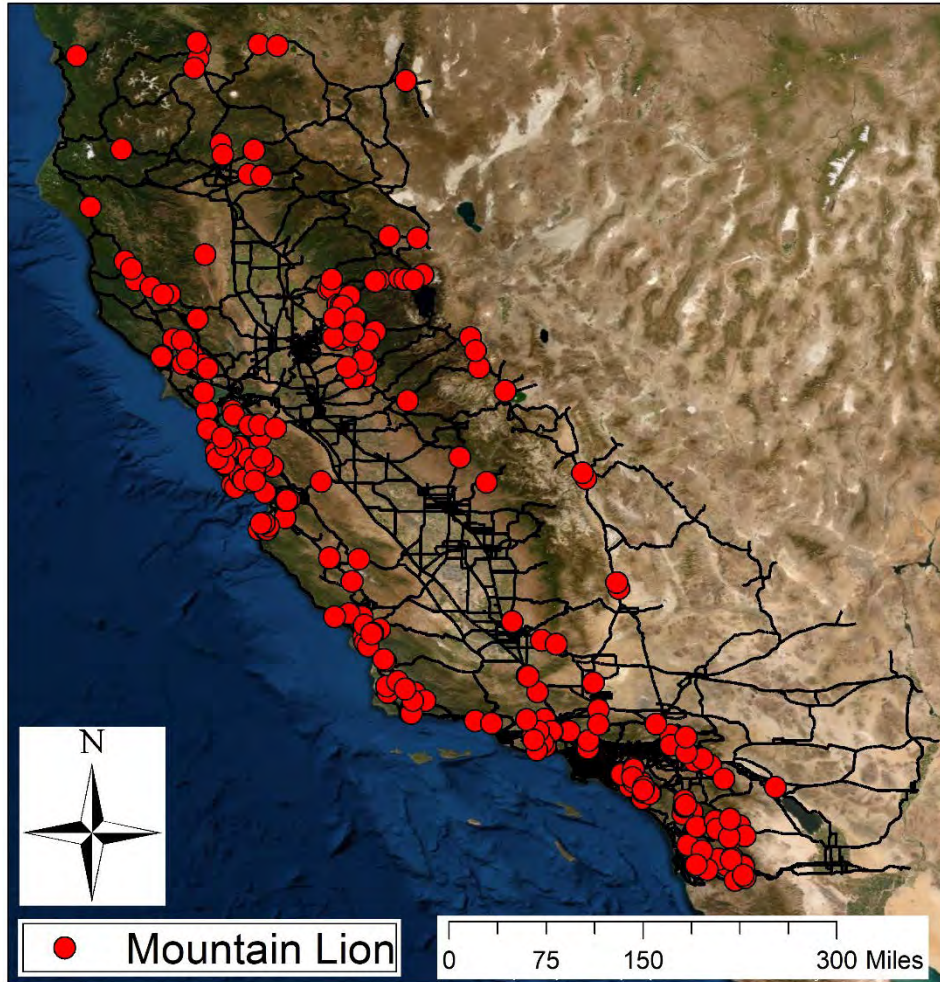


**Figure 3.** High-density WVC hotspots for 2015 to 2018. Hotspots can vary in length from 1 to several miles. Density is expressed as # incidents per mile per year. Greater than 2 WVC/mile-year is a recognized cost-benefit standard for transportation agencies to start planning for impact mitigation.

### Impacts to Specific Wildlife: Mountain Lions

Like most species at the top of the food web, mountain lions are especially vulnerable to WVC because they move around a lot and cross roads and highways. Mountain lions are important ecologically because they are the only large, widespread predator in most California ecosystems. They are also important socially, with great interest in their well-being in Southern California and Bay Area urban regions.

A critical problem for mountain lions in California is that there is no formal program, system or requirement to report when they are killed on roads, which happens frequently. As such, we only know the minimum killed each year on roads, when they are reported to CROS, and have



**Figure 4.** Mountain lions reported killed on roads, or involved in traffic incidents by the California Roadkill observation System, CDFW, CHP, or Winston Vickers and other biologists in Southern California (Vickers et al. 2015, and Vickers unpublished data).

no way of knowing the actual WVC impact to this important and charismatic species. Between 2015 and 2018, inclusive, 299 mountain lions killed on roads (~75/year) were reported by a combination of CROS volunteers, CHP, CDFW, and biologists in Southern California (Figure 4). The cover photograph for this report highlights the problem. It was taken by a wildlife biologist who happened upon the dead animal as part of her work. She reported the finding informally to colleagues in the

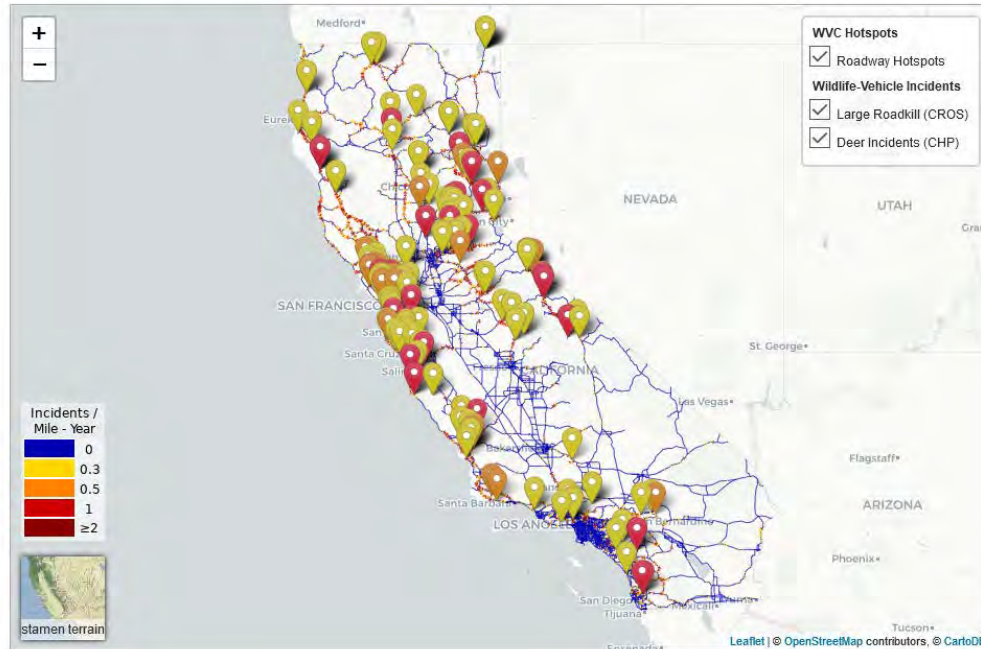
California Department of Fish and Wildlife, who similarly informally reported the observation to us. This story highlights the need in California for a systematic and legislated approach to reporting wildlife mortality on roadways in order that we can understand the distribution, impacts and risk to wildlife populations and species.

### Real-Time, Automated Web-Map of WVC

To provide more current information for California agencies and the driving public, we make our WVC data available in real time, the first tool of its kind in the world. You can see recent WVC events and WVC hotspots here: <https://roadecology.ucdavis.edu/hotspots/map>. The map was developed with support from the National Center for Sustainable Transportation and can support automatic ingestion by web-systems or driver-assistance programs.



## Real-time Deer Incidents & Wildlife-Vehicle Conflict (WVC) Hotspots

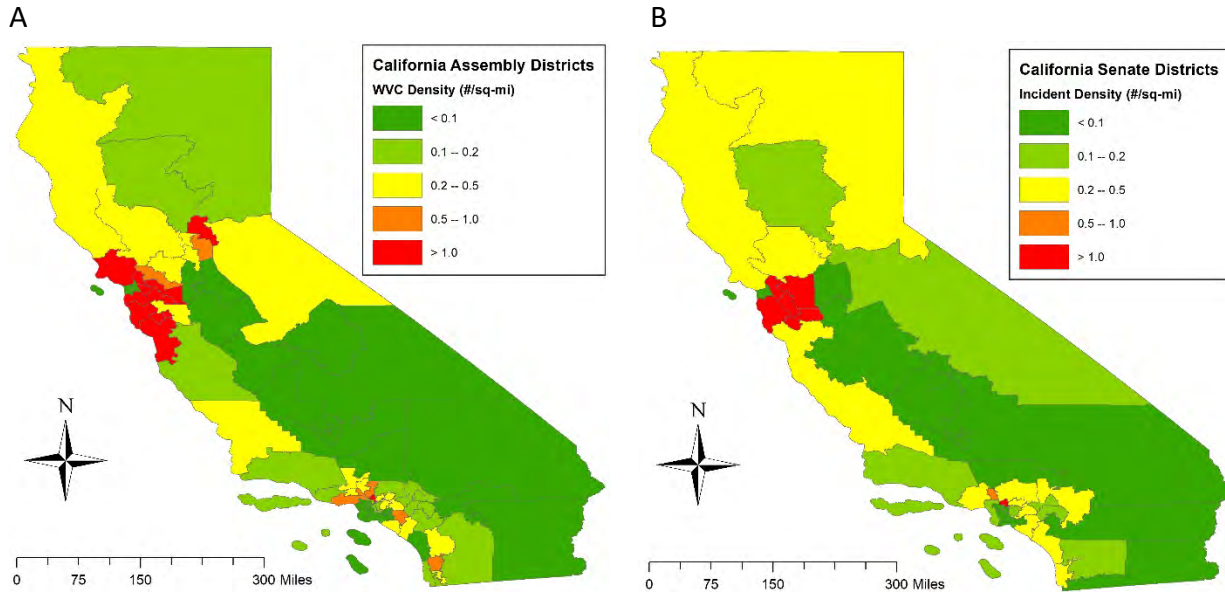


**Figure 4.** Locations of recent (7/22/2019) WVC incidents and roadkill carcasses (points) overlaying WVC hotspots, defined by annual WVC density (lines). Map available at: <https://roadecology.ucdavis.edu/hotspots/map>.

### Impacts within Assembly & Senate Districts

The ultimate authority for legislating reporting and mitigating impacts to driver and wildlife safety from WVC lies with the state Assembly and Senate. They have the ability to require state agencies to report WVC (e.g., crashes and carcasses), to require analyses (such as the one you are reading), to mitigate impacts at an adequate rate, and to spend available funds (e.g., from the SB1 Fuel Tax). We calculated the total number of WVC with large mammals within Assembly and Senate Districts for the 2015-2018 time period. The total number of WVC varied between a low of 1 for Assembly District 66 (Palos Verde) to 6,466 for Senate District 1 (rural NE California). Because the Districts vary widely in size, we also calculated the density of WVC (#/square-mile). This calculation revealed that the highest-densities of WVC are in Assembly and Senate Districts around the edges of the urban regions of the Bay Area, Sacramento and Southern California (Figure 4). The 10 Assembly Districts with the highest WVC rates were politically-mixed, with 6 represented by Democrats and 4 by Republicans. Our calculations showed that WVC as a conservation and safety problem is not limited to one political party or type of region (rural vs. urban).





**Figure 4.** Density of WVC by (A) state Assembly and (B) state Senate districts for 2015-2018, inclusive.

### Cost to Society

Any type of collision involves risk and actual damage to drivers and their vehicles. It is no different for collisions involving wildlife, whether the collision is with the animal, or with another object after the driver swerved to avoid hitting the animal. As in previous years, we used cost coefficients from the US Department of Transportation (Harmon et al., 2018, Crash Costs for Highway Safety Analysis. FHWA-SA-17-071) to estimate the total cost to society from collisions involving wildlife. These costs include the expense of vehicle damage, injury treatment and recovery, emergency response, lost work, loss of the wildlife and other costs. We found that the total cost was lower in 2018 than in previous years: ~\$232 million in 2018 vs. \$307 million in 2017 (Table 1). This was in part due to a lower estimated property damage cost to vehicles and a lower estimated number of fatal collisions, which is only estimated because California does not release these statistics. The total number of collisions did not change very much from year to year.

**Table 1.** Impact to drivers and estimated cost to society of reported collisions with animals on CA highways and certain major roads in 2018. Equivalent costs for accident types were obtained from Harmon et al. (2018).

Type of Accident	Coefficient (cost as \$/event)	Number (2018)	Cost (2018)
Lost animal value (all animals)*			\$37,300,000
Collision/Swerve (property damage)	\$11,900	6,412	\$76,302,800
Injury (minor)	\$125,600	271	\$34,037,600
Injury (major)	\$655,000	43	\$28,165,000
Fatality	\$11,295,400	5**	\$56,477,000
<b>Total</b>			<b>\$232,282,400</b>

\* This value includes both reported and estimated un-reported carcasses, with an estimated 5 times as many total as reported. Others have reported under-reporting rates for carcasses from collisions of 5-10 fold.

\*\* This is an estimate as CA does not release annual rates of fatal collisions with wildlife

Another way to measure costs is according to a California jurisdiction. We totaled all types of injury and non-injury accidents within California Assembly Districts. Except for District 10 (Marin County), the top-5 highest costs were associated with rural Districts (1, 5, 2, 35). District 10 was also among the top-10 districts with the highest number of total WVC and density of WVC, primarily because of US 101. Besides Assembly District 10, other Districts with high total number of WVC, density, and cost were District 16 (San Ramon, I-680, I-580, SR 24) and District 24 (Los Altos, I-280). The total cost over a 4-year period (2015-2018) for the top 10 Assembly Districts was ~\$445 million.

**Table 2.** Estimated number of WVC, injury accidents (from collisions with wildlife) and cost to society of reported WVC between 2015 and 2018, inclusive, for the Assembly Districts with the most WVC impact.

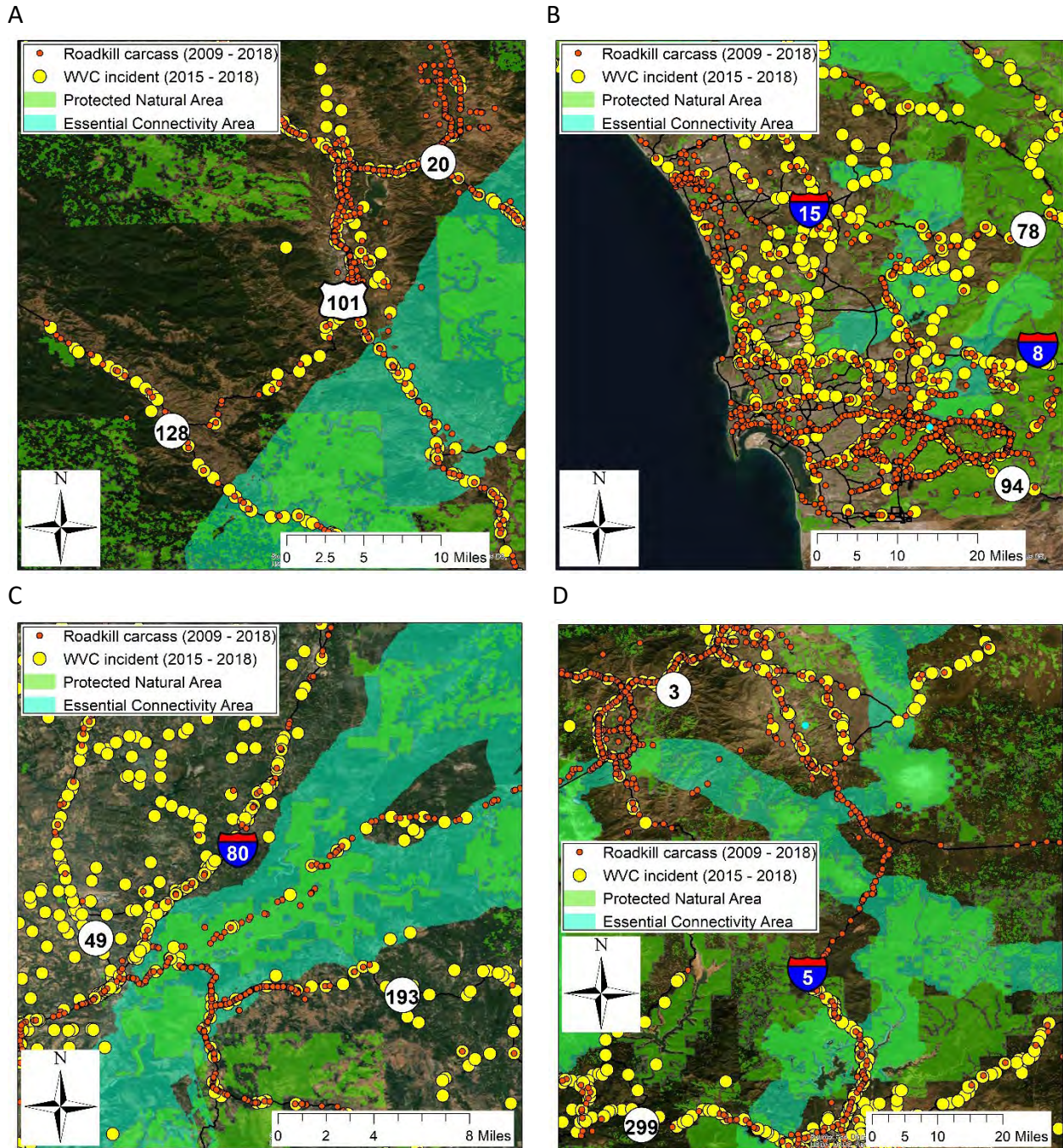
Assembly District	Total Collisions	Injury Accidents	Total Cost (\$)
1	4969	226	\$105,308,820
5	4395	202	\$93,547,800
2	2804	141	\$61,660,480
10	1555	60	\$31,040,220
35	1505	86	\$34,786,980
29	1493	48	\$27,098,140
16	1102	36	\$20,043,740
24	1039	66	\$25,853,820
4	1018	57	\$24,364,640
3	1016	51	\$21,287,780
			\$444,992,420

## Corridors, Linkages and Roadkill

Wildlife naturally move around their habitat, meeting daily, seasonal, reproductive, migratory, dispersal, and climate adaptation needs. A common misconception, even among conservation planners, is that wildlife will naturally follow “corridors” or “linkages” when roaming around on landscapes. This idea is related to the hypothesis that most species occupy “patches” of habitat and these patches are connected by corridors/linkages. Except for certain ungulates (e.g., mule deer in certain areas) there is little evidence that most or all of the roughly 180 mammal species in California (or anywhere else) follow predictable paths across landscapes, or only occupy mapped patches of habitat.

We compared densities of roadkilled animals on state highways with different connectivity values in the California Department of Fish and Wildlife’s Areas of Conservation Emphasis (ACE) and with the Essential Connectivity Areas in the California Essential Habitat Connectivity (EHC) project (Spencer et al., 2010). We tried all animals together and with different groupings (e.g., mammals). In all cases, we found no statistically significant relationship between location of roadkilled animals and linkage areas, or with connectivity values from ACE maps. Examples of the overlap between WVC/roadkill events and EHC linkage areas are shown in Figure 5. There were a few areas where concentrations of roadkill were associated with modeled linkages, which may indicate that these areas actually are important for wildlife movement. However, there were usually areas outside linkages that also had high concentrations of WVC/roadkill. The simplest explanation for these findings is that, in general, corridor and linkage maps don’t predict where animals are primarily moving and should not be used for mitigation planning that leaves out areas where animal movement is also provably occurring.

The importance of this finding is that many people in transportation and conservation planning use these maps as if they were related to wildlife connectivity movement and use the term “data” to describe the maps. In reality they are not data, nor are they based on data for all (or most) wildlife movement. In urban and agricultural regions, the “linkages” were more likely to seem related to locations of WVC, which is probably because these are the only natural habitat areas remaining in these regions. For example, if a stream with a healthy riparian area passes through an urban/residential area, then there tended to be a greater likelihood of predicted connectivity and concentration of WVC. The solution to the problem that our findings highlight is that maps of wildlife connectivity must be based upon where wildlife occur and are moving for them to have utility in wildlife conservation planning. Including additional areas where wildlife may occur after protection and restoration could also be useful.



**Figure 5.** Comparison of WVC/roadkill incidents and maps of essential connectivity areas and natural areas from the California Essential Habitat Connectivity project (Spencer et al., 2010). A) North Bay Area, B) coastal San Diego County, C) American River canyon, and D) Mt Shasta area.

## Summary

Monitoring wildlife movement and mortality is critical for improving wildlife connectivity and survival of wildlife species in the face of the combined threats they face, such as transportation systems, climate change, rodenticides, and habitat loss. We reported here on long-term,



successful methods for monitoring WVC in California, an annual (2018) analysis of locations and costs of WVC to wildlife and drivers and society. We provided key recommendations for ways to reduce WVC in California through support for a several-fold increase in mitigation projects with net benefit for wildlife and driver safety. Finally, we suggest that any WVC-reduction and wildlife connectivity mitigation be planned based on evidence-based connectivity design, not the current “linkage” models.

## **Acknowledgements**

We appreciate the support from the National Center for Sustainable Transportation (using USDOT funding) and the Institute of Transportation Studies (CA SB1 funding) for development of the automated wildlife-vehicle conflict hotspot tool and one-click reporting tool California Roadkill Observation System (CROS, <https://wildlifecrossing.net/california>). This and previous reports and the analyses contained within would not have been possible without the concerted and coordinated efforts of hundreds of volunteer roadkill observers over the last 10 years who contribute to CROS. Through their endeavors, they have so far (7/2019) collected >60,000 observations of >430 species, representing one of the largest and most comprehensive wildlife monitoring programs in California and the US. Their accuracy rate for species identification is >97% and have high locational accuracy (median <±13 meters). For the scientific article describing CROS, see citation below (you can paste the “doi” value below into a browser and access the papers). The report also benefited from the efforts of many unknown law enforcement personnel who described traffic incidents in enough detail that we could use their observations to help plan for reduced wildlife-vehicle conflict. Finally, we have partnered with other similar systems around the world in the Globalroadkill.net project (<http://globalroadkill.net>).

**Citation for CROS: Waetjen DP and Shilling FM (2017) Large Extent Volunteer Roadkill and Wildlife Observation Systems as Sources of Reliable Data. *Frontiers in Ecology & Evolution* 5:89. [doi:10.3389/fevo.2017.00089](https://doi.org/10.3389/fevo.2017.00089)**

**Additional CROS citation: Tiedeman, K., R.J. Hijmans, A. Mandel, D.P. Waetjen, F. Shilling (In Press) The quality and contribution of volunteer collected animal vehicle collision data in ecological research. *Ecological Indicators*. <https://doi.org/10.1016/j.ecolind.2019.05.062>**

Contact: Fraser Shilling, Co-Director, Road Ecology Center, UC Davis; [fmshill@ucdavis.edu](mailto:fmshill@ucdavis.edu).



# Birdsong and anthropogenic noise: implications and applications for conservation

HANS SLABBEKOORN and ERWIN A. P. RIPMEESTER

*Institute of Biology, Leiden University, 2300 RA Leiden, The Netherlands*

## Abstract

The dramatic increase in human activities all over the world has caused, on an evolutionary time scale, a sudden rise in especially low-pitched noise levels. Ambient noise may be detrimental to birds through direct stress, masking of predator arrival or associated alarm calls, and by interference of acoustic signals in general. Two of the most important functions of avian acoustic signals are territory defence and mate attraction. Both of these functions are hampered when signal efficiency is reduced through rising noise levels, resulting in direct negative fitness consequences. Many bird species are less abundant near highways and studies are becoming available on reduced reproductive success in noisy territories. Urbanization typically leads to homogenization of bird communities over large geographical ranges. We review current evidence for whether and how anthropogenic noise plays a role in these patterns of decline in diversity and density. We also provide details of a case study on great tits (*Parus major*), a successful urban species. Great tits show features that other species may lack and make them unsuitable for city life. We hypothesize that behavioural plasticity in singing behaviour may allow species more time to adapt to human-altered environments and we address the potential for microevolutionary changes and urban speciation in European blackbirds (*Turdus merula*). We conclude by providing an overview of mitigating measures available to abate noise levels that are degrading bird breeding areas. Bird conservationists probably gain most by realizing that birds and humans often benefit from the same or only slightly modified measures.

*Keywords:* adaptation, biodiversity, city life, conservation, ecological speciation, homogenization, traffic noise, urbanization

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## Introduction

Urbanization concerns all environmental changes associated with urban development and is a global phenomenon affecting animals, including humans, as well as plants (Vitousek et al. 1997; Western 2001). Expectations are that in the next two decades an additional two billion people will need a place to live, and they will not live in the current cities but in newly developed urban areas (Meyer & Turner 1992; World Resources Institute 2004). Urbanization usually has a negative effect on rare species and favours others that become more and more common, which can be native generalist species, but often means non-native urban colonizers (Bolger et al. 1997; Sewell & Catterall 1998;

Lim & Sodhi 2004; Marzluff 2005). At a local scale, urbanization does not necessarily lead to a drop in species diversity because the heterogeneous urban habitat does provide quite a variety of niches. However, at a larger scale, urbanization leads to homogenization and a drop in diversity because the typical urban species turn out to be the same everywhere irrespective of the original fauna (Clergeau et al. 2006; McKinney 2006). For species that still occur within and outside of cities, it is known that urban challenges may be relatively stressful as reflected for example by a divergence in heterophil-leucocyte ratios (Ruiz et al. 2002) or increased baseline corticosterone levels in male birds of city environments (Bonier et al. 2007). Nevertheless, although many species disappear from urban areas because they depend on habitat features that do not exist anymore, others find a new niche among bricks and concrete and adapt to a life in the city (Luniak 2004).

Correspondence: Hans Slabbekoorn, Fax: 31 71 527 4900; E-mail: h.w.slabbekoorn@biology.leidenuniv.nl

Cities differ from rural or forested areas in a number of ways (Warren *et al.* 2006; Slabbekoorn *et al.* 2007). Urban areas are usually warmer, have artificial lighting regimes, more chemical pollution, and have relatively little and often exotic vegetation in a landscape dominated by street pavement and concrete buildings. Furthermore, cities harbour a different suit of parasites (Gregoire *et al.* 2002) and predators including domestic cats (Woods *et al.* 2003; Lepczyk *et al.* 2004), and a different set of food sources (Horak & Lebreton 1998). For example, urban house sparrows are reported to have higher cholesterol levels compared to rural ones, and food samples indeed reveal higher fat and protein content in urban diets (Gavett & Wakeley 1986). Consequently, food preferences also affect which species are more likely to do well under the urban food conditions; omnivorous and frugivorous birds are typically more successful than insectivorous and carnivorous species (Clergeau *et al.* 1998; Lim & Sodhi 2004).

One of the most prominent novel urban conditions concerns the ambient noise and the acoustic space available for animals to use acoustic signals (Slabbekoorn & Peet 2003; Katti & Warren 2004). All habitats are noisy to some extent, but the usual urban cacophony produced by cars, mopeds and all sorts of machinery is evolutionarily speaking novel and dramatically different from most natural habitats. Urban noise is typically loud and low in pitch which also applies to anthropogenic noise in areas around highways, railway lines and airports – which together form an ever denser network penetrating deeply into rural and forested areas (Forman & Alexander 1998; Reijnen & Foppen 2006). Anthropogenic noise could be an important factor driving bird species out of cities and away from highways, even when other habitat requirements are still sufficient.

Many studies have reported lower species diversity and lower breeding densities of birds along highways (Van der Zande *et al.* 1980; Reijnen & Foppen 1991, 1994; Illner 1992; Kuitunen *et al.* 1998, 2003). The negative impact of roads on birds has been linked repeatedly with traffic load (Reijnen *et al.* 1995, 1997; Forman *et al.* 2002; Peris & Pescador 2004), showing that the impact is not due to the mere presence of a road. However, direct evidence for traffic noise being the dominant detrimental factor is still lacking and other potential factors are visual disturbance, chemical pollution, road-kills and soil vibration. An interesting study concerns an impact assessment along a German motorway, which revealed a song-frequency-dependent pattern in breeding density in two transects parallel to the road (Rheindt 2003). Bird species with relatively low mean song frequencies were less abundant near the road, while species singing with higher frequencies occurred in higher numbers near the noisy road than in the more quiet transect. Although the lack of replication and statistical significance were limitations to this study, this is the first

direct indication that low-frequency traffic noise may constrain breeding opportunities of birds.

Few studies have tried to assess a negative impact of anthropogenic noise on birds while excluding other possibly contributing factors. A study in natural habitat of the Rocky Mountains, USA, showed a negative correlation between the number of species and anthropogenic noise levels (Stone 2000). Another recent study reported the first data on a decline in reproductive success due to anthropogenic noise without confounding parameters typically associated with highway or urban studies (Habib *et al.* 2007). The authors compared ovenbirds (*Seiurus aurocapilla*) in Canada, in two sets of territories of equal quality, except for either being located next to noise-generating compressor stations or next to noiseless well pads. Significantly more inexperienced first-year breeders were found at the noisy locations, while the pairing success at noisy territories showed a considerable decline, independent of the individual quality. This study unequivocally confirms a negative impact of human-generated ambient noise, but how does the sound affect the birds?

In this paper, we will address in what way birds may be affected by anthropogenic noise as well as how birds may counteract artificially altered noise conditions in their territories. We will discuss a case study of great tits (*Parus major*) which provides insight into how a successful urban species gets at least partly around the noise problem in cities across Europe. Subsequently, we will address to what extent urban habitat may drive divergence of urban populations and how sensible it is to make a case for ecological speciation in this context. The potential emergence of new urban species takes place over an evolutionary time scale and does not relate to conservation of today's biodiversity. Therefore, we will conclude with considering the available options to abate the negative impact of anthropogenic noise on current species at an ecological time scale.

### *Noise annoys*

Extreme noise levels can result in temporary and permanent hearing loss (Ryals *et al.* 1999), but also the ubiquitous condition of more moderate noise levels may have adverse impacts. In humans, traffic noise at the front door of people's houses is a significant predictor of ischemic heart disease (a hospital-based case-control study with controls matched according to sex, age and hospital: Babisch *et al.* 2005), and repetitive exposure to aircraft noise has been shown to reduce performance at school (Stansfeld *et al.* 2005). Even relatively modest noise levels of train- and car traffic can already negatively affect cognitive development and reading skills (Lercher *et al.* 2003). Clearly, humans pay a price for

living in noisy cities or along roads with heavy traffic loads with respect to physical and psychological welfare (Miedema & Vos 1998; Nilsson & Berglund 2006). This may also be true for animals, including birds.

Measurements to assess direct and detrimental physical effects of anthropogenic noise on birds, such as an increased heart-beat (Helb & Hüppop 1991), are rare or nonexistent. Nevertheless, a wide variety of animal species has been reported to be affected by anthropogenic noise as indicated by behavioural changes (e.g. birds: Slabbekoorn & Peet 2003; Brumm 2004; whales: Foote *et al.* 2004; Miller *et al.* 2000; frogs: Sun & Narins 2005; ground squirrels: Rabin *et al.* 2006). One of the behavioural changes concerns an increase in vigilance behaviour at the expense of time spent feeding (Rabin *et al.* 2006). For example, chaffinches (*Fringilla coelebs*) spend less time with their head down, pecking at food, during artificially increased noise levels (Quinn *et al.* 2006). The nature of the behavioural change in this experiment suggests that these birds did not change general alertness due to a novel stimulus but have to rely more on visual scanning for predators when the detection of auditory cues is limited by masking noise. Predation risk in noisy conditions may therefore have negative consequences for food-intake rates and ultimately lead to lower survival and lower reproductive success.

Anthropogenic noise may not only hamper the detection of heterospecific predators but also the detection of conspecifics. Many animal species, and especially birds, depend heavily on acoustic signals for intraspecific communication (Catchpole & Slater 1995; Marler & Slabbekoorn 2004). Typically, males defend a territory for access to food, hiding places and nest sites. Singing and song features such as repertoire size or spectral and temporal details may have a direct impact on how well they are able to do so. Encoded in acoustic variation, birds may convey a message about their species identity, fighting ability and motivation to defend a resource (e.g. Ten Cate *et al.* 2002; Ripmeester *et al.* in press). Successful transmission of such a message may prevent competitors from approaching and may save energy, time and risks of injury. In addition, females also pay attention to these messages and are known to select their mates based on male song features (Riebel 2003). Therefore, whether songs are heard properly or not may have serious consequences for territory tenure and mate attraction (Klump 1996), potentially affecting individual fitness and population viability.

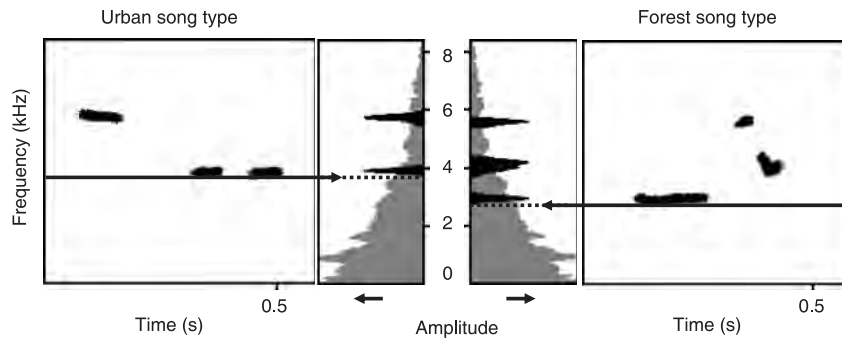
However, there are many signalling strategies available to birds to avoid or reduce masking by ambient noise (Brumm & Slabbekoorn 2005). Species-specific abilities in this respect may explain why some species resist urban noise conditions and others do not. A widespread strategy,

for example, concerns the Lombard effect: birds as well as humans raise their signal amplitude with noise level. Recently, urban nightingales (*Luscinia megarhynchos*) in the city of Berlin, Germany, were found to raise their song volume in response to traffic noise; as a result they appear to sing louder on weekday mornings than in weekends (Brumm 2004). Another way to adjust to fluctuating noise conditions concerns a temporal shift in singing activity. Several urban bird species are reported to start singing earlier during the day than their forest counterparts (Bergen & Abs 1997), but the potential relationship with avoiding traffic peaks has not been investigated in enough detail yet. However, European robins (*Erithacus rubecula*) sing both, during day and night time, and whether or not birds are active during the night was recently shown to be dependent on day-time noise levels in a study in the city of Sheffield, UK (Fuller *et al.* in press). There was less of an effect in this study of ambient light pollution, to which nocturnal singing in urban birds is frequently attributed. Although it is not clear yet whether nocturnally active robins reduce their day-time activity and whether they gain any fitness benefits by doing so, it seems plausible that this strategy may enable them to avoid masking noise and breed in noisy territories. In general, a division between species surviving in urban conditions and those fleeing the cities may very well depend on how effectively members of a species can adjust their signalling behaviour to the volume, temporal fluctuations or spectral characteristics of traffic noise.

#### *Signalling flexibility in urban great tits*

Over the last five years, we have studied patterns of song variation among individual great tits (*Parus major*) within an urban population in Leiden, The Netherlands, and among 20 different urban and forest populations across Europe. We first found in the single-population study that individual variation in the frequency range correlated to local urban noise levels (Slabbekoorn & Peet 2003). Birds of noisier territories sang with higher minimum frequencies, thereby avoiding masking by low-pitched traffic noise (Fig. 1). We speculated at the time that these results could mean that urban birds could have diverged from forest birds, and that flexibility through learning may be the behavioural mechanism underlying the correlation. Subsequently, we confirmed that urban birds across Europe have diverged from nearby forest birds in several parameters, among which the minimum frequency. A surprising 10 out of 10 independent city–forest comparisons revealed a consistent shift (Slabbekoorn & den Boer-Visser 2006).

The habitat-dependent acoustic shift in great tits could be an evolutionary or ontogenetic shift, or it could be based on the ability to adjust at an even shorter temporal



**Fig. 1** Sonograms of a three-note song type recorded in an urban habitat, with a relatively high minimum frequency (3.8 kHz, left graph) and of a three-note song type recorded in a forest habitat with a relatively low minimum frequency (2.7 kHz, right graph). The centre panels illustrate the energy concentration of each of the spectral components present in the song, normalized at an equal amplitude and contrasted, at an arbitrary level, against the energy distribution of a typical anthropogenic sound spectrum of urban traffic noise. Noise levels gradually increase towards lower frequencies, and the figure illustrates that critical signal-to-noise ratios leading to perceptual problems are more likely for notes of low frequency. As a consequence, song types without relatively low notes will on average be heard better in noisy cities.

scale (Patricelli & Blickley 2006). It is known from long-term field observations that great tits are probably capable of postdispersal adjustment of song-type repertoires guided by vocal interactions with neighbours (McGregor & Krebs 1989). Noisy conditions may affect such social influences through selective copying or selective reinforcement: song types of neighbours that are not heard well may not be copied, and song types sung but hardly eliciting a response from neighbours may be dropped. Recently, we found that adult males are even more flexible than previously thought. We played back unfamiliar song types and assessed the repertoire of a series of males before and after playback (Franco & Slabbekoorn, unpublished). The song-type repertoire size remained relatively constant over the season, but the rates at which different song types were sung varied and the repertoire composition was sometimes modified dramatically within a week. This shows that great tits have a larger repertoire memorized than they actually sing at a time or that they can make up new song types late in life. Most importantly, this means they have remarkably flexible singing behaviour. They are capable of mobilizing a large set of song types to adjust to new neighbours or possibly to new noise conditions.

The singing behaviour and repertoire flexibility of great tits has likely evolved to fit their social system in the context of the original forest habitat. They may be just lucky in the sense that these features turn out to be very suitable for coping with dramatic and, evolutionarily speaking, sudden rises in anthropogenic noise levels. The ability to spectrally adjust their song after dispersal to the local circumstances of a breeding territory, and this potentially throughout life, may be key to urban success. At the same time, despite the fact that they remain in cities breeding at relatively high densities,

it is not certain that great tits are not at all negatively affected by anthropogenic noise (see Box 1). However, their acoustic counter-strategy seems at least sufficient for urban populations to survive under potentially sub-optimal conditions (also see Junker-Bornholdt *et al.* 1998). Our results from the single-population study have now been independently replicated in two other North American bird species that are also very successful in urban environments (house finch, *Carpodacus mexicanus*: Fernández-Juricic *et al.* 2005; song sparrow, *Melospiza melodia*: Wood & Yezerinac 2006). An earlier study on chaffinches did not find a correlation between traffic noise levels and call characteristics (Skiba 2000). Nevertheless, this species, which can be very common in cities, does show the same increase in minimum frequency of their songs with varying levels of natural river noise (Brumm & Slater 2006). We are now waiting for data showing that bird species which are less successful in noisy areas are lacking the ability of spectral adjustment through repertoire changes.

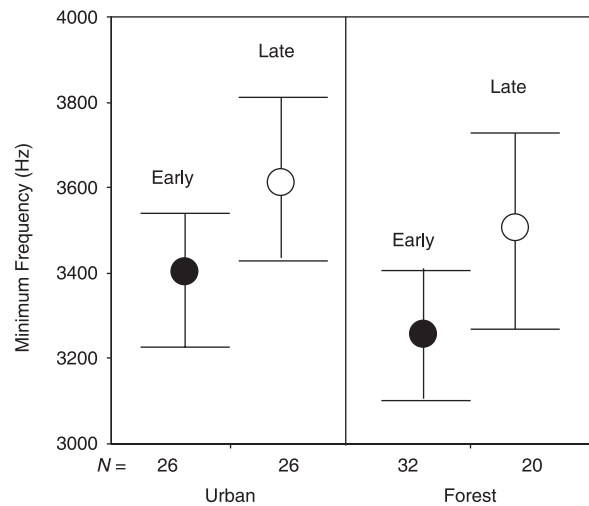
#### *Divergent phenotypes in great tits: a case for urban speciation?*

Behavioural plasticity may allow urban birds enough time to evolve and adapt to human-altered environments. Although it is possible, currently there is no evidence that the acoustic divergence between city and forest tits involves any microevolutionary changes and associated genetic differentiation. However, habitat-dependent divergence in a sexual trait like song in birds may play an important role in population divergence and ecological speciation (Slabbekoorn & Smith 2002a, b), and we may be able to consider urban speciation. Species with a distribution across ecological gradients may evolve different subpopulations in different habitats. These

**Box 1 Is singing low important to great tits?**

There is a general relationship in birds between body size and frequency of pitch: larger species typically sing lower. Small birds with small vocal organs may be lacking the power, the essential size of the vibrating source, or the suitable resonance features of the vocal tract, that allow the production of low-pitched sounds. This creates the possibility of using low frequencies as a way to signal condition or size to competitors and potential mates (Ten Cate *et al.* 2002). However, we do not know whether intraspecific variation in male body measures is related to the minimum frequency in great tits, nor do we know if female great tits prefer males singing low-pitched songs. If it were hard for great tits with a territory to sing low, you may expect that they sing songs relatively high in pitch when the motivation to sing is low. Such a situation occurs at the end of the breeding season, in both urban and forest habitat. Males still sing their stereotypic song types but the resources at stake in their territory have decreased in value until the start of the next breeding season. A decline in motivation to sing is clear from a decline in number of repeated songs (phrases) in a strophe, independent of habitat: in the city of Rotterdam from six to three phrases, and in the forest called the Liesbos from six to four phrases on average (ANOVA:  $F_{2,100} = 27.4, P < 0.001$ ). Interestingly, controlling for habitat differences, we found that the minimum frequency increases dramatically when recordings from relatively early in the season (early April: 'Early') are compared to recordings from late in the season (late May: 'Late', ANOVA:

$F_{2,100} = 7.8, P < 0.01$ ). We therefore hypothesize that it may be an important signal of quality to have low-pitched notes in the song type repertoire, which may cause a trade-off especially for the urban birds in noisy territories. Low-frequency noise may constrain the capacity to signal individual qualities: urban birds may need to choose between being heard well or being rated high as a competitor or mate. High noise levels may increase the number of intruding competitors needing physical combat and may affect the number and quality of potential mates that are attracted. Consequently, although great tits are successful in cities, and even though they show a remarkable flexibility in spectral adjustment to local noise conditions, this does not mean that traffic noise interference is not harmful to individual birds.



subpopulations may show genetic divergence in fitness-related traits related to morphology, physiology, neurobiology or life-history. Congruent geographical patterns of variation in sexual and fitness-related traits may arise because varying environmental selection pressures in different habitats shape both types of traits. Congruent patterns may also emerge because acoustic changes are an inherent result of, for example, changes in bill morphology (Slabbekoorn & Smith 2000; Podos *et al.* 2004). As a consequence, under both conditions, songs may guide female birds to the locally adapted males, accelerating the process of reproductive divergence. The fact that many birds learn their songs from conspecifics adds a layer of complexity (Baker & Cunningham 1985; Slabbekoorn & Smith 2002b), as it will accelerate phenotypic divergence among populations but may actually constrain genetic differentiation (Ellers & Slabbekoorn 2003). Nevertheless, divergence in learned song will still

increase the rate and chance of speciation for a subset of evolutionary scenarios (Lachlan & Servedio 2004; Ellers *et al.* unpublished).

In terms of gene flow, it may be improbable that urban habitat could generate phenotypically distinct and reproductively isolated subpopulations, as cities are typically scattered geographically and form a patchy network within a matrix of forested and agricultural area (Marzluff 2005). Habitat imprinting, on the other hand, may strongly influence dispersal patterns, and urban-borne birds may preferentially settle in urban territories (see e.g. Septon *et al.* 1995). In terms of consistent directional selection, despite considerable heterogeneity within urban habitat, some urban selection pressures are clearly distinct and dramatically different from those in more natural habitat. These consistent habitat-dependent selection pressures may have the potential for driving divergence of an urban phenotype despite ongoing gene flow.



We are not aware of any publications on gene flow, or dispersal, between urban and nonurban populations of great tits, but there are some studies on urban-related phenotypic divergence. Plastic environmental responses were found for carotenoid-derived plumage coloration, with urban birds being less yellow compared to forest birds (Horak & Lebreton 1998) and also for timing of reproduction and clutch size, with later and smaller broods in (sub)urban great tits compared to their forest counterparts (Riddington & Gosler 1995). Another study, not involving urban habitat, addressed the balance between the response to divergent selection pressures and levels of gene flow over a very short distance. A partial cross-fostering experiment with great tits of two qualitatively different parts of Wytham Woods in Oxfordshire, UK, allowed the separation of genetic and environmental sources of variation (Shapiro *et al.* 2006). Nestlings in the high-quality part of the forest were larger, heavier and in better condition than in the low-quality part irrespective of the part from which they originated. Interestingly, in addition, significant differences in condition and shape could be attributed to area of origin, suggesting genetic differentiation. The areas of varying quality in this comparison were only a few kilometres apart and interconnected by forest, which reveals the evolutionary potential of divergent selection in ecologically distinct habitat for driving populations apart. Another recent and small-scale study on great-tit populations also reported interesting findings with respect to the balance between divergent selection and gene flow. A biased influx of birds from the mainland to only one side of the Dutch island of Vlieland created a local abundance of breeding birds that were not locally adapted (Postma & van Noordwijk 2005).

#### *Evidence for microevolutionary changes in urban habitat*

The evidence for genetic differentiation related to anthropogenic selection pressures in cities is also still scarce when we look at bird species beyond great tits. A nice example of selection in an urban environment driving evolutionary change is found in an exceptional urban bird population on the campus of the University of California in San Diego, USA. Dark-eyed juncos (*Junco hyemalis*) have been breeding in this urban setting since the early 1980s (Yeh & Price 2004). The birds were presumably winter visitors that decided to stay instead of return to their natural breeding habitat: montane pine forest at least more than 70 km away (Nolan *et al.* 2002). Population comparisons and a common-garden experiment with hand-raised birds revealed that wing- and tail size, as well as a sexual trait (the amount of white in the tail) has diverged on campus beyond the extend attributable to phenotypic plasticity or drift (Rasner *et al.* 2004; Yeh 2004). However, there was only limited evidence for song divergence between this

small urban population of about 70 pairs and four forest populations (Slabbekoorn *et al.* 2007). Although there were strong indications for divergent selection pressures on acoustic signals related to sound transmission, sexual selection based on song may be relaxed, as suggested by a reduced response to playback of junco songs in the urban population (Newman *et al.* 2006). The urban juncos make a strong case for microevolutionary changes related to anthropogenic selection pressures, but they require more study and better replication to increase our insight into the role of song in urban speciation.

Another bird species for which there is growing evidence for urban-related population divergence is the European blackbird (*Turdus merula*), a very common city bird in most parts of Europe (Luniak *et al.* 1990). Urban blackbirds breed in higher densities and start breeding earlier in the year than their forest counterparts (Partecke 2003). A common garden experiment, with nestlings collected in the city of Munich and the nearby Lichtenauer Forest, revealed phenotypically plastic divergence but also suggested that some of the variation reflects genetic differentiation (Partecke *et al.* 2004, 2005, 2006a). The habitat-dependent difference in timing of reproduction corresponds to an earlier initiation of the development of the reproductive system in male and female urban birds (Partecke & Gwinner 2007). The prolonged breeding season allows urban individuals to have more breeding attempts per year than individuals from forests, who on the other hand have a larger clutch size and more fledglings per successful nest (Gregoire 2003). Urban blackbirds also live longer than forest birds (Luniak *et al.* 1990), have a smaller tendency to migrate (Stephan 1999; Partecke & Gwinner 2007) and have a lower acute corticosterone stress response (Partecke *et al.* 2006b). Finally, a pattern of habitat-dependent divergence starts to emerge from several studies at different geographical locations, with blackbirds from cities and forests being distinct from each other in several morphological measures (Lippens & van Hengel 1962; Partecke 2003; Ripmeester & Slabbekoorn, unpublished).

European blackbirds may become the first bird species for which there is evidence for urban habitat-related divergence in both, fitness-related traits (as described above) and acoustic traits (Ripmeester & Slabbekoorn, unpublished). We are in the process of testing with playback recordings whether urban songs trigger stronger responses in city birds than in forest birds and vice versa. At the moment, we do not know yet whether congruent habitat-dependent divergence in song and morphology promotes the process of urban speciation. There is also no information available yet about habitat-guided dispersal, although a first study on divergence in neutral markers between the urban and forest birds of the common garden experiment in Germany could not confirm such a

phenomenon (Partecke *et al.* 2006a). It is clear, however, that the aspects of coding and neutral genetic divergence between urban and forest blackbirds warrant further investigation and several complementary studies are on the way.

#### *Considerations on making bird breeding habitat more quiet*

It is possible to make bird breeding habitat close to, or surrounded by, anthropogenic noise sources more quiet. We can build noise barriers, make depressed highways or underground tunnels (e.g. Maekawa 1977), or introduce porous road surfaces, speed limitations and restrictions on allowable noise emissions for road traffic related to engine features, break systems and tire types (e.g. Sandberg 1991). There are many examples of successful implementation of these techniques, typically to reduce noise exposure to humans. This means that the main threshold for applications to the benefit of wildlife will likely be the financial costs. However, when considering expensive mitigating measures, it is very important to realize that birds and humans often benefit from the same, or only slightly modified, measures. Urban birds live and breed near human residences, and birds of more natural areas inhabit space often used for recreational activities. The importance to human health and well-being can be used as additional arguments for installing measures to improve bird-breeding areas. In cases where noise barriers are already in place to the benefit of humans, small cost-effective modifications (e.g. increased height, added absorbent) could be a successful strategy (see Box 2).

Urban planners are increasingly aware of the need to consider noise pollution in constructing cities and residential neighbourhoods from a human perspective (Grimm *et al.* 2000; Yli-Pelkonen & Niemelä 2005; Bucur 2006; Nilsson & Berglund 2006). For example, the idea of urban canyons has received considerable attention: the use of relatively continuous rows of office buildings or apartment flats separating noisy human activities from living space in which noise is not appreciated (de Ruiter 2004). This living space may concern pedestrian areas, urban parks and private gardens, all areas in which urban birds would also benefit from reduced noise levels. The strategy of urban canyons also entails concentration of noise sources: canalization of traffic in a limited number of busy through-roads. This will limit the number of canyons to be constructed and make plans economically more feasible (Thorsson & Ögren 2005). Similarly, it is more realistic to concentrate on a restricted set of specified areas which are shielded from noise, instead of trying to reduce noise levels in all public areas (Kihlman & Kropp 2001; Thorsson *et al.* 2004). Urban canyons and 'quiet zones' provide people living in noisy cities with access to

at least some quiet areas nearby, which may be a last resort for noise-sensitive bird species at the same time. In the best scenario, bird-breeding data and species-conservation values would be incorporated in the process of selecting the areas to be relieved from urban racket.

More and more tools have been developed to assist policy makers to predict and extrapolate noise levels spatially, based on traffic flow, vehicle types and distance to the road (e.g. Horoshenkov *et al.* 1999; Li *et al.* 2002; de Coensel *et al.* 2005). Spatial extrapolation has also been applied to reveal the impact of traffic noise on bird habitat by using road effect-distances based on general dB-threshold values that are just acceptable for birds, and which depend on habitat type and target species (Reijnen *et al.* 1997). For example, roads with 50 000 vehicles a day result in effect-distances from 75 to 930 meters for grassland species and from 60 to 810 meters for woodland species, as was shown by a meta-analysis combining nine studies (Reijnen & Foppen 2006). Highways may negatively affect bird-breeding habitat in a variety of ways, as stated earlier (e.g. collision, chemical pollution). However, visual disturbance and noise are the primary factors that reach furthest in open habitat, while noise is the single most important factor impacting forested habitat beyond 50 meters from the road (Reijnen & Foppen 2006).

#### *The importance of temporal and spectral overlap*

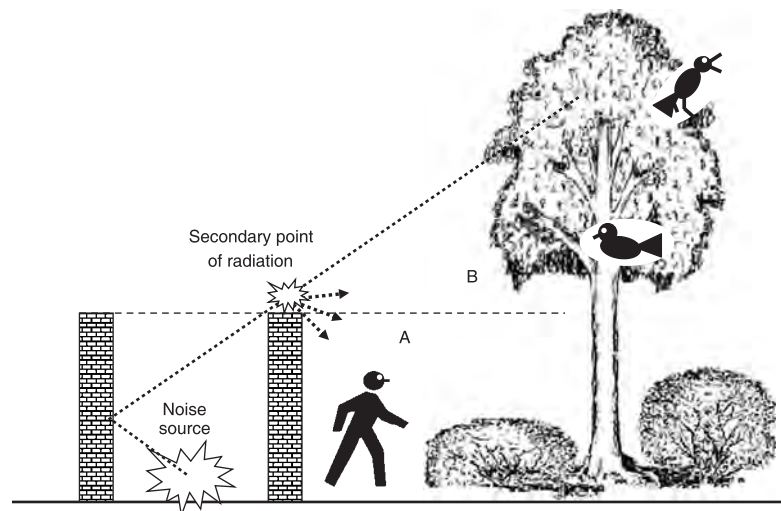
Birds often have a diurnal cycle of vocal activity which matches periods of optimal sound transmission early in the day (Staicer *et al.* 1996; Brown & Handford 2003). Diurnal fluctuations in anthropogenic noise levels are also highly stereotypic with, not surprisingly, noise peaks during the morning and evening rush hour (Jabben *et al.* 2001). Interestingly, traffic jams during these periods may bring down noise levels because of lower driving speeds. Most importantly, however, this means that dawn chorus and rush hour can co-occur at optimal times for sound transmission depending on latitude and season (see Warren *et al.* 2006). Good signalling periods are thus disproportionately affected due to temporal overlap with traffic activity.

The fact that there are often periods during the day in which anthropogenic noise is most detrimental due to concentration of bird singing activity and optimal noise-transmission conditions seems 'bad luck' but also provides the opportunity to ecologically sensible noise control. Reducing traffic flow for short but crucial periods of time, for example, on roads through nature reserves, will raise habitat quality for breeding birds with limited impact on human activities. Similarly, on a slightly larger temporal scale, traffic limitations through sensitive areas during the critical period in spring, when males vocally attract females, could also significantly improve habitat

### Box 2 Noise barriers for birds

Raising a barrier between the noise source and bird breeding habitat can lead to a significant reduction in detrimental noise levels. Vegetation is only of limited use, although the effectiveness will increase with stem and leaf density and width of the zone (e.g. Cook & van Haverbeke 1972; Bucur 2006). A solid barrier as close as possible to the noise source will be most effective (Maekawa 1977; Ishizuka & Fujiwara 2004). Adding an overhang on the road side or increasing the height of a barrier which is already in place to benefit pedestrians at ground level (A), could be a very cost-effective measure to the benefit of flying and tree-dwelling birds at a higher level (B). It is usually also easier to filter out the bird-relevant frequency components of traffic or industrial noise than to block the lower frequencies. Construction details and barrier shape especially can have a big impact in the frequency range between 2.0 and 8.0 kHz. For example, sound-pressure levels at the barrier's edge (= secondary point of radiation) can be significantly decreased by installing a soft, absorbent material on top. This will lead to a decrease in the noise level behind the barrier, especially in the field below the barrier height (A). Specific shapes of the barrier top with multiple diffracting edges may add to this effect. For example, T-shaped noise barriers with soft material on top only have to be three meters high to be as effective

as a 10-metre high rigid-edged plain barrier (Ishizuka & Fujiwara 2004). This effect steadily gets stronger with frequencies above 250 Hz, also for the sound field above barrier height (B), which concerns the habitat layer typically most important for acoustic signalling in many bird species (Slabbekoorn 2004). Noise barriers at both sides of a road shield areas in both directions, but multiple reflections and scattering effects between the barriers will reduce the shielding capacity. Noise levels become higher especially above the barrier compared to a single barrier situation (Maekawa 1977). Buildings by the side of a busy road typically also increase noise levels within the street or urban canyon (Oldham & Radwan 1994; Heutschi 1995). Both inside and outside urban areas, the problem can be brought down by noise abatement schemes using a more absorbent ground surface and intermittent or continuous absorbers on the walls of buildings or noise barriers (Horoshenkov *et al.* 1999). Placing noise barriers at an angle will also reduce the impact of reflections by beaming them more upward into the sky or downward back towards the tarmac. Finally, the choice of construction material or absorbent matter may make noise barriers also bird-friendly in nonacoustic ways. Combination barriers incorporating trees or shrub layers can reduce the negative impact of an artificial, visual barrier in the landscape, and potentially provide nesting and foraging opportunities.



quality. These critical periods can be quite brief, as in some migratory species, for example, where males arrive at the breeding grounds just before the females. For such species, male singing effort peaks upon arrival and may already decline after one or two weeks.

In addition to seasonal and diurnal fluctuations in bird singing activity and noise levels, more short-term fluctuations may also warrant some attention. Fluctuating noise levels in terms of overall amplitude are usually more annoying to humans than relatively continuous noise levels,

especially when areas are relatively quiet overall with sudden unpredictable noise peaks (de Coensel *et al.* 2005). For birds, mean noise levels may similarly not describe the potential for auditory masking or stress levels adequately. Therefore, analyses of sound-level fluctuations in time can add a relevant descriptor capturing more of the dynamics of noise interference.

Traffic-noise fluctuations in terms of frequency are chaotic, but most of the common anthropogenic noise sources show a general decrease in amplitude from low to high frequencies. Bird species in many taxa, such as doves, owls, corvids, woodpeckers, herons and rails use frequencies well below 1.0 kHz. Whether or not species in these groups occur in urban areas or along highways (and some are typically abundant within these habitat types) is probably largely determined by other factors than the impact of noise interference. However, declining signalling efficiency may influence the balance between costs and benefits of city life, especially for those species relying on vocalizations for long-distance communication. Not many noncorvid songbirds use frequencies below 2.0 kHz. The majority of these species uses a bandwidth of 3.0–6.0 kHz, starting at 2.0 or 3.0 kHz and often going up to around 8.0 kHz. The few songbirds that do use very low frequencies down to 1.0 kHz, typically use wideband songs with a bandwidth of about 6.0–9.0 kHz (examples are: European blackbird; nightingale; house sparrow, *Passer domesticus*; European starling, *Sturnus vulgaris*; house martin, *Delichon urbica*), and may therefore be less vulnerable to noise pollution (although we do not know yet whether this is true). Few songbird species rely just on relatively low frequencies, but species that do, like the oriole (*Oriolus oriolus*), the great reed warbler (*Acrocephalus arundinaceus*) and the mistle thrush (*Turdus viscivorus*), may for this reason be relatively sensitive to the masking effect of traffic noise.

A study on distribution and breeding success of great reed warblers in a wetland area in the central part of The Netherlands provides interesting support for the suspected sensitivity to noise in this species (Foppen & Deuzeman 2007). A reed bed in the Vossemeer was known to be inhabited by about 5–10 pairs of reed warblers up until the early 1990s. This reed bed has not changed much since, but it is now situated right beside a road (Vossemeerdijk) with a few thousand cars passing by per day. In the last 15 years, typically only one or two territories each spring have been occupied by singing reed warblers. However, in two years (2003 and 2004) the road was closed to traffic for a substantial time during spring due to road works. The absence of the usual traffic was correlated with an increase from two in 2002 to seven territories in 2003. The return of the noise source was correlated with a decline from five in 2004 back to one territory in 2005. These fluctuations over the course of four seasons consti-

tute only anecdotal evidence, but they do suggest that the vulnerability to a masking of the low-pitched song by traffic noise may have contributed to the overall decline in reed warbler territories in this area since the early 1990s.

Although low-frequency bird songs are most affected by typical anthropogenic noise, it is not true that higher frequencies are free of the impact of anthropogenic noise interference. Masking depends on the amplitude of the acoustic signal relative to the amplitude of the ambient noise within the same frequency range (Lohr *et al.* 2003; Brumm & Slabbekoorn 2005), both measured at the receiver. So, the impact on detection and recognition of acoustic detail can still be serious and deleterious for faint high-pitched notes. Also, high-pitched songs heard at a large distance from the singer, with the receiver potentially being closer to the noise source, may be hampered by the high component of traffic noise which has most energy at low frequencies.

## Conclusions

It is becoming more and more clear that the omnipresence of anthropogenic sounds is not only detrimental to human health and well-being, but can also negatively affect birds. Efforts to bring down anthropogenic noise levels to the benefit of bird-breeding areas will almost certainly encounter financial trade-offs. Mitigating measures are typically expensive or counteract economic values, for instance by slowing down, or putting restrictions on, traffic flow. When considering or arguing for expensive noise-reducing actions, it is very important to realize that birds and humans often benefit from the same or only slightly modified measures.

It is obvious from the remarks above on song spectra that we need a thorough comparative study to assess noise sensitivity of bird communities, or at least of those species of high conservation value. Although it may be true in general that making habitat more quiet will improve breeding conditions for many species, we still lack much essential data to guide conservation efforts with adequate detail. Optimally, such data would come from a comparative study that includes experimental assessment of developmental flexibility, tolerance to spectral range reduction and an assessment of the fitness consequences of masking (cf. Habib *et al.* 2007). Data on urban survivors, such as the great tit (Slabbekoorn & Peet 2003; Slabbekoorn & den Boer-Visser 2006), as well as urban 'losers' will be valuable to generate the insight needed to come up with ecologically solid recommendations.

Behavioural flexibility, such as song plasticity in postdispersal adjustment to neighbours under local noise conditions, may allow some species more time to adapt to human-altered environments. Consequently, thriving urban populations may be diverging from their

forest counterparts in several traits and may be on a track towards becoming even more successful and potentially an independent urban species. However, this may be true for a 'lucky' few, since many species will not be able to go down this fortunate path. Hopefully in the near future, we will be able to explain which species are negatively affected by anthropogenic noise and why. For those situations for which there is the political will and the financial support to reduce detrimental noise exposure, we hope our considerations on making bird breeding habitat more quiet will prove to be useful.

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Hans Slabbekoorn is Assistant Professor in Behavioural Biology at Leiden University in the Netherlands. His research focuses on ecological speciation in birds and he is especially interested in the role of vocalizations in the process of reproductive divergence. Erwin Ripmeester is a PhD-student at the same institute and runs a project on acoustic, genetic and morphological divergence between urban and forest populations of the European blackbird.

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## Research

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**Author for correspondence:**

Justine A. Smith

e-mail: [jsmith5@ucsc.edu](mailto:jsmith5@ucsc.edu)

# Top carnivores increase their kill rates on prey as a response to human-induced fear

Justine A. Smith, Yiwei Wang and Christopher C. Wilmers

Center for Integrated Spatial Research, Environmental Studies Department, University of California, 1156 High Street, Santa Cruz, CA 95064, USA

The fear induced by predators on their prey is well known to cause behavioural adjustments by prey that can ripple through food webs. Little is known, however, about the analogous impacts of humans as perceived top predators on the foraging behaviour of carnivores. Here, we investigate the influence of human-induced fear on puma foraging behaviour using location and prey consumption data from 30 tagged individuals living along a gradient of human development. We observed strong behavioural responses by female pumas to human development, whereby their fidelity to kill sites and overall consumption time of prey declined with increasing housing density by 36 and 42%, respectively. Females responded to this decline in prey consumption time by increasing the number of deer they killed in high housing density areas by 36% over what they killed in areas with little residential development. The loss of food from declines in prey consumption time paired with increases in energetic costs associated with killing more prey may have consequences for puma populations, particularly with regard to reproductive success. In addition, greater carcass availability is likely to alter community dynamics by augmenting food resources for scavengers. In light of the extensive and growing impact of habitat modification, our study emphasizes that knowledge of the indirect effects of human activity on animal behaviour is a necessary component in understanding anthropogenic impacts on community dynamics and food web function.

## 1. Introduction

Anthropogenic disturbance can cause shifts in biotic community dynamics, generally through the loss of native species, introduction of novel species or artificially enhanced populations of native generalists [1]. These changes are characterized most often by quantifying the population size or presence of particular species. However, behaviour-mediated interactions are predicted to have equal or greater impacts on animal populations than purely numerical mechanisms [2–4]. Animal behavioural responses to anthropogenic disturbances have the potential to be cryptic but powerful drivers of ecological change in modified habitats [5].

Large carnivores are widely recognized to be sensitive to human disturbances owing to slow life cycles, large space requirements, direct persecution by humans and avoidance of human-dominated areas, often resulting in their decline or extirpation. Reduced large carnivore density and occupancy in some developed areas has resulted in both mesopredator release [6,7] and overpopulation of primary consumers [8,9]. Yet, some large carnivores do persist in modified landscapes, but alter their behaviour to reduce interactions with humans [10,11]. Owing to the strong regulatory influence large carnivores can exert on their competitors and prey, changes in their behaviour are likely to contribute to whole community responses to anthropogenic disturbances [12].

Hunting and foraging are costly behaviours for carnivores, but are often assumed to be optimized so that individuals gain the most energy (or other limiting nutrients) for the least effort [13]. Animals that choose to expend more energy than what is perceived to be optimal may be responding to risks that increase the long-term pay-off of certain energy-expensive behaviours through decreased chance of non-starvation mortality [14]. Hunting in high-risk habitats can therefore create a risk-foraging trade-off in which animals sacrifice efficient foraging to compensate

for increased vigilance and risk avoidance. Giving-up density studies support that an animal's perceived risk is inversely correlated with food intake, suggesting that time spent consuming a food item reflects the fear experienced by forager [15].

Top carnivores generally kill large-bodied prey species, which require a high initial energetic cost during the hunting stage [16], but provide high energy gain during consumption. However, because carnivores are constrained by gut capacity, solitary carnivores can only maximize their caloric yield by repeatedly returning to feed on a prey carcass. In developed habitats, carnivores can be particularly vulnerable to risk-foraging trade-offs because disturbance-induced carcass abandonment can result in food loss owing to scavenging [17] or decomposition [18]. Prey consumption time can therefore be limited by external forces that reduce carnivore access to a carcass. Anthropogenic disturbances can ultimately reduce the net caloric gain carnivores receive from consuming large prey [19] by displacing carnivores from kill sites and decreasing their prey consumption time at kills. If perceived risk increases with human disturbance, the magnitude of human impact should be a predictor of foraging efficiency and consumption time.

We examined puma (*Puma concolor*) behavioural changes associated with perceived risk at kill sites with increasing housing density levels and investigated the relationship between risk-avoidance behaviours and kill rates in disturbed areas. We hypothesized that disturbance would displace pumas more often in highly developed areas, reducing overall prey consumption time and increasing kill rates. In the long term, we anticipate that more frequent risk-avoidance behaviours will increase puma kill rate and subsequently alter interactions with prey, competitors and scavengers.

## 2. Material and methods

Our research was conducted in the Santa Cruz Mountains, which lie in the Central Coast region of California. We captured 30 pumas from 2008 to 2013 and fitted them with GPS/radio telemetry collars (IACUC no. WILMC1011 Model GPS Plus 1 or 2 D, Vectronics Aerospace, Berlin, Germany). Collars were programmed to record locations every 4 h, and location data were downloaded remotely via UHF once a month. We used a custom cluster generation algorithm integrated in the Geographical Information Systems program ARCGIS (v. 10; ESRI, 2010) using the programming languages R (v. 2.1.3.1; R Development Core Team, 2010) and PYTHON (v. 2.6; Python Software Foundation, 2010) to identify groups of locations in which each location was within 100 m of the cluster centre and 6 days of another location in the cluster (for full details on the algorithm, see [10]). We field-investigated clusters in reverse chronological order from their time of formation using the most recently downloaded GPS data. Clusters were investigated within 30 days of their first recorded locations. At investigated clusters, we recorded whether a kill was present, and if so, the species, age and sex of the kill (if identifiable).

We constructed a mixed-effects binomial logistic regression model to predict deer kill sites from all generated clusters. We chose to only use deer kills because deer are the preferred prey in our study area. In addition, small prey cannot be predicted accurately from location data in our study area owing to high variability in puma behaviours at small kill sites. The variables used to fit the model were behavioural characteristics associated with clusters, including number of night locations (NIGHT), a binary variable indicating greater than 1 day duration (BINARY), the harmonic mean distance of locations from the cluster centre within the cluster (HMDIST), the proportion of locations occurring at night (P.NIGHT), site fidelity measured by the proportion of

points occurring within the cluster over the cluster duration (P.ACTIVE) and the farthest distance travelled during a cluster period (DIST). Total duration of a cluster (DUR) was excluded owing to high correlation ( $r > 0.7$ ) with variables already used in the model. We allowed for random slopes and intercepts for individual pumas when fitting the best model. We also constructed a truncated model without behavioural variables that we expected to correlate with housing density in order to allow inference on behavioural influences on kill rates. This model excluded P.NIGHT, P.ACTIVE and DIST. We compared the truncated model and best-fit model to assess if we could confidently use the truncated model. We constructed receiver operating characteristic curves for both full and truncated models and calculated the area under the curve (AUC) to ensure that both models were similar in their predictive abilities. The AUC for the full model (AUC = 0.818) and the truncated model (AUC = 0.820) were nearly identical, and both support good discriminative ability [20]. We assigned each generated cluster as a deer kill or not a deer kill by applying the truncated model to all generated clusters.

We first investigated puma behavioural responses at the population level at four levels of housing density within 150 m of predicted kill sites: no housing, rural (greater than 0.0 and up to 0.062 houses per hectare), exurban (greater than 0.062 and up to 1.236 houses per hectare) and suburban (greater than 1.236 and up to 9.884 houses  $\text{ha}^{-1}$ ; [21]). Owing to the discrete nature of housing count data, each housing class was rounded up to the nearest number of houses, resulting in housing classes within 150 m of a cluster to be defined as 0 houses for no housing, one house for rural, two to nine houses for exurban and greater than nine houses for suburban. We used the 150 m buffer because this is the scale of development found to most impact puma hunting in our study area [10]. We constrained the response variables to only include behaviours we expected to be associated with risk aversion, which were narrowed down to P.NIGHT, P.ACTIVE, DUR, DIST and a final measure of prey consumption time (P.C.TIME) which was calculated as P.ACTIVE  $\times$  DUR. We added the prey consumption time measure because it best reflects the energetic gain an animal receives from a kill. We tested the differences in behaviours at all predicted kill sites in different housing density categories using an ANOVA test and examined pairwise comparisons with Tukey's HSD test for all behaviours found to vary significantly with housing density.

To determine kill rates, we calculated the total number of deer predicted to be killed by each puma from the output of the deer kill prediction model using all generated GPS clusters. We divided the predicted number of kills by the total time each puma was actively collecting GPS data to obtain annual deer kill rates. We investigated sex-specific relationships between kill rates and average values for P.NIGHT, P.ACTIVE, DIST, DUR and P.C.TIME for individual pumas using univariate linear regressions owing to high correlation values ( $r > 0.7$ ) among variables.

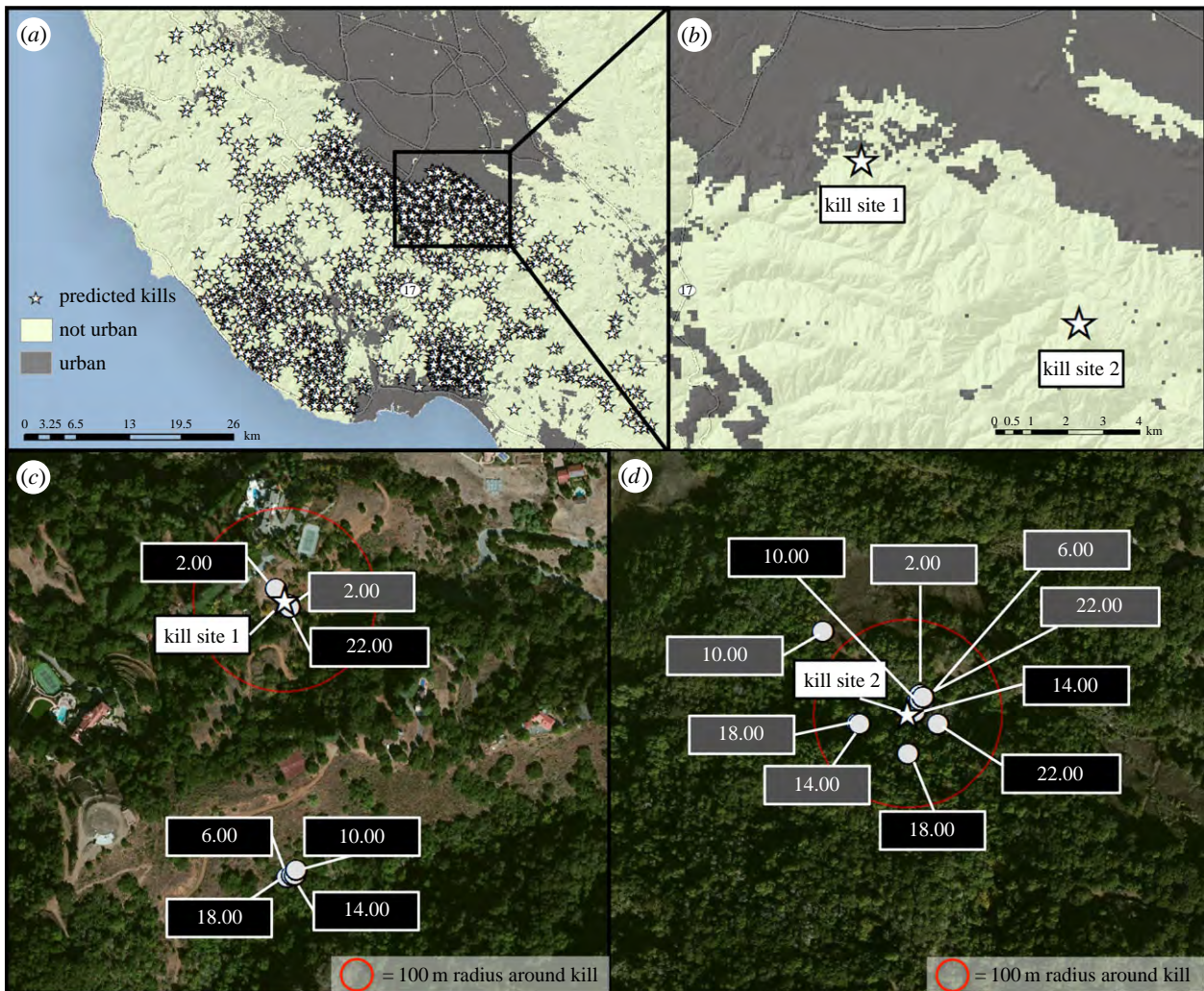
In order to assess the impact of housing on individual pumas, we calculated housing density within each puma home range. Puma home ranges were obtained using a local convex hull (LOCOH) home range estimator, where the 95% isopleth represented the home range boundary [22,23]. All housing points in the Santa Cruz Mountains were manually digitized from high-resolution satellite imagery. We calculated puma home range housing density as the number of houses per  $\text{km}^2$ . We tested for the relationship between individual puma kill rates and home range housing densities using univariate linear regression.

## 3. Results

### (a) Behavioural shifts

Of 703 field-investigated clusters, 208 were classified as deer kill sites. The other remaining clusters included 66 non-deer





**Figure 1.** (a) Study area and predicted kill sites in relation to housing density. Box shows area (b) in which kill site examples (c,d) are shown. Kill site 1 (c) belongs to puma 13F, whose home range is in the top quartile of housing densities among female pumas. Kill site 2 (d) belongs to 28F, whose home range is in the bottom quartile of housing densities among female pumas. Grey labels depict location times during the first day at the kill site and black labels depict location times during the second day. Note that at kill site 1, the puma has made a kill close to development but spends the majority of time away from the kill, whereas at kill site 2, which has no nearby development, the puma stays within the vicinity of the kill. (Online version in colour.)

kills (e.g. raccoons and house cats) and 429 non-kills (often bed sites). Our best-fit binomial logistic regression model to predict deer kills included NIGHT, BINARY, HMDIST, P.NIGHT and P.ACTIVE. The truncated model included NIGHT, BINARY and HMDIST. Neither the random intercept nor a random slope was included in the best-fit full model or the best-fit truncated model. We used the truncated model to predict 1537 deer kills from 8523 generated clusters (figure 1).

At predicted kill sites, females had lower P.ACTIVE ( $F = 67.7, p \ll 0.001$ ), higher DIST ( $F = 16.0, p < 0.001$ ) and shorter P.C.TIME ( $F = 44.2, p \ll 0.001$ ) as housing density increased (figure 2; example shown in figure 1). In suburban habitat, female P.ACTIVE was 36% lower, DIST was 31% higher and P.C.TIME was 42% lower than in no housing areas. Both males ( $F = 19.3, p < 0.001$ ) and females ( $F = 144.4, p \ll 0.001$ ) were more nocturnal (higher P.NIGHT) with increasing housing density at kill sites. Males did not show any responses to housing density concerning time spent at kill sites. Identical analyses using only confirmed kills supported each of the reported trends for predicted kills.

### (b) Deer kill rates

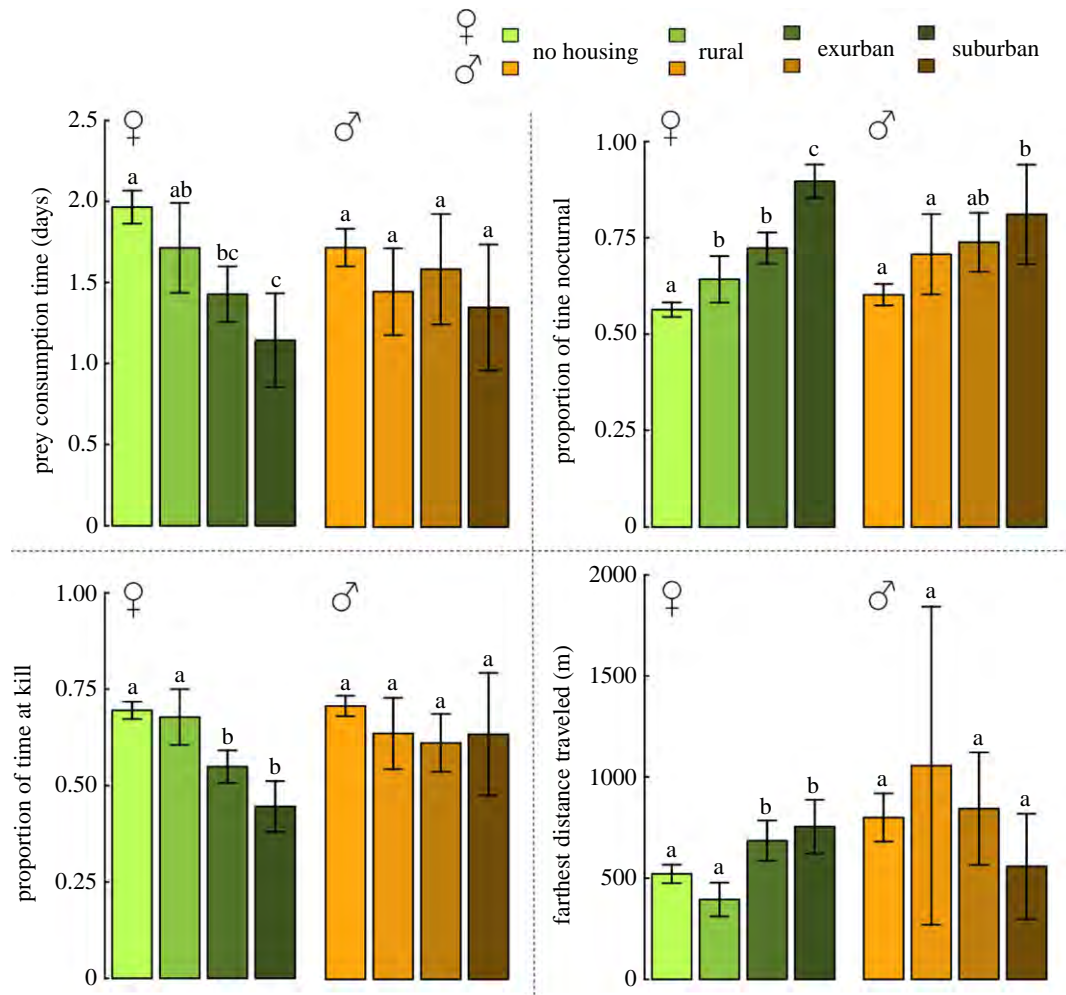
Male average home range size was  $163.0 \pm 7.7$  s.e.  $\text{km}^2$  with  $15.6 \pm 0.8$  s.e. houses  $\text{km}^{-2}$ . Female average home range

size was  $53.8 \pm 2.1$  s.e.  $\text{km}^2$  with  $25.5 \pm 1.3$  s.e. houses  $\text{km}^{-2}$ . Males had an average deer kill rate of  $43.7$  deer  $\text{yr}^{-1}$ , whereas females killed on average  $67.3$  deer  $\text{yr}^{-1}$ . Male deer kill rates were not correlated with any of our variables of interest (P.ACTIVE, P.NIGHT, DIST, DUR or P.C.TIME), nor with home range housing density ( $p = 0.9, r^2 = 0.005$ ; figure 3). Conversely, female deer kill rates showed a strong positive and linear correlation with home range housing density within its observed range ( $p = 0.0003, r^2 = 0.745$ ; figure 3). Females with home ranges in the top quartile of housing density killed 36% more deer per year (81.2) than females in the bottom quartile of housing density (59.7). Female kill rates were also negatively correlated with average fidelity to kill sites (P.ACTIVE;  $p = 0.05, r^2 = 0.322$ ).

## 4. Discussion

Our estimate of average male kill rates ( $43.7$  kills  $\text{yr}^{-1}$ ) stayed constant across housing densities and was comparable to previously reported values described by Knopff *et al.* (35 ungulates  $\text{yr}^{-1}$ , [24]) and Anderson & Lindzey (47 kills  $\text{yr}^{-1}$ , [25]). However, female kill rates increased positively, strongly and linearly with housing density. Although female kill rates in lower housing density areas ( $59.7$  kills  $\text{yr}^{-1}$ ) were





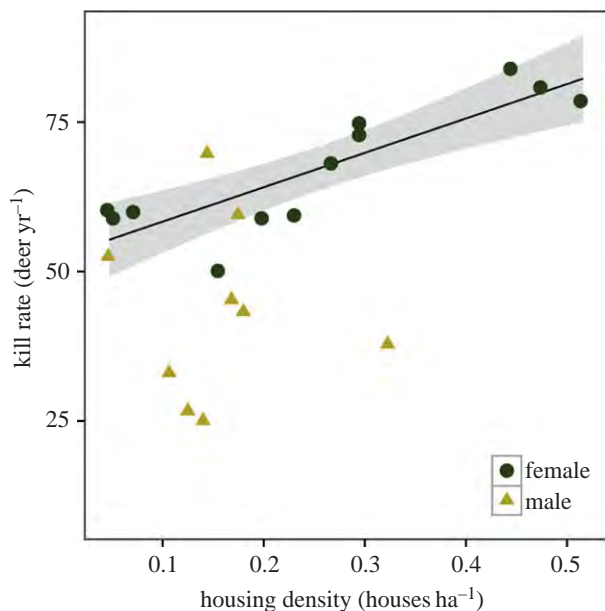
**Figure 2.** Behaviours that vary with housing density at predicted kill sites. Pairwise comparisons from Tukey's HSD tests reported in superscripts, where different letters represent a statistically significant difference. Error bars represent two standard errors from the mean. Sample sizes of housing classes at female kills are: no housing, 719; rural, 83; exurban, 186; suburban, 71. Sample sizes of housing classes at male kill sites are: no housing, 389; rural, 32; exurban, 42; suburban, 15. (Online version in colour.)

comparable to previously estimated mule deer kill rates for solitary adult females (52.5 kills  $\text{yr}^{-1}$ , [25]) and females with kittens (62.4 kills  $\text{yr}^{-1}$ , [26]; 68.1 kills  $\text{yr}^{-1}$ , [25]; 57.2 kills  $\text{yr}^{-1}$ , [24]), female kill rates in the highest quartile of home range housing densities were substantially higher (81.2 kills  $\text{yr}^{-1}$ ). This 36% increase in kill rates between the top and bottom quartiles indicates that development may exert a significant energetic cost associated with hunting behaviour.

Hunting deer requires large energetic investments in the stalking, subduing and killing stages for pumas [16]. We have documented a sizable increase in female kill rates that we expect represents higher energetic costs for females in developed landscapes. Although these costs do not appear to influence adult survival (C. C. Wilmers 2014, unpublished data), impacts on reproductive success possibly make development-interface zones sinks for the puma population. Anecdotally, we have observed that the tagged female living in the most developed habitat in our study area has lost at least three litters in the last 3 years, one of which was confirmed as abandonment (C. C. Wilmers 2014, unpublished data). The three other females living in less developed portions of our study area for which we have also documented at least three dens have had the majority of their litters survive. Although there are many stressors in a developed landscape that might influence kitten survival, we expect that higher energetic costs from increased hunting may contribute to this pattern.

Males did not alter their kill rates or prey consumption time at kills with increasing housing density. Because male life histories are constrained by requirements to defend much larger territories [27], this is perhaps not surprising. We found that male pumas have home ranges that are approximately three times as large as female home ranges on average. Male pumas are also known to spend significantly more time performing scent-marking behaviours than females [28]. We found that males have lower DUR at kills than females by 7.2 h on average (males = 2.86 days  $\pm$  0.06 s.e., females = 2.56 days  $\pm$  0.05 s.e.;  $t = 3.83$ , d.f. = 1000,  $p < 0.001$ ), probably owing to their need to patrol and defend their home range boundaries from encroaching males. Therefore, because males already tend to leave their kills early, they may be less influenced by chronic disturbance. In addition, male home ranges are characterized by much lower overall housing densities, indicating that males may exhibit risk-avoidance behaviours at the landscape scale rather than at the kill site scale.

Higher deer kill rates by females in response to increased housing density appear to be driven by a behavioural shift to a lower proportion of time spent at kill sites over the consumption period. Although females did not alter their total duration spent at clusters, their overall prey consumption times declined owing to a lower proportion of time spent at kills, indicating reduced utilization of carcasses at higher housing densities.



**Figure 3.** Kill rates of individual male and female pumas in response to housing density per hectare within their 95% LOCOH home range. Regression line and 95% CIs for female kill rates in relation to housing density are shown. Housing density coefficient  $\beta_1 = 91.4$ . (Online version in colour.)

Other possible explanations for female increase in deer kill rate are not supported by our understanding of puma energetics and reproduction. Deer in our study have lower detection rates in more developed habitats (C. C. Wilmsers 2014, unpublished data), therefore variation in deer activity or abundance is unlikely to explain these patterns. In addition, it is unlikely that increased kill rate could be a result of greater reproductive activity in high housing density areas because females in our study area avoid anthropogenic development when denning [10]. We conclude that behavioural risk avoidance is a substantial contributor to female prey consumption time and hence hunting patterns, due to our observation that housing density is associated with decreased prey consumption time. Both food loss and increased movement as a result of these behavioural shifts may contribute to observed increased kill rate in human-modified habitats.

An increase in ungulate carcasses left by female pumas may impact the biotic community by providing additional carrion subsidies to scavengers. By leaving their kills for longer periods of time in more developed areas, female pumas might create greater opportunity for scavenging by mesopredators and birds. Subordinate predators often scavenge kills of apex predators when kills are abandoned or not guarded [29], and carrion can form a large proportion of their diets [30]. Pumas are known to be important sources of food subsidies to

mesopredators through carcass abandonment [31]. Our results suggest that mesopredator release may occur not only through the well-documented pathway of apex predator extirpations, but also via behaviour changes in extant apex predators leading to increased food provisioning. The presence of scavengers can exacerbate this pattern by reducing apex predator prey consumption time via food loss [17].

## 5. Conclusion

The results presented here have bearing on human-modified systems globally. Behavioural responses are often overlooked as ecosystem drivers in modified systems, overshadowed by population declines and extirpations. However, many species are able to persist in developing landscapes, but in an altered behavioural state. Our findings suggest a strong, perceivable impact of observed human-induced behavioural change on species interactions instigated by the presence of development. Risk aversion behaviours that result from anthropogenic disturbances are likely to restructure predator–prey interactions in a variety of contexts, given the large effects risk has been shown to have on foraging across taxa. Behaviour-mediated interactions are powerful forces in biotic systems, often playing an even more impactful role than consumptive interactions. A greater focus on behaviour-mediated effects of habitat alteration can further expand our understanding of community-level processes in human-modified systems.

**Ethics statement.** The study was carried out under the IACUC approval no. WILMC1011.

**Data accessibility.** Because pumas are a specially protected species in California, the location data are sensitive and have not been made accessible. However, the data can be available on request by contacting Justine A. Smith at [jsmith5@ucsc.edu](mailto:jsmith5@ucsc.edu).

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**Author contributions.** J.A.S. conceived the study, carried out the data analysis and drafted the manuscript. Y.W. assisted in project development and edited the manuscript. C.C.W. conceived and designed the overall study, supervised data collection, advised on data analysis and edited the manuscript.

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**Conflict of interests.** We have no competing interests.

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## Research

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**Author for correspondence:**

Justine A. Smith  
e-mail: [jsmith5@ucsc.edu](mailto:jsmith5@ucsc.edu)

†These authors contributed equally to this paper.

# Fear of the human 'super predator' reduces feeding time in large carnivores

Justine A. Smith<sup>1</sup>, Justin P. Suraci<sup>1,2</sup>, Michael Clinchy<sup>2</sup>, Ayana Crawford<sup>1</sup>, Devin Roberts<sup>2</sup>, Liana Y. Zanette<sup>2,†</sup> and Christopher C. Wilmers<sup>1,†</sup>

<sup>1</sup>Center for Integrated Spatial Research, Environmental Studies Department, University of California, Santa Cruz, CA 95064, USA

<sup>2</sup>Department of Biology, Western University, London, Ontario, Canada N6A 5B7

JAS, 0000-0001-8753-4061; JPS, 0000-0001-5952-2186; MC, 0000-0003-4691-3879; LYZ, 0000-0003-2574-3452; CCW, 0000-0003-2063-1478

Large carnivores' fear of the human 'super predator' has the potential to alter their feeding behaviour and result in human-induced trophic cascades. However, it has yet to be experimentally tested if large carnivores perceive humans as predators and react strongly enough to have cascading effects on their prey. We conducted a predator playback experiment exposing pumas to predator (human) and non-predator control (frog) sounds at puma feeding sites to measure immediate fear responses to humans and the subsequent impacts on feeding. We found that pumas fled more frequently, took longer to return, and reduced their overall feeding time by more than half in response to hearing the human 'super predator'. Combined with our previous work showing higher kill rates of deer in more urbanized landscapes, this study reveals that fear is the mechanism driving an ecological cascade from humans to increased puma predation on deer. By demonstrating that the fear of humans can cause a strong reduction in feeding by pumas, our results support that non-consumptive forms of human disturbance may alter the ecological role of large carnivores.

## 1. Introduction

Humans have assumed the role of 'super predator' in animal communities globally, killing terrestrial carnivores at rates as much as nine times higher than their natural predators [1]. In addition to directly killing large carnivores, humans might also elicit fear responses in these species as they do in other wildlife taxa that experience human-caused mortality [2,3]. Indeed, correlative evidence of human-induced changes in large carnivore space use and movement suggests that fear of humans is a common phenomenon among top predators [4–8]. However, it has yet to be experimentally tested if large carnivores perceive humans as predators and whether changes in large carnivore behaviour caused by fear of humans affects ecological communities.

It is increasingly recognized that, even in the absence of direct mortality, fear of predators can itself drive cascading changes across food webs [9,10]. Human-induced fear in large carnivores is likely to have similar cascading effects because of the well-documented top-down effects of large carnivores on their prey and competitors [11–13]. However, different outcomes of human-induced fear in carnivores on prey populations might be expected depending on the nature of the carnivore response. One potential outcome of large carnivore fear of humans is the human shield effect, whereby prey find refuge in human-dominated habitats and are released from top-down forces because carnivores spatially avoid human disturbance [14,15]. However, human disturbance could have the opposite effect on the regulatory role of large carnivores if carnivores persist in human-dominated habitat by instead avoiding humans temporally. This counterintuitive response may actually increase predation pressure on prey by altering carnivore hunting behaviour to accommodate an enhanced risk–foraging trade-off; temporal avoidance could lead to reduced total feeding



time at a kill, which would require increased kill rates to compensate for lost energetic return from each kill. As land is increasingly transformed by anthropogenic development, quantifying how the fear of humans affects interactions between large carnivores and their prey is essential to understanding novel ecological dynamics emerging in human-dominated landscapes [7,11,16].

We previously reported that pumas (*Puma concolor*) in the Santa Cruz Mountains of Central California spent less time at kill sites in more residential areas and increased kill rates of prey [5]. This increased kill rate could potentially be explained by altered prey communities in human-dominated habitats (either from a perceived human shield or access to anthropogenic food subsidies) leading to more vulnerable [17] or available [18] prey. However, if reduced time at kill sites near residential development is fear-induced, it could also result in increased kill rates to compensate for reduced energy gained per individual predation event. Here, we experimentally test whether pumas exhibit fear responses to the human 'super predator' and whether changes in puma feeding behaviour in response to human-induced fear can explain our previously reported differences in puma feeding time and kill rate between areas of high and low human presence in the Santa Cruz Mountains [5]. To our knowledge this is the first direct experimental test of whether large carnivores respond fearfully to human presence, and whether this response has measurable ecological consequences.

To test the relationship between fear of humans and feeding behaviour, we executed a playback experiment on wild pumas. Predator playback experiments have been used to substantiate fundamental ecological relationships [19], including that the fear of predation reduces reproductive success in birds [20], that fear can have cascading impacts on animal communities [10], and that mesocarnivores exhibit heightened fear responses to human 'super predators' relative to non-human predators [3]. However, no study has linked the fear of humans to feeding behaviour in large carnivores. Our study builds on protocols used in over 200 predator playback experiments [19]. Hearing a predator vocalization signals to prey the direct presence of the predator in relatively close proximity, which is why simulating this using audio predator playbacks provides such a powerful means of directly testing fear responses [3,19,21]. Previous experiments have established that prey hunted by the human 'super predator' react to human vocalizations just as prey react to the vocalizations of any other predator [3], demonstrating that assessing responses to human vocalizations provides the means to directly test the prey's perception of humans as predators, rather than humans as simply a source of noise and disturbance (*sensu* [4]). Our experimental approach correspondingly allows us to make direct inferences concerning fear of the human 'super predator' and the resulting consequences of anthropogenic disturbance on risk–foraging trade-offs in a large carnivore. Combined with our previous work [5] our study reveals an ecological cascade from humans to increased predation on deer mediated by fear.

## 2. Methods

Our experiment was part of a long-term study on puma ecology in the Santa Cruz Mountains of Central California, USA [5,6]. The region has a Mediterranean climate characterized by a

rainy season in winter and dry season in summer. Habitat types include mixed hardwood forest, redwood forest, chaparral and grassland. The Santa Cruz Mountains are heavily impacted by human use, particularly residential development and outdoor recreation. Puma exposure to humans here is thus commonplace; all pumas in this study have housing developments in their home range (mean: 21.7 houses km<sup>-2</sup>) and kill and cache prey as close to 5 m from people's homes [5]. Pumas have a good reason to be fearful of humans in this region, as they were bounty hunted in California for decades and even today humans are their primary source of mortality in the Santa Cruz Mountains (Wilmers unpublished data).

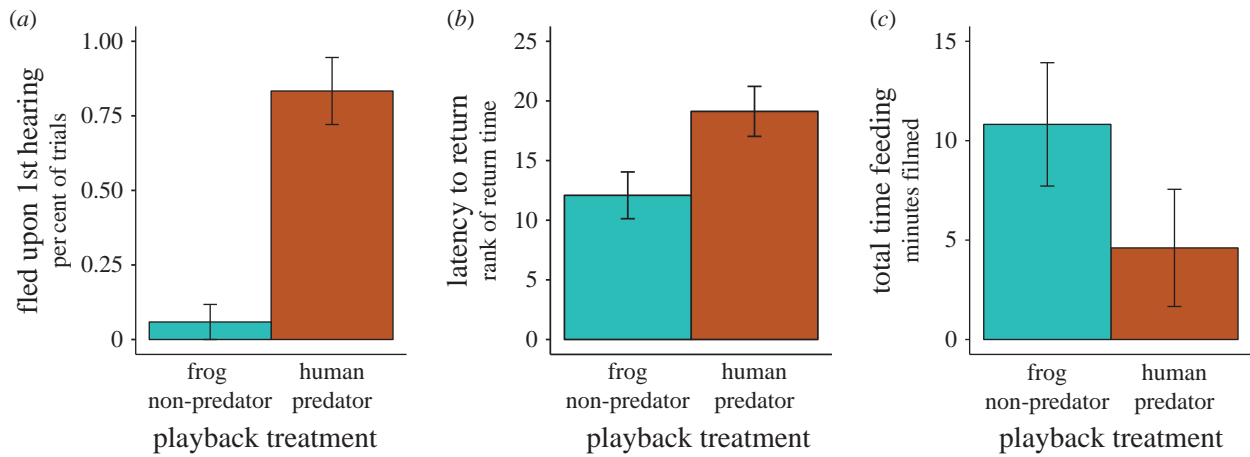
We conducted a playback experiment on pumas at their active kill sites. We first located puma kill sites from recent GPS tracks of collared individuals (IACUC no. WILMC1011). We downloaded recent GPS locations successfully transmitted through GSM or Iridium technologies and identified potential fresh kill sites as clusters of locations within 100 m of one another that occurred between sunset and sunrise. We field-investigated potential kill sites that were no more than 3 days old and at which the puma was present the previous night. If a fresh kill was found, we tied the carcass down so it could not be dragged out of the view of our cameras. Any behavioural effects of tying down the carcass were experienced for both control and experimental playback treatments, therefore baseline disturbance levels should not influence the relative difference in response between treatments.

To test whether pumas fear humans and quantify the cost of this fear, we broadcast predator (human) or non-predator (Pacific tree frog, *Pseudacris regilla*) playbacks at puma kill sites following well-established experimental methods [10,19,20]. Tree frog vocalizations provide an ideal control – like humans, tree frogs occur throughout the study area, but unlike humans they are neither predators, prey, nor competitors of pumas, and thus represent an equally familiar but benign stimulus. Tree frog vocalizations further provide an ideal control because they may naturally be heard both night and day, whenever pumas are active. Controls in other playback studies testing for fear responses in wildlife include running water (study organism: moose; [22]), seals (study organism: raccoon; [10]), sheep (study organism: European badger; [3]) and assorted non-threatening birds (study organism: song sparrow; [20]).

We recorded puma responses to playbacks using an Automated Behavioral Response (ABR) system (i.e. video-enabled camera trap linked to a playback unit triggered by the camera's activation) [21]. We deployed the playback speaker 400–450 cm from the centre of the carcass. Videos were 30 s long, the playback being broadcast for 10 s in the middle of the video. If the puma repeatedly triggered the camera it could hear the playback as often as twice per minute. We used seven exemplars of each playback type [23], the human exemplars all consisting of a single individual speaking conversationally. We edited all exemplars for consistency in amplitude and quality using Audacity® (v. 2.1.0, Audacity Team 2014), and broadcast the playbacks at a consistent peak sound pressure level of 80 dB at 1 m (measured using Radioshack 33-2055 Digital Sound Level Meter set to fast response and C weighting). This volume was chosen to mimic the natural volume of human conversation. Using these exemplars we composed 30 min playlists of each treatment. The playlists alternated between frogs and humans every 30 min; which treatment the puma heard first being determined by when it triggered the camera, and was thus effectively random. An individual puma might be exposed to either or both treatments over 24 h, depending upon its reaction. For pumas that heard both treatments, there was no significant difference in the proportion of each treatment first heard ( $Z = 1.63$ ,  $p = 0.103$ ). Pumas were exposed to each treatment only once over the course of the study.

We tested for the fear response of pumas and its ecological cost as follows: (i) We examined the puma's initial response to





**Figure 1.** Responses of pumas to predator (human) and non-predator (frog) playbacks at puma feeding sites. (a) Proportion of pumas that fled following their first exposure to frog or human playbacks. (b) Latency in time to return (rank) after initial playback exposure. (c) Total time spent feeding during the first 24 h of playback treatment. Bars represent standard error. Although transformation of feeding data was required to meet normalization assumptions for our analysis, here we show mean and standard error of raw feeding time measures for purposes of visualization. (Online version in colour.)

the playbacks by quantifying whether the puma fled (ran away) upon first hearing a treatment. We tested for significant differences in fleeing using Fisher's exact test. (ii) We assessed recovery time following puma initial exposure to each playback as the time difference between their first exposure to a playback treatment and the next video in which they subsequently appeared (hereafter, 'latency to return time'). We ranked the latency to return time for each trial, assigning the highest rank to individuals who did not return. We tested for a treatment effect by applying a Mann–Whitney  $U$  test to the ranked return times. Some pumas were exposed to both treatments enabling us to additionally test these two responses (fleeing and latency) using repeated-measures Wilcoxon matched pairs tests, which provided qualitatively the same answers, reinforcing the robustness of the results. Because there is no qualitative difference, but these repeated-measure tests do necessitate excluding some individuals, we report the results of the between-group comparisons to best reflect the full dataset. (iii) We measured the aggregate effect of hearing a playback treatment on feeding time by calculating the total time a puma was observed feeding during each treatment over the course of 24 h. We Box-Cox transformed these data to meet normality assumptions and tested for differences using ANOVA. Again, because some pumas were exposed to both treatments, we began by including individual identity as a random effect in the feeding analysis (the only parametric test), but because this did not explain any additional variation we removed it from the model and accordingly report results from the univariate (predator versus non-predator) fixed effects model.

### 3. Results

We successfully conducted 29 experimental trials on 17 pumas. All 17 heard non-predator (frog) playbacks and 12 were exposed to both predator (human) and non-predator (frog) playbacks. Pumas fled in the majority of cases (83%) upon first hearing humans and only once upon first hearing frogs (6%; figure 1a; Fisher's exact  $p < 0.001$ ). The latency to return time after pumas first heard a treatment was significantly greater in response to human playbacks (figure 1b; M-W  $U_{12,17} = 151.5$ ,  $p = 0.028$ ) because pumas returned to the carcass less often following their first hearing of a human playback (42% of trials) than following their first hearing of a non-predator (frog) playback (18%), or if they did return, they took longer to do so after first hearing humans

(median = 20 min, range = 0–257) than after first hearing frogs (median = 2 min, range = 0–40). Feeding time was significantly less for the human treatment than the non-predator (frog) treatment ( $F_{1,27} = 5.74$ ,  $p = 0.024$ ; figure 1c). Over the course of 24 h, pumas fed for less than half as long when exposed to humans ( $4.6 \pm 2.9$  SE min; median = 0.03 min) as when exposed to frogs ( $10.4 \pm 3.1$  SE min; median = 4.5 min).

### 4. Discussion

Our results experimentally demonstrate that fear of the human 'super predator' induces substantial behavioural changes in pumas, ultimately leading to significant reductions in time spent feeding. We observed almost unanimous fleeing behaviour in response to the human playback treatment, directly tying a strong fear response to subsequent declines in feeding. Our previous work showed that pumas nearly halve their feeding time of deer in suburban areas compared to areas with less housing [5]. The halving of feeding time during human trials compared to non-predator trials that we observed in this study suggests that this difference in puma behaviour at kills based on nearby housing densities can be fully accounted for by fear, and that this consequently causes pumas to increase their kill rates by 36% [5]. In a previous study we found that deer occupancy was not influenced by housing density, therefore it is unlikely that relative deer availability explains observed changes in kill rate [18]. Our results support the conclusion that increased kill rates in residential areas are driven by a top-down mechanism (fear of humans), rather than a bottom-up mechanism (availability of prey). Thus, non-consumptive forms of human disturbance may alter the ecological role of large carnivores by affecting the link between these top predators and their prey.

Prey generally respond to both direct (e.g. predator vocalizations) and indirect (e.g. moonlight or cover) cues of predation risk, and the strength of their response depends upon both the nature and number of cues. A single direct cue typically induces a stronger response than a single indirect cue, but multiple indirect cues may induce an equivalent or even stronger response than a single direct one [24–26]. Our experiment demonstrates that pumas respond fearfully to a direct cue indicative of the immediate presence of the human 'super predator' (i.e. hearing

human vocalizations). In human-dominated landscapes, pumas are exposed to multiple indirect cues indicative of the presence of the human 'super predator' (e.g. anthropogenic lighting, sounds of vehicles and dogs), and our previous work shows that pumas respond to these indirect cues [5,6,18]. Our purpose in testing the responses of pumas to human vocalizations was to evaluate the perception of humans as predator, as explained above. In the present study, exposure to a single direct cue (hearing human vocalizations) had the same magnitude of effect on feeding time as did cumulative indirect (e.g. lighting, vehicles) and less direct (e.g. hearing humans at a distance) cues [5], as might be expected in the response of any prey to any predator. Fear-induced trophic cascades are not caused by responses to a specific cue, but by prey responding to any and every cue signalling the presence of the predator it fears [9,10,25].

Our results are consistent with theoretical predictions made from other playback experiments that have demonstrated the ability for humans to cause fear responses in wildlife [3] and for fear responses in carnivores to cascade to lower trophic levels [10]. We have combined these concepts in context of large carnivores due to their important regulatory role and susceptibility to disproportionately high mortality rates via the human 'super predator' [1]. Our results show that large carnivores are not exempt from human-induced fear, and that human impacts on their feeding behaviour might have surprising cascading effects.

In this study, we implemented a novel ABR playback experiment [21] to quantify a large carnivore's behavioural response to humans. Such direct testing of human disturbance has not previously been done on a large carnivore due to the challenge of observing these animals in the wild. Our use of recent puma kill sites accompanied by the integrated ABR technology allowed us to make inferences on humans as a driver of risk–foraging trade-offs in a large carnivore.

Similar methods could be executed on other elusive species to investigate a diversity of risk responses to invasive predators, extirpated predators or competing predators.

Overlap between large carnivores and humans is increasing in regions where continued agricultural and residential development coincides with the recovery of large carnivore populations [27,28]. Although the coadaptation of humans and carnivores can lead to coexistence in human-dominated landscapes [29], carnivore behavioural adaptations might result in unintended indirect effects on other species [11]. Our work suggests that fear-induced trophic cascades instigated by the human 'super predator' are likely to contribute to altered ecological dynamics in human-dominated landscapes. As the habitats used by wildlife and humans are increasingly shared, additional work is needed on the extent to which fear in top predators cascades through ecosystems.

**Data accessibility.** Data have been made available in the Dryad data repository: <http://dx.doi.org/10.5061/dryad.6pn0b> [30].

**Authors' contributions.** J.A.S., M.C., C.C.W. and L.Y.Z. conceived of; J.A.S., J.P.S., M.C., C.C.W. and L.Y.Z. designed; and J.A.S., A.C. and C.C.W. conducted the study. J.A.S., M.C., A.C. and D.R. processed and analysed data. J.A.S. wrote the manuscript, with help from J.P.S., M.C., L.Y.Z. and C.C.W. All authors gave final approval for publication.

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# The Millenium Ark: How Long a Voyage, How Many Staterooms, How Many Passengers?

Michael Soulé, Michael Gilpin, William Conway, and Tom Foose

*School of Natural Resources, University of Michigan, Ann Arbor (M.S.); Department of Biology, University of California, La Jolla (M.G.); New York Zoological Society, Bronx (W.C.); Minnesota Zoological Gardens, Apple Valley (T.F.)*

Barring holocausts, demographic forecasts suggest a "demographic winter" lasting 500-1,000 years and eliminating most habitat for wildlife in the tropics. About 2,000 species of large, terrestrial animals may have to be captively bred if they are to be saved from extinction by the mushrooming human population. Improvements in biotechnology may facilitate the task of protecting these species, but it probably will be decades at least before cryotechnology per se is a viable alternative to captive breeding for most species of endangered wildlife. We suggest that a principle goal of captive breeding be the maintenance of 90% of the genetic variation in the source (wild) population over a period of 200 years. Tables are provided that permit the estimation of the ultimate minimum size of the captive group, given knowledge of the exponential growth rate of the group, and the number of founders. In most cases, founder groups will have to be above 20 (effective) individuals.

**Key words:** zoos, captive breeding, genetic variation, endangered species, heterozygosity, population growth

## INTRODUCTION

According to the models of the UN [United Nations, 1982] and the World Bank [World Bank, 1984], the world population is likely to level off at around 10 to 12 billion about 100 years from now. The implicit assumptions of these forecasts are (1) that agricultural output continues to increase at current rates, (2) that the climatic and agricultural consequences of CO<sub>2</sub> warming, loss of topsoil, and deforestation are insignificant, and (3) that water supplies on a per capita basis can be sustained. These are all unlikely. Thus, famines and other catastrophes may limit the population, especially in Africa, before it approaches these levels. Nevertheless, we can probably expect a near doubling in population size within 100 years.

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Given the rate of habitat destruction today (with only 4.8 billion people), it is likely that the rate will be higher in the year 2100. The reasons are, first, that land and firewood are likely to be in short supply for many decades, especially in the tropical, developing countries. These demands will place additional strains on the remaining 50% of tropical forests. Second, the capacity for regeneration of the renewable resources will be compromised by increased levels of exploitation as it already has been in fisheries owing to overfishing [Nelson and Soulé, in press], in grasslands owing to overgrazing [Eckholm and Brown, 1977], and in forests owing to extraction and erosion [Myers, 1980].

How long will the human population remain at or near the peak level and when will the human usurpation of wildlands end? That is, what is the duration of the "demographic winter?" Ignoring the obligatory disclaimers about extrapolative speculation, our guess is about 500 or 1,000 years. It is obviously impossible to foresee cultural values and public policy in any nation several centuries from now. Nevertheless, we assume that after achieving zero population growth, it will be very difficult

**TABLE 1. A Preliminary Attempt to Predict the Number of Mammalian Species That Will Require Captive Maintenance in the Next 200 Years\***

Order	No. of recognized species	No. of vulnerable species that may require captive breeding
Monotremata	4	
Marsupialia	123	2
Peramelina (bandicoots)	18	
Paucituberculata (shrew-like)	7	
Diprotodontia (herbivores)	101	
Insectivora	409	
Dermoptera (colugos)	2	2
Chiroptera	~ 900	100
Primates	160	160
Edentata (anteaters, sloths)	25	10
Pholidota (pangolins)	7	5
Mysticeta	10	2
Odontoceta (toothed whales)	65	10
Carnivora		
Canidae	35	35
Ursidae	7	2
Felidae	72	60
Others	193	100
Lagomorpha	53	?
Rodentia	~ 1,700	100
Tubulidentata	1	1
Proboscidea	2	2
Hyracoidea	11	5
Sirenia	4	4
Perissodactyla	15	15
Artiodactyla	~ 172	100
<b>Total</b>		<b>815</b>

\*The estimates of "Number of vulnerable species that may require captive breeding" assume the virtual destruction of natural habitats in the tropics, with the exception of northern Australia and scattered nature reserves. It is assumed that none of the nature reserves will be sufficiently large to protect the larger mammals [Frankel and Soulé, 1981].



to bring down the population to an optimum level. Only in very disciplined, regimented cultures is the goal of one child per family likely to be achieved. On the other hand, a resolution of the population explosion might occur much sooner as a consequence of famines, epidemics, or a nuclear holocaust.

Even if we assume that the population drops relatively quickly, say in two or three centuries, we cannot be certain that this will result in the abandonment of the lands that, today, are habitat for wildlife, but that tomorrow will be cities, villages and farms. It is unrealistic to assume that peoples will be easily convinced to abandon villages and farms that have become traditional sites of occupation, unless the land is no longer arable. On the other hand, the reconstruction of quasinatural habitats might become a major social goal in the future. People, especially the young, will leave rural areas if there are real or imagined economic incentives, as evidenced by the exodus to cities now occurring in many tropical nations.

There is another problem, as well. Most of the tropical and temperate lands that still support wildlife today, even the forested lands, are hydrologically and agriculturally marginal. Many of these lands will be seriously degraded if they are settled, and their soils eroded, compacted, or turned to brick. So, even if these lands can be relinquished, centuries may pass before they could provide optimum habitat for wildlife.

This brief futuristic preamble seems to support the pessimistic view that contemporary zoological and botanical gardens must be prepared to be stewards of their charges for many centuries or millenia, barring the development of less space-intensive ways of maintaining viable populations. But even if technological solutions are found for maintaining many species in miniaturized and suspended states, it may be impossible to recapture a true twentieth century ecosystem, with all its complex biotic and functional diversity. The reason is that the large majority of species are smaller plants and animals. These will have been extinct for a long time unless relatively large and well managed fragments of habitat are maintained during the demographic winter [Soulé and Simberloff, 1986].

## HOW MANY KINDS?

How many species will be in the ark? Myers [1984] suggests that we will lose between one-quarter and one-half of all species. Assuming that there are between 10 million and 31 million [Erwin, 1982] species on the planet, we must anticipate losing between 3 million and 16 million species. Of course, the vast majority of these are insects [Raven, 1976; Erwin, 1982].

How many will be vertebrates, especially birds and mammals? A worst case scenario assumes a near total blitzkrieg of national parks and similar reserves in the tropical countries. This is not at all unlikely in the opinion of some [eg, Myers, 1984] with experience in Africa and parts of tropical Asia and Latin America. If this most dreary scenario comes to pass, then we can assume that the larger vertebrates will be the hardest hit. In Table 1 we provide a rough analysis of the number of mammalian species that would be in serious jeopardy. The following groups will all but disappear unless they are captively maintained: primates (160), the large carnivores (ca 100), the perissodactyls (15) and most of the artiodactyls (ca 100). In addition, about 300 species from the other orders will be wiped out. This is about 800 species. We estimate that the same will be true for birds. Locally endemic species in the tropics

[Terborgh and Winter, 1983] and migratory birds are especially vulnerable because they are entirely dependent for their survival on habitats (islands, tropical forests) with dismal prospects. There will probably also be several hundred species of reptiles and amphibians in need of special protection. Therefore, we must consider that at least 2,000 species of large, terrestrial vertebrates will be among the missing unless there is room in the ark.

During the past 2 years, about 19% of the world's mammals and about 9% of all the species of birds have been bred by those zoos reporting to the International Zoo Yearbook (IZY) censuses. The mostly North American collections reporting in the International Species Inventory System (ISIS) contain about 60,000 specimens of mammals and birds (reptiles, amphibians, fishes, and invertebrates are not yet in this system) in 175 reporting collections. Ninety percent of all mammals and almost 75% of all birds added to these collections last year were bred in captivity, and the numbers of many of the endangered species they hold are steadily increasing.

Between 1973 and 1983, for example, there was a doubling of the numbers of snow leopards (130 to 300). Many other species showed similar increases including Siberian tigers (400 to 1,200), golden lion tamarins (85 to about 400), many endangered ungulates such as barasingha (114 to 291), brow-antlered deer (37 to 101), gaur (32 to 83), scimitar-horned oryx (141 to 511), Arabian oryx (75 to 161), addax (142 to 329), and dama gazelle (58 to 178) and many others.

The ability of zoos to breed most mammals and birds is no longer in doubt, but the ultimate carrying capacity of zoos is far from clear. If zoos are to undertake the long-term maintenance of the increasing numbers of refugee species, organized planning should begin now, and on an international scale. Among the difficult questions that need answers: "Is there enough space in the ark?"

Although there are nearly 540,000 mammals, birds, reptiles, and amphibians in zoos reporting to the American Association of Zoological Parks and Aquaria and the IZY, it is unrealistic to assume that more than half of these spaces can be used for long-term propagation. Analysis of present zoo populations suggests that about 330 mammals could be sustained at a population size of 275; 467 birds, 96 reptiles, and 32 amphibians, each at a population of 300; 925 species in all. These sizes (275 and 300) may be larger than necessary for strictly genetic considerations, and might be reduced eventually. Even the number 925, however, may be optimistic given the present logistical and collaborative disarray [Conway, in press]. Such calculations are quite arbitrary (for reasons elaborated below), but they suggest the magnitude of the problem, and the level of commitment required.

Within two or three decades, it may be necessary to devote most of the space in zoos to the captive breeding of endangered species. Such a statement might alarm many in the zoo community, until it is realized that most of the species currently held in zoos will be shifted, one by one, from the nonendangered to the endangered category by virtue of habitat destruction. Nevertheless, the message of the preceding paragraphs is that zoos will need help. Current budgets, facilities, and techniques are no match for the gigantic task of conserving the plant's megafauna.

Is help on the way? The ultimate solution, we believe, must come from research in developmental and reproductive biology focused on the preservation and regeneration of viable organisms from zygotes and embryonic cells. Admittedly, cryogenics, like most technological fixes, is no magic solution. Millions of dollars and decades of research have been invested in the development of the techniques for just a single

species—cattle—and to a lesser extent for horses. So far, the techniques are not transferable to many other species.

On the other hand, there is continuing progress in this field, especially considering where the science was just 20 years ago. Based on the recent successes in bovids, equids, and primates, we consider it likely that traditional captive breeding programs for many species in these groups will be obsolete in a few decades (given reliable refrigeration), and that the vacated space will become available for other taxa. (Even such technological breakthroughs will not obviate the need to maintain some living representatives of most species to serve educational, cultural, recreational and technical-scientific purposes.) In addition, we cannot predict what unforeseen technologies will be developed. We would strongly urge the research community, in and out of zoos, to give high priority to research on cryogenic or other technologies for the long-term preservation of sperm, ova, and embryonic materials, along the lines of the recommendations of the recent FAO/UNEP report on this subject [FAO, 1984].

In the meantime, zoos and similar institutions will have to do their best to maintain relatively large, viable populations of higher vertebrates that are threatened with extinction in their natural habitats. We must therefore determine, as best as we can, the minimum number of individuals in such breeding colonies that will guarantee the maintenance of viability.

#### HOW MANY OF EACH KIND?

As has been described elsewhere [Frankel and Soulé, 1981], the number of individuals required for the maintenance of genetic fitness in a population depends on several variables. These are (1) the definition and the criteria for fitness, (2) the intended duration of the program, and (3) the generation time. We must add a fourth variable, one that is only appropriate for breeding programs with a finite lifetime—the maximum tolerable loss of genetic variation. No loss of additive genetic variation should be tolerated in a program of indefinite length. These four variables will be described briefly.

Fitness in the *immediate*, or short-term, sense concerns individuals. It is the current viability and reproductive success of the individuals in the group. Inbreeding can compromise short-term fitness by producing abnormally high levels of homozygosity for deleterious, recessive genes, the genetic load. There is a large body of evidence [Soulé, 1980; Allendorf and Leary, 1986] suggesting that even very modest decreases in heterozygosity can reduce fitness as estimated by physiological efficiency, growth rates, and developmental (morphological) stability. By trial and error, animal breeders have learned that inbreeding problems (depression) can be avoided if the rate of inbreeding per generation,  $F$ , remains below 2% [Franklin, 1980; Soulé, 1980]. Employing the approximation

$$F = \frac{1}{2N_e} \quad (1)$$

where  $N_e$  is the effective size of the population, the corresponding effective population size is about 25. Franklin [1980], Soulé [1980], and Frankel and Soulé [1981]

recommended a slightly more conservative short-term maximum rate of inbreeding ( $F = 1\%$ ), equivalent to an effective size of about 50. A 1% rate of genetic erosion was considered tolerable by these authors because they were assuming that the groups would be released into the wild within a very short time, say 100 years, an interval that now appears optimistic.

Fitness in the long-term or *ultimate* sense means the capacity of the population to maintain itself indefinitely in its environment. Thus, long-term viability or fitness is variously defined as adaptability (genetic) to environmental change, the maintenance of evolutionary fitness, and population homeostasis. Obviously, the retention of long-term fitness or viability requires the preservation of genetic variation.

How do we go about estimating the time-frame of the ex situ conservation effort for vertebrates? In light of the unpleasant demographic scenario painted above, it would not be unreasonable to plan for a voyage of 1,000 years. An optimist, on the other hand, would argue that applications of molecular biology to the fields of development and reproductive physiology are just entering an “exponential growth phase,” and that technologies for storage and regeneration of embryonic cells that are unimaginable today will be available in less than a century. As these technologies come on line, more species can be moved from the space- and resource-intensive “living zoo” to the miniaturized, “suspended zoo.” If this scenario is correct, our descendants will be able to replace the millenium ark with a “millenium freezer.”

We wish to make it clear that none of us is enamored of the “technological fix” as a solution to major social ills. Technology has never permanently “solved” major human problems such as hunger, poverty, injustice, and warfare. But technology, when applied to specific, technical objectives is very successful, as evidenced by word processors, putting humans in space, and refrigeration.

Regarding the security of frozen or suspended zoos, they are as secure as society itself. There would be redundancy in the holdings, with collections dispersed throughout the world. For those who are nervous about the power failing everywhere at once, the consequences of such a planet-wide catastrophe would be just as serious for zoos as for suspended collections—the pillaging of zoos with all their meat on the hoof, would take no longer than the thawing of all the freezers. In this context, it is not as far-fetched as it sounds to begin planning long-term storage facilities on the back side of the moon.

Another obvious caveat is that a suspended zoo cannot protect the vast majority of smaller organisms that are now threatened with extinction, especially in the tropics. The majority of insect species are undescribed taxonomically [Erwin, 1982] as are a large fraction of neotropical plants [Gentry, 1986]. Whether described or not, most organisms, especially those in the tropics, are small, relatively inconspicuous, and unknown ecologically. Their only human constituency is a handful of biologists; their only refuge is in nature reserves.

Returning to the “how long?” issue, the consensus of the authors is that 200 years is a reasonably conservative temporal horizon. Great works of art have been preserved much longer, even if their collectors and repositories were not. A longer time frame ignores the exponential rate of progress in biological technology. Those who think that 200 years is either too short to too long are free to adjust their programs accordingly. Indeed, conservationists of the 21st Century will have the option to modify their time horizons and to make compensatory changes in effective population sizes, if they conclude that such action is necessary. Fortunately, decisions

made during the initiation phases about effective size are, to some extent, revocable in the first few decades.

Because ultimate or long-term viability or adaptive potential depends on the store of genetic variability, it is desirable to retain as much genetic variability as possible. Ignoring the input of genetic variability from mutation (which in any case will probably be less than the loss when the effective population size is less than a few hundred), we believe that a 90% criterion is reasonable and realistic. That is, the goal should be to preserve at least 90% of the genetic variability that existed in the source population over the next 200 years. Any such criterion is clearly arbitrary. Nevertheless, it was the consensus that the 90% threshold represents, intuitively, the zone between a potentially damaging and a tolerable loss of heterozygosity.

It is prudent to have as many founder individuals as possible. There are two principal reasons for this. First, the more founders, the more genetic variability. Even though a pair of individuals will contain, on average, 75% of the genetic variation or heterozygosity for quantitative traits in the source population (assuming no dominance and epistasis), rare alleles will not survive such a small bottleneck in the number of founders [Allendorf, 1986; Fuerst et al, 1986]. The ratio of genetic variation in the founders compared to the source population approaches 1.0 asymptotically in the range of 25–30 individuals [Gilpin and Soulé, in preparation].

Second, the more founders, the sooner the group will reach the target population size or  $N_K$ . The rate of approach to  $N_K$  depends on the population growth rate [Nei et al, 1975]. When the growth rate is low, the loss of genetic variation from genetic drift can be high in the early generations. The optimum situation, therefore, is to have a large number of founders, say more than 20, and to achieve  $N_K$  very quickly. Parenthetically, the potential for interaction and gene flow between captive groups and wild populations of a species is important. Where survival of a wild population is possible, the benefits of coordinated management should not be dismissed by purists on either side.

Generation time is critical because reproduction is the only point in the life history when there is loss of alleles or genetic variation. Consequently, the longer the generation time, the fewer opportunities there will be for the loss of genetic variation. For example, there will only be eight such opportunities in 200 years when the generation time is 25 years.

Our principal conclusions are summarized in Tables 2–8. The methodology is presented elsewhere [Gilpin and Soulé, in preparation]. Each of the tables was generated by using a unique value for the intrinsic rate of increase per generation (population growth) for the group, from the time of founding until it reached  $N_K$ . These growth rates span the range that is typical of zoo species. The other assumptions used in the calculations include (1) a 200-year program, (2) the retention of 90% of the genetic variation for quantitative traits, and (3) random breeding within the group, as well as (4) non-overlapping generations, (5) an equal sex ratio, and (6) Poisson-distributed family size. The absence of values in the upper parts of some of the tables indicates that more than 10% of the genetic variation is lost even if  $N_K$  is infinite. The value 999 indicates that  $N_K$  lies between 1,000 and 10,000.

Some remarks about these results are in order. First, note that the founder effective size must always be six or above if the 90% criterion is to be met. With fewer than six founders, the group will lose more than 10% or more of the genetic variation existing in the source population as soon as it reproduces.



**TABLE 2. Carrying Capacities Necessary for the Retention of 90% of the Initial Genetic Variance\***

No. of founders	Length of generation (years)										
	1	2	4	6	8	10	15	20	25	30	50
16	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	20
20	—	—	—	—	—	—	—	—	—	—	19
22	—	—	—	—	—	—	—	—	—	—	19
24	—	—	—	—	—	—	—	—	—	—	18
26	—	—	—	—	—	—	—	—	—	31	18
28	—	—	—	—	—	—	—	—	—	29	17
30	—	—	—	—	—	—	—	—	—	29	17
32	—	—	—	—	—	—	—	—	—	29	17
34	—	—	—	—	—	—	—	—	40	28	17
36	—	—	—	—	—	—	—	—	39	28	17
38	—	—	—	—	—	—	—	—	39	28	17
40	—	—	—	—	—	—	—	53	39	28	16

\*The exponential growth rate per generation is 0.05.

**TABLE 3. Carrying Capacities Necessary for the Retention of 90% of the Initial Genetic Variance\***

No. of founders	Length of generation (years)									
	1	2	4	6	8	10	15	20	25	30
6	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	32
26	—	—	—	—	—	—	—	—	—	30
28	—	—	—	—	—	—	—	—	—	29
30	—	—	—	—	—	—	—	—	43	29

\*The exponential growth rate per generation is .1.

Second,  $N_K$  is very sensitive to  $N_F$ , the number of founders, although above  $N_F$ s of about 25, the effect diminishes very rapidly. A very great decrease in  $N_K$  can be achieved by doubling  $N_F$ , especially if it is combined with artificially delayed reproduction. As shown in Table 5, for example, a decrease in  $N_K$  from 617 to 124 is achieved by an increase in  $N_F$  from 12 to 24 while increasing the generation time from 6 to 10 years.

Third, the tables contain regions of biological impossibility. For example, Table 7, which corresponds to the intrinsic rate of increase of small rodents that produce several litters of about five offspring per year, shows generation lengths that are unattainable in such species. It should be noted also that the goal of 90% retention of genetic variance for 200 years is virtually unattainable at generation growth rates of

**TABLE 4. Carrying Capacities Necessary for the Retention of 90% of the Initial Genetic Variance\***

No. of founders	Length of generation (years)									
	1	2	4	6	8	10	15	20	25	30
6	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	39
20	—	—	—	—	—	—	—	112	60	34
22	—	999	999	999	642	384	137	77	50	32
24	999	999	999	582	362	243	106	66	45	30
26	999	999	768	424	274	192	92	60	43	30
28	999	999	617	348	234	164	84	56	42	29
30	999	999	538	309	208	148	79	54	40	29

\*The exponential growth rate per generation is .3.

**TABLE 5. Carrying Capacities Necessary for the Retention of 90% of the Initial Genetic Variance\***

No. of founders	Length of generation (years)									
	1	2	4	6	8	10	15	20	25	30
6	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	157	55
16	999	999	999	936	617	424	188	110	70	39
18	999	999	882	517	348	253	124	80	55	35
20	999	999	655	384	269	196	102	69	49	32
22	999	999	538	321	225	167	90	62	45	31
24	999	999	468	285	200	148	84	59	43	30
26	999	936	432	258	184	137	79	55	42	30
28	999	865	399	243	174	129	76	54	41	29
30	999	815	376	229	164	124	73	52	40	29

\*The exponential growth rate per generation is .5.

<0.1, unless both generation length and  $N_F$  are >25. For example, Table 8 tabulates the values for slowly reproducing animals (exponential growth rate per generation = 0.05). Very large numbers of founders are required to meet the 90% criterion. Actual growth rates in zoos are often far below those in the wild, for a variety of reasons. Examples of some actual exponential growth rates per year in captive groups might be useful: okapi, 0.1; lion-tailed macaque, 0.05; Siberian tiger, 0.09 (rate is artificially low); Przewalski's horse, 0.10; gaur, 0.11; golden lion tamarin, 0.22.

Figure 1 illustrates a small sample of the tabulated results from Table 5. Curve A was generated with  $N_F = 10$ ; curve B with  $N_F = 20$ ; curve C with  $N_F = N_K$ . The latter assumption is very unrealistic, but note the small effect on  $N_K$  of increasing the founder size above 20.

**TABLE 6. Carrying Capacities Necessary for the Retention of 90% of the Initial Genetic Variance\***

No. of founders	Length of generation (years)									
	1	2	4	6	8	10	15	20	25	30
6	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—
10	—	—	999	999	999	999	682	392	225	102
12	999	999	999	617	432	321	174	117	80	49
14	999	999	655	399	285	216	122	85	61	40
16	999	999	517	321	229	174	102	71	53	35
18	999	955	450	280	200	154	90	65	48	33
20	999	848	399	253	184	140	84	60	45	32
22	999	783	376	234	170	132	79	57	43	31
24	999	738	355	220	161	124	76	55	42	30
26	999	709	334	212	154	119	73	53	42	30
28	999	682	321	204	151	117	71	52	41	29
30	999	655	315	200	145	115	70	52	40	29

\*The exponential growth rate per generation is 1.

**TABLE 7. Carrying Capacities Necessary for the Retention of 90% of the Initial Genetic Variance\***

No. of founders	Length of generation (years)									
	1	2	4	6	8	10	15	20	25	30
6	—	—	—	—	—	—	—	—	—	—
8	999	999	999	723	527	407	239	167	122	80
10	999	999	617	392	291	225	134	98	73	49
12	999	993	477	303	225	174	106	77	59	40
14	999	848	407	264	192	151	92	67	52	37
16	999	768	369	239	177	140	85	62	48	34
18	999	709	348	225	167	129	79	60	46	33
20	999	682	328	212	157	124	76	57	44	32
22	999	655	315	204	151	119	74	55	43	31
24	999	630	309	200	148	115	73	54	42	30
26	999	617	297	192	143	112	71	53	42	30
28	999	605	291	188	140	110	70	52	41	29
30	999	593	285	184	137	108	69	52	40	29

\*The exponential growth rate per generation is 3.

Our model does not take into account the generation of genetic variation by mutation. Above some theoretical equilibrium size, a population will gain genetic variance by mutation faster than it loses it by genetic drift [Franklin, 1980]. Existing data do not permit an estimate of such an equilibrium. (Actually, there are as many equilibria as there are categories of phenotypic traits for which mutation rates can be measured.) Nevertheless, we are in agreement that the marginal genetic advantage of an effective size of 500 versus 250 is probably insignificant. Because space and facilities will continue to be limiting resources for zoos in the foreseeable future, we believe that the maintenance of more than 200 to 300 effective individuals of a given species is a profligate use of precious resources. For example, one popular species

**TABLE 8. Carrying Capacities Necessary for the Retention of 90% of the Initial Genetic Variance\***

No. of founders	Length of generation (years)									
	1	2	4	6	8	10	15	20	25	30
6	—	—	—	999	999	999	999	999	999	738
8	999	999	831	527	392	303	184	134	100	67
10	999	999	538	341	253	200	122	89	67	47
12	999	899	432	280	208	164	100	73	56	40
14	999	783	384	248	184	145	89	66	52	37
16	999	723	355	229	170	134	82	62	48	34
18	999	682	334	216	161	127	79	60	46	33
20	999	655	321	208	154	119	76	57	44	32
22	999	630	309	200	148	117	74	55	43	31
24	999	617	303	196	143	115	73	54	42	30
26	999	593	291	188	143	112	71	53	42	30
28	999	582	285	184	140	110	70	52	41	29
30	999	582	285	184	137	108	69	52	40	29

\*The exponential growth rate per generation is 5.

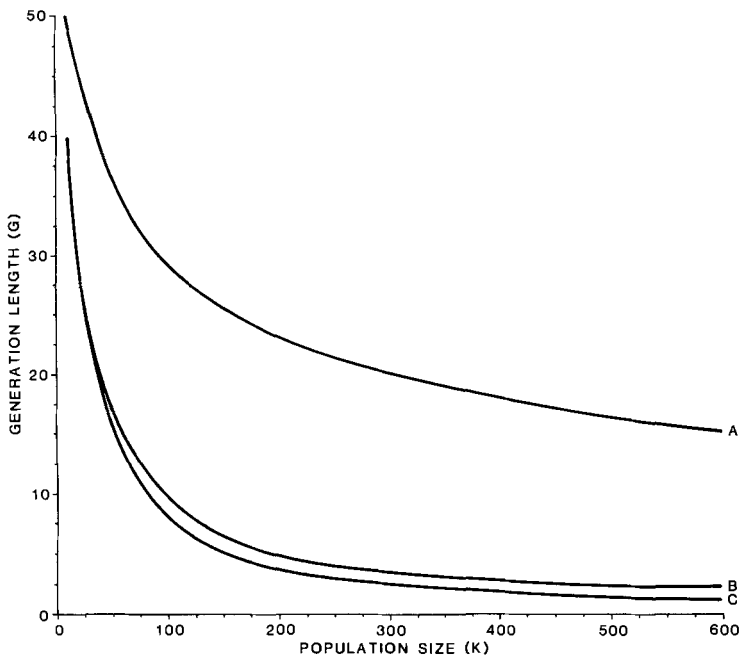


Fig. 1. Combinations of ultimate effective population sizes and generation lengths in years required to maintain 90% of the genetic variation in the source population. Curve A, founder size of 10; curve B, founder size of 20; curve C, founder size equals ultimate size.

(such as tigers) could monopolize much of the space available for large cats. Parenthetically, it is often pointed out that the census number can be significantly reduced by any manipulations that tend to equalize the reproductive output of families.

A certain amount of subdivision will often be desirable, as discussed by Foose et al [1986]. For large animals, the unit of subdivision may often be all the zoos on a continent. Therefore, the values in the tables could represent the target sizes for either the European or the North American subpopulation, though a strict application of this principle would reduce by half the number of species that could be maintained.

## CONCLUSIONS

We have considered the questions “how long, how many staterooms, and how many passengers?” as a cryptic way of asking

1. How long will it be before habitat for wildlife begins to *increase* rather than decrease?
2. How many species of terrestrial vertebrates will require captive maintenance and propagation?
3. What population sizes are necessary to prevent the decay of fitness and genetic variation in captively bred species?

To the first question, our answer is a millenium, plus or minus 500 years, barring human catastrophes. With regard to captive breeding, however, we qualify this: Assuming that our institutions, and, with them biological technology, survive, a planning horizon of 200 years appears sufficient. By this time, in all likelihood, entirely new technologies for maintaining and regenerating species in miniaturized and suspended states will have been developed.

To the second question, our answer is about 2,000 species of vertebrates (excluding fish), probably plus or minus 500. The captive breeding of so many species will saturate the available space and resources, but, hopefully, advances in cryogenics and similar technologies will obviate the need to maintain all of these at one time as living organisms.

To the third question, the answer is more complex. Our approach is to assume that a reasonable goal is to retain at least 90% of the genetic variance in the founder group for the interval of two centuries. (Considering such a finite period of time permits much more concrete and tailored answers to the question.) The actual target number is found to depend on the effective size of the founder group, the rate of growth of the population in captivity, and the generation time. The results are tabulated for a range of parameter values.

Even with the highest rates of population growth, the effective size of the founder group must be six or more, assuming that 90% of the genetic variation in the source populations is to be conserved. Larger founder sizes allow substantial decreases in  $N_k$ . This should not be construed, however, to mean that hope should be abandoned if such founder sizes are impractical. The goal of 90% retention is arbitrary, but it was the consensus that it intuitively represented the zone between a potentially damaging and a tolerable loss of heterozygosity. With careful manage-



ment, the viability of a captive group should be sustainable, even with fewer founders, and even if the 90% goal is not attainable.

Animals with very long generation times can be maintained with relatively few individuals. For example, an effective size of only about 40 need be kept if the generation time is 25 years. On the other hand, such small populations may be vulnerable to the misfortunes and vagaries of disease, accidents, and occasional breakdowns in curatorial vigilance. Though zoos, to a large extent, are able to buffer the random variation in their environments and in the demographics of their captive groups, formal captive breeding management plans should estimate the frequencies, probabilities, and genetic consequences of such stochastic perturbations.

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State	Estimated Industry Claims Counts 2015-16	Licensed Drivers	2015-16 Likelihood of Collision with Deer	2015-16 State Ranking	Estimated Industry Claims Counts 2014-15	Licensed Drivers	2014-15 Likelihood of Collision with Deer	2014-15 State Ranking	% increase or decrease
ALABAMA	28,794	3,881,542	1 in 135	22	29,111	3,859,403	1 in 133	21	1.5% Decrease
ALASKA	1,135	531,744	1 in 468	43	1,024,590	528,873	1 in 516	44	10.3% Increase
ARIZONA	4,155	4,881,801	1 in 1,175	50	3,593	4,791,450	1 in 1,334	50	13.5% Increase
ARKANSAS	22,100	2,111,873	1 in 96	14	20,763	2,097,201	1 in 101	13	5.2% Increase
CALIFORNIA	23,316	24,813,346	1 in 1,064	49	23,281	24,390,236	1 in 1,048	47	8.8% Decrease
COLORADO	14,782	3,883,362	1 in 263	37	12,643	3,837,488	1 in 304	40	15.6% Increase
CONNECTICUT	8,118	2,542,588	1 in 313	41	8,653	2,534,090	1 in 293	38	6.4% Decrease
DELAWARE	4,948	732,349	1 in 148	28	5,113	723,657	1 in 142	23	4.1% Decrease
DISTRICT OF COLUMBIA	609	419,896	1 in 689	46	392	405,555	1 in 1,035	48	50.2% Increase
FLORIDA	15,390	13,898,347	1 in 903	47	14,706	13,670,441	1 in 930	46	3% Increase
GEORGIA	52,819	6,650,434	1 in 126	19	51,766	6,607,016	1 in 128	19	1.6% Increase
HAWAII	48	902,639	1 in 18,955	51	104	915,033	1 in 8,765	51	53.8% Decrease
IDAHO	7,688	1,128,497	1 in 147	26	7,635	1,111,485	1 in 146	26	0.7% Decrease
ILLINOIS	43,634	8,373,565	1 in 192	32	41,597	8,261,582	1 in 199	33	3.6% Increase
INDIANA	32,779	4,448,099	1 in 136	23	31,679	4,500,403	1 in 142	23	4.4% Increase
IOWA	32,559	2,227,950	1 in 68	4	31,755	2,143,665	1 in 68	3	no change
KANSAS	16,181	2,021,271	1 in 125	18	16,100	2,017,759	1 in 125	18	no change
KENTUCKY	29,156	3,004,919	1 in 103	15	26,748	3,019,283	1 in 113	14	9.7% Increase
LOUISIANA	11,031	3,312,630	1 in 300	39	9,778	3,278,143	1 in 335	41	11.7% Increase

MAINE	7,357	1,018,918	1 in 138	24	6,397	1,011,385	1 in 158	28	14.5% Increase
MARYLAND	29,716	4,142,997	1 in 139	25	30,985	4,140,105	1 in 134	22	3.6% Decrease
MASSACHUSETTS	7,500	4,765,586	1 in 635	45	10,750	4,765,586	1 in 443	43	30.2% Decrease
MICHIGAN	82,702	7,046,433	1 in 85	8	72,109	6,986,587	1 in 97	10	14.1% Increase
MINNESOTA	42,207	3,357,468	1 in 80	7	41,203	3,330,725	1 in 81	7	1.3% Increase
MISSISSIPPI	22,733	1,977,679	1 in 87	10	22,373	1,968,907	1 in 88	8	1.1% Increase
MISSOURI	36,770	4,295,224	1 in 117	17	35,557	4,280,438	1 in 120	17	2.6% Increase
MONTANA	13,316	768,703	1 in 58	2	12,172	766,716	1 in 63	2	8.6% Increase
NEBRASKA	10,509	1,383,693	1 in 132	21	9,625	1,374,529	1 in 143	25	8.3% Increase
NEVADA	1,765	1,796,443	1 in 1,018	48	1,549	1,756,095	1 in 1,134	49	11.4% Increase
NEW HAMPSHIRE	4,590	1,071,963	1 in 234	34	4,217	1,061,433	1 in 252	35	7.7% Increase
NEW JERSEY	24,617	6,152,634	1 in 250	36	25,976	6,081,386	1 in 234	34	6.4% Decrease
NEW MEXICO	3,042	1,444,857	1 in 475	44	2,810	1,456,500	1 in 518	45	9.1% Increase
NEW YORK	70,405	11,318,198	1 in 161	30	70,355	11,210,783	1 in 159	27	4.3% Decrease
NORTH CAROLINA	61,047	7,025,333	1 in 115	16	59,422	6,822,902	1 in 115	16	no change
NORTH DAKOTA	5,773	527,541	1 in 91	11	4,557	513,838	1 in 113	14	24.2% Increase
OHIO	62,874	7,915,907	1 in 126	19	61,268	8,030,421	1 in 131	20	4% Increase
OKLAHOMA	12,605	2,451,972	1 in 195	33	12,217	2,418,307	1 in 198	32	1.5% Increase
OREGON	11,661	2,785,446	1 in 239	35	10,991	2,773,373	1 in 252	35	5.4% Increase
PENNSYLVANIA	133,817	8,915,641	1 in 67	3	126,275	8,896,590	1 in 70	4	4.5% Increase
RHODE ISLAND	2,167	748,337	1 in 345	42	2,833	749,232	1 in 264	37	23.5% Decrease

<b>SOUTH CAROLINA</b>	<b>39,052</b>	<b>3,617,535</b>	<b>1 in 93</b>	<b>12</b>	<b>37,298</b>	<b>3,536,404</b>	<b>1 in 95</b>	<b>9</b>	<b>2.2% Increase</b>
<b>SOUTH DAKOTA</b>	<b>8,765</b>	<b>609,908</b>	<b>1 in 70</b>	<b>5</b>	<b>8,282</b>	<b>603,643</b>	<b>1 in 73</b>	<b>5</b>	<b>4.3% Increase</b>
<b>TENNESSEE</b>	<b>31,408</b>	<b>4,613,166</b>	<b>1 in 147</b>	<b>26</b>	<b>27,039</b>	<b>4,605,100</b>	<b>1 in 170</b>	<b>29</b>	<b>15.6% Increase</b>
<b>TEXAS</b>	<b>54,408</b>	<b>15,648,733</b>	<b>1 in 288</b>	<b>38</b>	<b>52,000</b>	<b>15,447,273</b>	<b>1 in 297</b>	<b>39</b>	<b>3.1% Increase</b>
<b>UTAH</b>	<b>9,511</b>	<b>1,425,703</b>	<b>1 in 150</b>	<b>29</b>	<b>8,531</b>	<b>1,661,219</b>	<b>1 in 195</b>	<b>30</b>	<b>30% Increase</b>
<b>VERMONT</b>	<b>3,114</b>	<b>545,312</b>	<b>1 in 175</b>	<b>31</b>	<b>2,783</b>	<b>543,057</b>	<b>1 in 195</b>	<b>30</b>	<b>11.4% Increase</b>
<b>VIRGINIA</b>	<b>61,141</b>	<b>5,769,063</b>	<b>1 in 94</b>	<b>13</b>	<b>57,503</b>	<b>5,602,765</b>	<b>1 in 97</b>	<b>10</b>	<b>3.2% Increase</b>
<b>WASHINGTON</b>	<b>17,612</b>	<b>5,401,139</b>	<b>1 in 307</b>	<b>40</b>	<b>15,743</b>	<b>5,301,630</b>	<b>1 in 337</b>	<b>42</b>	<b>9.8% Increase</b>
<b>WEST VIRGINIA</b>	<b>28,254</b>	<b>1,171,907</b>	<b>1 in 41</b>	<b>1</b>	<b>26,928</b>	<b>1,177,136</b>	<b>1 in 44</b>	<b>1</b>	<b>7.3% Increase</b>
<b>WISCONSIN</b>	<b>54,597</b>	<b>4,188,194</b>	<b>1 in 77</b>	<b>6</b>	<b>54,280</b>	<b>4,171,427</b>	<b>1 in 77</b>	<b>6</b>	<b>no change</b>
<b>WYOMING</b>	<b>5,012</b>	<b>423,987</b>	<b>1 in 85</b>	<b>8</b>	<b>4,236</b>	<b>421,473</b>	<b>1 in 100</b>	<b>12</b>	<b>17.6% Increase</b>
<b>UNITED STATES TOTAL</b>	<b>1,309,288</b>	<b>214,092,472</b>	<b>1 in 164</b>	<b>NA</b>	<b>1,254,704</b>	<b>212,159,728</b>	<b>1 in 169</b>	<b>NA</b>	<b>3% Increase</b>

# Deer Collision 2017 – 2018

State	Estimated Industry Claims Counts 2017-18	Licensed Drivers	2017-18 Likelihood of Collision with Deer	2017-18 State Ranking	Estimated Industry Claims Counts 2016-17	Licensed Drivers	2016-17 Likelihood of Collision with Deer	2016-17 State Ranking	Percentage Change in Likelihood
ALABAMA	28,966	3,943,082	1 in 136	22	29,830	3,907,038	1 in 131	23	3.8% DECREASE
ALASKA	1,348	534,585	1 in 396	42	1,309	533,227	1 in 407	44	2.7% INCREASE
ARIZONA	4,738	5,082,305	1 in 1,073	48	5,119	4,978,762	1 in 973	49	9.3% DECREASE
ARKANSAS	22,531	2,391,103	1 in 106	14	21,922	2,119,578	1 in 97	14	8.9% DECREASE
CALIFORNIA	23,280	26,199,436	1 in 1,125	50	22,855	25,532,920	1 in 1,117	50	0.7% DECREASE
COLORADO	14,659	4,066,580	1 in 277	39	15,728	3,974,521	1 in 253	36	8.9% DECREASE
CONNECTICUT	9,930	2,611,007	1 in 263	37	8,434	2,566,673	1 in 304	40	15.7% INCREASE
DELAWARE	5,455	756,328	1 in 139	24	5,644	742,524	1 in 132	24	5.1% DECREASE
DISTRICT OF COLUMBIA	555	489,831	1 in 883	47	639	455,602	1 in 713	46	19.2% DECREASE
FLORIDA	17,653	14,675,160	1 in 831	46	16,845	14,262,715	1 in 847	47	1.9% INCREASE
GEORGIA	53,242	6,975,900	1 in 131	19	56,768	6,906,191	1 in 122	18	7.1% DECREASE
HAWAII	146	931,703	1 in 6,379	51	133	909,797	1 in 6,823	51	7.0% INCREASE
IDAHO	7,066	1,160,922	1 in 164	27	7,507	1,135,009	1 in 151	29	8.0% DECREASE
ILLINOIS	42,618	8,514,644	1 in 200	32	41,394	8,462,193	1 in 204	32	2.3% INCREASE
INDIANA	31,015	4,553,259	1 in 147	25	30,837	4,467,848	1 in 145	27	1.3% DECREASE



IOWA	30,684	2,245,640	1 in 73	5	32,080	2,224,130	1 in 69	4	5.3% DECREASE
KANSAS	15,640	2,030,025	1 in 130	18	16,031	2,028,657	1 in 127	19	2.5% DECREASE
KENTUCKY	28,274	3,031,447	1 in 107	15	30,344	3,021,266	1 in 100	15	7.1% DECREASE
LOUISIANA	10,793	3,395,095	1 in 315	40	10,098	3,357,091	1 in 332	41	5.7% INCREASE
MAINE	7,581	1,021,332	1 in 135	21	8,024	1,019,879	1 in 127	19	5.7% DECREASE
MARYLAND	30,933	4,264,875	1 in 138	23	32,913	4,185,752	1 in 127	19	7.8% DECREASE
MASSACHUSETTS	10,750	5,040,662	1 in 469	44	8,500	5,040,662	1 in 593	45	26.5% INCREASE
MICHIGAN	87,959	7,074,674	1 in 80	8	83,477	7,104,484	1 in 85	9	5.8% INCREASE
MINNESOTA	43,689	3,377,910	1 in 77	7	45,528	3,351,430	1 in 74	7	4.8% DECREASE
MISSISSIPPI	22,155	2,018,862	1 in 91	10	20,951	1,988,396	1 in 95	12	4.1% INCREASE
MISSOURI	38,603	4,249,579	1 in 110	16	37,667	4,213,302	1 in 112	17	1.6% INCREASE
MONTANA	14,098	797,145	1 in 57	2	13,640	781,427	1 in 57	2	1.3% INCREASE
NEBRASKA	9,412	1,404,479	1 in 149	26	10,436	1,394,301	1 in 134	25	10.5% DECREASE
NEVADA	1,721	1,872,376	1 in 1,088	49	1,899	1,835,511	1 in 966	48	11.2% DECREASE
NEW HAMPSHIRE	4,529	1,096,234	1 in 242	35	4,267	1,074,766	1 in 252	35	4.1% INCREASE
NEW JERSEY	26,859	6,238,436	1 in 232	33	27,037	6,179,318	1 in 229	34	1.6% DECREASE
NEW MEXICO	3,358	1,521,785	1 in 453	43	3,696	1,467,782	1 in 397	43	12.4% DECREASE
NEW YORK	72,314	11,947,568	1 in 165	28	72,500	11,689,839	1 in 161	30	2.4% DECREASE
NORTH CAROLINA	64,200	7,267,042	1 in 113	17	65,628	7,160,621	1 in 109	16	3.6% DECREASE

NORTH DAKOTA	5,402	555,935	1 in 103	13	6,297	545,027	1 in 87	10	51.9% DECREASE
OHIO	59,396	7,974,951	1 in 134	20	61,921	7,923,439	1 in 128	22	4.7% DECREASE
OKLAHOMA	15,169	2,498,178	1 in 165	28	13,526	2,621,733	1 in 194	31	17.7% INCREASE
OREGON	11,138	2,855,746	1 in 256	36	11,070	2,808,548	1 in 254	37	1.1% DECREASE
PENNSYLVANIA	141,777	8,996,815	1 in 63	3	141,145	8,942,967	1 in 63	3	0.2% DECREASE
RHODE ISLAND	1,400	753,143	1 in 538	45	2,667	745,470	1 in 280	39	48.0% DECREASE
SOUTH CAROLINA	38,292	3,746,681	1 in 98	11	38,951	3,683,824	1 in 95	12	3.3% DECREASE
SOUTH DAKOTA	8,304	622,663	1 in 75	6	8,989	655,707	1 in 73	6	2.7% DECREASE
TENNESSEE	30,128	5,197,904	1 in 173	30	32,352	4,621,401	1 in 143	26	17.2% DECREASE
TEXAS	60,857	16,162,382	1 in 266	38	59,105	15,879,876	1 in 269	38	1.2% INCREASE
UTAH	8,202	1,960,366	1 in 239	34	8,602	1,913,564	1 in 222	33	6.9% DECREASE
VERMONT	3,205	553,670	1 in 173	30	3,653	548,799	1 in 150	28	13.0% DECREASE
VIRGINIA	59,610	5,912,048	1 in 99	12	61,592	5,820,209	1 in 94	11	4.7% DECREASE
WASHINGTON	14,268	5,635,715	1 in 395	41	15,483	5,516,134	1 in 356	42	9.8% DECREASE
WEST VIRGINIA	25,176	1,159,348	1 in 46	1	27,403	1,167,346	1 in 43	1	7.5% DECREASE
WISCONSIN	58,435	4,206,770	1 in 72	4	57,940	4,194,759	1 in 72	5	0.6% INCREASE
WYOMING	4,812	421,098	1 in 88	9	5,325	422,450	1 in 79	8	9.4% DECREASE
UNITED STATES TOTAL	1,332,322	221,994,424	1 in 167	NA	1,345,701	218,084,465	1 in 162	NA	2.7% DECREASE

Source for number of licensed drivers is FHWA  
(<https://www.fhwa.dot.gov/policyinformation/statistics/2015/>)

State	2017-18 State Ranking	State	2016-17 State Ranking
WEST VIRGINIA	1	WEST VIRGINIA	1
MONTANA	2	MONTANA	2
PENNSYLVANIA	3	PENNSYLVANIA	3
WISCONSIN	4	IOWA	4
IOWA	5	WISCONSIN	5
SOUTH DAKOTA	6	SOUTH DAKOTA	6
MINNESOTA	7	MINNESOTA	7
MICHIGAN	8	WYOMING	8
WYOMING	9	MICHIGAN	9
MISSISSIPPI	10	NORTH DAKOTA	10
SOUTH CAROLINA	11	VIRGINIA	11
VIRGINIA	12	MISSISSIPPI	12
NORTH DAKOTA	13	SOUTH CAROLINA	12
ARKANSAS	14	ARKANSAS	14
KENTUCKY	15	KENTUCKY	15
MISSOURI	16	NORTH CAROLINA	16
NORTH CAROLINA	17	MISSOURI	17
KANSAS	18	GEORGIA	18
GEORGIA	19	KANSAS	19
OHIO	20	MAINE	19
MAINE	21	MARYLAND	19
ALABAMA	22	OHIO	22
MARYLAND	23	ALABAMA	23
DELAWARE	24	DELAWARE	24
INDIANA	25	NEBRASKA	25
NEBRASKA	26	TENNESSEE	26
IDAHO	27	INDIANA	27
OKLAHOMA	28	VERMONT	28
NEW YORK	28	IDAHO	29
TENNESSEE	30	NEW YORK	30
VERMONT	30	OKLAHOMA	31

ILLINOIS	32	ILLINOIS	32
NEW JERSEY	33	UTAH	33
UTAH	34	NEW JERSEY	34
NEW HAMPSHIRE	35	NEW HAMPSHIRE	35
OREGON	36	COLORADO	36
CONNECTICUT	37	OREGON	37
TEXAS	38	TEXAS	38
COLORADO	39	RHODE ISLAND	39
LOUISIANA	40	CONNECTICUT	40
WASHINGTON	41	LOUISIANA	41
ALASKA	42	WASHINGTON	42
NEW MEXICO	43	NEW MEXICO	43
MASSACHUSETTS	44	ALASKA	44
RHODE ISLAND	45	MASSACHUSETTS	45
FLORIDA	46	DISTRICT OF COLUMBIA	46
DISTRICT OF COLUMBIA	47	FLORIDA	47
ARIZONA	48	NEVADA	48
NEVADA	49	ARIZONA	49
CALIFORNIA	50	CALIFORNIA	50
HAWAII	51	HAWAII	51

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# Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities

STEPHEN C. TROMBULAK\* AND CHRISTOPHER A. FRISSELL†

\*Department of Biology, Middlebury College, Middlebury, VT 05753, U.S.A., email [trombulak@middlebury.edu](mailto:trombulak@middlebury.edu)

†Flathead Lake Biological Station, University of Montana, 311 Bio Station Lane, Polson, MT 59860-9659, U.S.A.

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**Abstract:** *Roads are a widespread and increasing feature of most landscapes. We reviewed the scientific literature on the ecological effects of roads and found support for the general conclusion that they are associated with negative effects on biotic integrity in both terrestrial and aquatic ecosystems. Roads of all kinds have seven general effects: mortality from road construction, mortality from collision with vehicles, modification of animal behavior, alteration of the physical environment, alteration of the chemical environment, spread of exotics, and increased use of areas by humans. Road construction kills sessile and slow-moving organisms, injures organisms adjacent to a road, and alters physical conditions beneath a road. Vehicle collisions affect the demography of many species, both vertebrates and invertebrates; mitigation measures to reduce roadkill have been only partly successful. Roads alter animal behavior by causing changes in home ranges, movement, reproductive success, escape response, and physiological state. Roads change soil density, temperature, soil water content, light levels, dust, surface waters, patterns of runoff, and sedimentation, as well as adding heavy metals (especially lead), salts, organic molecules, ozone, and nutrients to roadside environments. Roads promote the dispersal of exotic species by altering habitats, stressing native species, and providing movement corridors. Roads also promote increased hunting, fishing, passive harassment of animals, and landscape modifications. Not all species and ecosystems are equally affected by roads, but overall the presence of roads is highly correlated with changes in species composition, population sizes, and hydrologic and geomorphic processes that shape aquatic and riparian systems. More experimental research is needed to complement post-hoc correlative studies. Our review underscores the importance to conservation of avoiding construction of new roads in roadless or sparsely roaded areas and of removal or restoration of existing roads to benefit both terrestrial and aquatic biota.*

Revisión de los Efectos de Carreteras en Comunidades Terrestres y Acuáticas

**Resumen:** *Las carreteras son una característica predominante y en incremento de la mayoría de los paisajes. Revisamos la literatura científica sobre los efectos ecológicos de las carreteras y encontramos sustento para la conclusión general de que las carreteras están asociadas con efectos negativos en la integridad biótica tanto de ecosistemas terrestres como acuáticos. Las carreteras de cualquier tipo ocasionan siete efectos generales: mortalidad ocasionada por la construcción de la carretera; mortalidad debida a la colisión con vehículos; modificaciones en la conducta animal; alteración del ambiente físico; alteración del ambiente químico; dispersión de especies exóticas e incremento en el uso de áreas por humanos. La construcción de carreteras elimina a organismos sésiles y a organismos de lento movimiento, lesiona a organismos adyacentes a la carretera y altera las condiciones físicas debajo ella misma. Las colisiones con vehículos afectan la demografía de muchas especies tanto de vertebrados como invertebrados; las medidas de mitigación para reducir la pérdida de animales por colisiones con vehículos han sido exitosas solo de manera parcial. Las carreteras alteran la conducta animal al ocasionar cambios en el rango de hogar, movimientos, éxito reproductivo, respuesta de escape y estado fisiológico. Las carreteras cambian la densidad del suelo, temperatura, contenido de agua en el suelo, niveles de luz, polvo, aguas superficiales, patrones de escurrimiento y sedimentación, además de agregar metales pesados (especialmente plomo), sales, moléculas orgánicas, ozono y nutrientes a los ambientes que atraviesan. Las carreteras promueven la dispersión de especies exóticas al alterar los hábi-*

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*tats, al estresar a las especies nativas y proveer corredores para movimiento. Las carreteras también promueven el incremento de la caza y la pesca, el hostigamiento pasivo de animales y modificaciones del paisaje. No todas las especies ni todos los ecosistemas son afectados por las carreteras de igual forma, pero en general la presencia de carreteras está altamente correlacionada con cambios en la composición de especies, los tamaños poblacionales y los procesos hidrológicos y geomorfológicos que afectan a la estructura de sistemas acuáticos y riparios. Se necesita más investigación experimental para complementar estudios correlativos post-hoc. Nuestra revisión hace énfasis en que en trabajos de conservación es importante evitar la construcción de nuevas carreteras en áreas carentes de ellas o en áreas con pocas carreteras, además de remover o restaurar carreteras existentes con la finalidad de beneficiar tanto a la biota acuática como la terrestre.*

## Introduction

Among the most widespread forms of modification of the natural landscape during the past century has been the construction and maintenance of roads (Diamondback 1990; Bennett 1991; Noss & Cooperrider 1994). As conservation biologists seek to understand the forces that influence the viability of populations and the overall health of ecosystems, it is important that we understand the scope of the ecological effects of roads of all types, especially important as conservation biologists are asked to participate in the development and implementation of strategies to protect or restore elements of biological diversity and integrity.

Roads of all kinds affect terrestrial and aquatic ecosystems in seven general ways: (1) increased mortality from road construction, (2) increased mortality from collision with vehicles, (3) modification of animal behavior, (4) alteration of the physical environment, (5) alteration of the chemical environment, (6) spread of exotic species, and (7) increased alteration and use of habitats by humans. These general effects overlap somewhat. In some cases animals modify their behavior and avoid roads because of concentrated human activity along roads. Roads may facilitate the spread of invasive species by disrupting native communities and changing physical habitats. Roads may fragment populations through roadkill and road avoidance. Despite the difficulty of categorizing discretely the causal basis in every example, these seven categories provide a useful framework for assessing what is known and unknown about the ecological effects of roads.

Selective road removal, relocation, or remediation may provide ecological benefits in certain situations. Yet, although roads are commonly identified as important correlates or indicators of loss of ecological health (e.g., Noss & Cooperrider 1994), the specific mechanisms by which biota are affected are often complicated or uncertain. Therefore, mitigation or treatment of specific effects, whether during road design or in post-construction remediation, can be costly and fraught with uncertainty.

## Mortality from Road Construction

Road construction kills any sessile or slow-moving organism in the path of the road. The extent to which road

construction contributes to direct mortality has not been estimated as has direct mortality from other forms of habitat destruction (e.g., Petranka et al. 1993). The fact that road construction kills individual organisms is obvious, however. The magnitude of such construction is not trivial; the 13,107,812 km of road lanes of all types in the conterminous United States, with an average width of 3.65 m per lane, have destroyed at least 4,784,351 ha of land and water bodies that formerly supported plants, animals, and other organisms (U.S. Department of Transportation 1996). The actual number is likely much higher because this estimate does not include shoulder pavement and land peripheral to the roadbed that is cleared during construction.

Construction may physically injure organisms adjacent to the path of construction. Roads built for extraction of white fir result in damage to trees that is visible up to 30 m from the road (Trafela 1987). Such damage contributes to a decline of up to 30% in forest productivity per rotation, due in part to a decline in growth of damaged trees. Construction also alters the physical conditions of the soil underneath and adjacent to the road. Riley (1984) showed that road construction increases soil compaction up to 200 times relative to undisturbed sites. These changes likely decrease the survival of soil biota that are not killed directly. Direct transfer of sediment and other material to streams and other water bodies at road crossings is an inevitable consequence of road construction (Richardson et al. 1975; Seyedbagheri 1996). High concentrations of suspended sediment may directly kill aquatic organisms and impair aquatic productivity (Newcombe & Jensen 1996).

## Mortality from Collision with Vehicles

Mortality of animals from collision with vehicles is well documented. Many reviews of the taxonomic breadth of the victims of vehicle collision have been published (e.g., Groot Bruinderink & Hazebroek 1996). Few if any terrestrial species of animal are immune. Large mammals ranging in size from moose (*Alces alces*) to armadillos (*Dasypus novemcinctus*) are the best-documented roadkills, probably due to interest in their demography and to their size (Bellis & Graves 1971; Puglisi et al. 1974;

Reilly & Green 1974; Holroyd 1979; Wilkins & Schmidly 1980; Bashore et al. 1985; Davies et al. 1987; Bangs et al. 1989; Palomares & Delibes 1992).

Roadkill among many other species includes American Kestrels (*Falco sparverius*; Varland et al. 1993), Barn Owls (*Tyto alba*; Newton et al. 1991), Northern Saw-whet Owls and Eastern Screech Owls (*Aegolius acadicus* and *Otis asio*; Loos & Kerlinger 1993), tropical forest birds (Novelli et al. 1988), garter snakes (Dalrymple & Reichenbach 1984), granivorous birds (Dhindsa et al. 1988), American crocodile (*Crocodylus acutus*; Kushlan 1988), green iguanas (*Iguana iguana*; Rodda 1990), desert snakes (Rosen & Lowe 1994), toads (van Gelder 1973), plus a wide range of invertebrates, especially insects (H. C. Seibert & Conover 1991).

This form of mortality can have substantial effects on a population's demography. Vehicle collision is the primary cause of death for moose in the Kenai National Wildlife Refuge in Alaska (Bangs et al. 1989) and for Barn Owls in the United Kingdom (Newton et al. 1991), the second highest form of mortality for Iberian lynx (*Felis pardina*) in southwestern Spain (after hunting; Ferreras et al. 1992), and the third highest form for white-tailed deer (*Odocoileus virginianus*) in New York (Sarbello & Jackson 1985) and wolves (*Canis lupus*) in Minnesota (Fuller 1989). Roadkill is a limiting factor in the recovery of the endangered American crocodile in southern Florida (Kushlan 1988) and is contributing to the endangerment of the prairie garter snake (*Thamnophis radix radix*; Dalrymple & Reichenbach 1984). Roadkill is often nonspecific with respect to age, sex, and condition of the individual animal (e.g., Bangs et al. 1989).

Amphibians may be especially vulnerable to roadkill because their life histories often involve migration between wetland and upland habitats, and individuals are inconspicuous and sometimes slow-moving. Roads can be demographic barriers that cause habitat and population fragmentation (Joly & Morand 1997). In the Netherlands, for example, roads with high traffic volume negatively affect occupancy of ponds by moor frogs (*Rana arvalis*; Vos & Chardon 1998). In Ontario, the local abundance of toads and frogs is inversely related to traffic density on adjacent roads, but the incidence of roadkill relative to abundance is higher on highly trafficked roads (Fahrig et al. 1995). Thus, even though populations in high-traffic areas have apparently already been depressed from cumulative road mortality, they continue to suffer higher proportionate rates of roadkill.

Mitigation measures have been employed in different locations with varying degrees of success (e.g., Yanes et al. 1995). For example, underpasses on Interstate 75 have been only partially successful in reducing roadkill of Florida panthers (*Felis concolor coryi*; Foster & Humphrey 1991). Despite mitigation efforts, roads are likely to be a persistent source of mortality for many species.

In general, mortality increases with traffic volume (e.g., Rosen & Lowe 1994; Fahrig et al. 1995). Some species are less likely to be killed on high-speed roads than on medium-speed roads because the former usually have vegetation cleared back further from the road's shoulder, creating less attractive habitat and greater visibility for both animals and drivers. Other species, however, are attracted to the modified habitat alongside and in the meridians of high-speed roads (Cowardin et al. 1985), making them population sinks.

## Modification of Animal Behavior

The presence of a road may modify an animal's behavior either positively or negatively. This can occur through five mechanisms: home range shifts, altered movement patterns, altered reproductive success, altered escape response, and altered physiological state.

Black bears (*Ursus americanus*) in North Carolina shift their home ranges away from areas with high road densities (Brody & Pelton 1989), as do grizzly bears in the Rocky Mountains (*Ursus horribilis*; McLellan & Shackleton 1988). Elk (*Cervus elaphus*) in Montana prefer spring feeding sites away from visible roads (Grover & Thompson 1986), and both elk and mule deer (*Odocoileus hemionus*) in Colorado in winter prefer areas >200 m from roads (Rost & Bailey 1979). Wolves will not establish themselves in areas with road densities greater than a region-specific critical threshold (Jensen et al. 1986; Thurber et al. 1994), probably as a result of a relationship between road density and hunting pressure. Mountain lion (*Felis concolor*) home ranges are situated in areas with lower densities of improved dirt roads and hard-surface roads (Van Dyke et al. 1986), suggesting that either mountain lions avoid these areas or road construction tends to avoid their prime habitat. Elephants (*Loxodonta africana*) in northeastern Gabon preferentially locate in forests away from both roads and villages (Barnes et al. 1991). Both Black Vultures (*Coragyps atratus*) and Turkey Vultures (*Cathartes aura*), on the other hand, preferentially establish home ranges in areas with greater road densities (Coleman & Fraser 1989), probably because of the increase in carrion.

Roads may also alter patterns of animal movement. Caribou (*Rangifer tarandus*) in Alaska preferentially travel along cleared winter roads that lead in the direction of their migration (Banfield 1974). Although the road may enhance caribou movement, it results in increased mortality from vehicle collisions and predation by wolves. After calving, female caribou with calves avoid roads (Klein 1991). The land snail *Arianta arbustorum* avoids crossing roads, even those that are unpaved and as narrow as 3 m (Baur & Baur 1990), and extend their movements along road verges. Reluctance to cross roads is also seen in white-footed mice (*Peromyscus*

*leucopus*; Merriam et al. 1989) and many other rodent species (Oxley et al. 1974), even when the road is narrow and covered only with gravel. Cotton rats (*Sigmodon hispidus*) and prairie voles (*Microtus ochrogaster*) avoid roads as narrow as 3 m (Swihart & Slade 1984). Black bear almost never cross interstate highways in North Carolina (Brody & Pelton 1989) but will cross roads with less traffic volume. Roads act as barriers to gene flow in the common frog (*Rana temporaria*) in Germany, leading to significant genetic differentiation among populations (Reh & Seitz 1990). Other animals that show a reluctance to cross roads include pronghorn antelope (*Antilocapra americana*; Bruns 1977) and mountain lions (Van Dyke et al. 1986).

Some animals seem unaffected by the presence of roads, at least at some spatial scales. Based on a study of 20 wolverines, Hornocker and Hash (1981) concluded that the sizes and shapes of home ranges of wolverines where they are still found in northwestern Montana are independent of the presence of highways. Similarly, the presence of highways explained none of the allelic differentiation among populations of brown hares (*Lepus europaeus*) in Austria (Hartl et al. 1989).

Roads may affect an animal's reproductive success. Productivity of Bald Eagles (*Haliaeetus leucocephalus*) in Oregon (Anthony & Isaacs 1989) and Illinois (Paruk 1987) declines with proximity to roads, and they preferentially nest away from roads. Golden Eagles (*Aquila chrysaetos*) also prefer to nest away from human disturbances, including roads (Fernandez 1993). The reduced nesting success of eagles in proximity to roads may be more a function of the presence of humans than of the road itself; nesting failure by Golden Eagles in Scotland correlates with how easy it is for people to approach but not with proximity to roads themselves (Watson and Dennis 1992). Relative to habitat availability, Sandhill Cranes (*Grus canadensis*) avoid nesting near paved and gravel public roads (Norling et al. 1992); they do not avoid private roads with low-traffic volume (Norling et al. 1992) and can habituate to roads over time (Dwyer & Tanner 1992). Mallards (*Anas platyrhynchos*) in North Dakota, on the other hand, prefer road rights-of-way for nesting (Cowardin et al. 1985), perhaps because of a lower level of predation there.

Roads can also alter escape responses. Pink-footed Geese (*Anser brachyrhynchus*) in Denmark are more easily disturbed when feeding near roads, flying away when humans approach within 500 m, a greater distance than when feeding in areas without roads (Madsen 1985). Both the Lapwing (*Vanellus vanellus*) and Black-tailed Godwit (*Limosa limosa*) are more easily disturbed near roads and have disturbance distances of 480–2000 m depending on traffic volume (Van der Zande et al. 1980). Less well known is the effect of roads and vehicles on an animal's physiological state. MacArthur et al. (1979) showed that heart rate and therefore

metabolic rate and energy expenditure of female big-horn sheep (*Ovis canadensis*) increase near a road independent of any use of the road. Roads contribute to fragmentation of populations through both increased mortality and modification of behavior that makes animals less likely to cross roads. Fragmentation may be accelerated by roads when spatially critical habitat patches (e.g., "stepping stones") become unoccupied as a result of increased local mortality or reduced recolonization.

## Disruption of the Physical Environment

A road transforms the physical conditions on and adjacent to it, creating edge effects with consequences that extend beyond the time of the road's construction. At least eight physical characteristics of the environment are altered by roads: soil density, temperature, soil water content, light, dust, surface-water flow, pattern of runoff, and sedimentation.

Long-term use of roads leads to soil compaction that persists even after use is discontinued. Soil density on closed forest roads continues to increase, particularly during winter months (Helvey & Kochenderfer 1990). Increased soil density can persist for decades: logging skid trails in northeastern California over 40 years old have soil that is 20% more compacted than soil in nearby areas that have not been used as trails (Vora 1988).

The reduction of water vapor transport on a road with a hard surface increases the surface temperature of a road compared to bare soil, an effect that increases with thickness of the road surface (Asaeda & Ca 1993). The heat stored on the road surface is released into the atmosphere at night, creating heat islands around roads. Animals respond to these heat islands: small birds (Whitford 1985) and snakes, for example, preferentially aggregate on or near warm roads, increasing their risk of being hit by cars and, at their northern range limits, reducing energetic demands for breeding.

During the dry season, the moisture content of soils under roads declines even if the roads are not in use (Helvey & Kochenderfer 1990), probably in response to changes in soil porosity. Roads through forests also increase the amount of light incident on the forest floor. The amount of increase depends on how much of the original canopy and lower strata remain, which depends in turn on the width of the road and roadside verge. The increase in light increases the density of species that preferentially grow where light levels are high, such as early-successional, disturbance-adapted species such as the North American orchid *Isotria medeoloides* (Mehrhoff 1989).

Road traffic mobilizes and spreads dust, which when settled on plants can block photosynthesis, respiration, and transpiration and can cause physical injuries to plants (Farmer 1993). These effects are sufficient to alter

plant community structure, especially in communities dominated by lichens and mosses (Auerbach et al. 1997). Although most sediment enters water bodies through overland flow or mass failure, dust from highly trafficked roads can serve as a source of fine sediments, nutrients, and contaminants to aquatic ecosystems (Gjessing et al. 1984).

Roads and bridges can alter the development of shorelines, stream channels, floodplains, and wetlands. Because of the energy associated with moving water, physical effects often propagate long distances from the site of a direct road incursion (Richardson et al. 1975). Alteration of hydrodynamics and sediment deposition can result in changes in channels or shorelines many kilometers away, both down- and up-gradient of the road crossing. The nature of such responses to channel and shoreline alteration is not always predictable; it may depend on the sequence of flood and sedimentation events after the alteration is made. Roads on floodplains can redirect water, sediment, and nutrients between streams and wetlands and their riparian ecosystems, to the detriment of water quality and ecosystem health. Roads are among the many human endeavors that impair natural habitat development and woody debris dynamics in forested floodplain rivers (Piégay & Landon 1997).

Road crossings commonly act as barriers to the movement of fishes and other aquatic animals (Furniss et al. 1991). Although many headwater populations of salmonid fishes are naturally migratory, they often persist today as fragmented headwater isolates, largely because of migration barriers created by road crossings and other human developments that fail to provide for fish passage (Kershner et al. 1997; Rieman et al. 1997). Salmonids and other riverine fishes actively move into seasonal floodplain wetlands and small valley-floor tributaries to escape the stresses of main-channel flood flows (Copp 1989), but valley-bottom roads can destroy or block access to these seasonally important habitats (Brown & Hartman 1988). Persistent barriers may encourage local selection for behaviors that do not include natural migration patterns, potentially reducing both the distribution and productivity of a population.

Roads directly change the hydrology of slopes and stream channels, resulting in alteration of surface-water habitats that are often detrimental to native biota. Roads intercept shallow groundwater flow paths, diverting the water along the roadway and routing it efficiently to surface-water systems at stream crossings (Megahan 1972; Wemple et al. 1996). This can cause or contribute to changes in the timing and routing of runoff (King & Tenyson 1984; Jones & Grant 1996; Ziemer & Lisle 1998), the effects of which may be more evident in smaller streams than in larger rivers (Jones & Grant 1996). Hydrologic effects are likely to persist for as long as the road remains a physical feature altering flow routing—often long after abandonment and revegetation of the

road surface. By altering surface or subsurface flow, roads can destroy and create wetland habitats.

Changes in the routing of shallow groundwater and surface flow may cause unusually high concentrations of runoff on hillslopes that can trigger erosion through channel downcutting, new gully or channel head initiation, or slumping and debris flows (Megahan 1972; Richardson et al. 1975; Wemple et al. 1996; Seyedbagheri 1996). Once such processes occur, they can adversely affect fishes and other biota far downstream for long periods of time (Hagans et al. 1986; Hicks et al. 1991). Roads have been responsible for the majority of hill-slope failures and gully erosion in most steep, forested landscapes subject to logging activity (Furniss et al. 1991; Hagans et al. 1986). Because most of these more catastrophic responses are triggered by the response of roads during infrequent, intense storm events, lag times of many years or decades pass before the full effects of road construction are realized.

Chronic effects also occur, however. The surfaces of unpaved roads can route fine sediments to streams, lakes, and wetlands, increasing the turbidity of the waters (Reid & Dunne 1984), reducing productivity and survival or growth of fishes (Newcombe & Jensen 1996), and otherwise impairing fishing (Buck 1956). Existing problem roads can be remediated to reduce future erosion potential (e.g., Weaver et al. 1987; Harr & Nichols 1993). The consequences of past sediment delivery are long-lasting and cumulative, however, and cannot be effectively mitigated (Hagans et al. 1986).

## Alteration of the Chemical Environment

More has been written about the effects of roads on the chemical environment than on all other effects combined. Maintenance and use of roads contribute at least five different general classes of chemicals to the environment: heavy metals, salt, organic molecules, ozone, and nutrients.

A variety of heavy metals derived from gasoline additives and road deicing salts are put into the roadside environment. The most widely documented is lead, but others include aluminum, iron, cadmium, copper, manganese, titanium, nickel, zinc, and boron (Garcia-Miragaya et al. 1981; Clift et al. 1983; Gjessing et al. 1984; Oberts 1986; Araratyan & Zakharyan 1988).

Heavy metal contamination exhibits five patterns. First, the amount of contamination is related to vehicular traffic (Goldsmith et al. 1976; Dale & Freedman 1982; Lesharne et al. 1992). Second, contamination of soils, plants, and animals decreases exponentially away from the road (Quarles et al. 1974; Dale & Freedman 1982). Most studies indicate that contamination declines within 20 m but that elevated levels of heavy metals often occur 200 m or more from the road. The pattern of decline is influenced

by prevailing wind patterns (Haqus & Hameed 1986). Once metals reach aquatic environments, transport rates and distances increase substantially (Gjessing et al. 1984).

Third, heavy metals can be localized in the soil, either close to the surface if downward transport has not occurred (Indu & Choudhri 1991) or deep below the surface if pollution levels in the past exceeded those in the present (Byrd et al. 1983). Transportation and localization is largely affected by the physical properties of the soil (Yassoglou et al. 1987). Metals and other persistent chemicals fixed to soils may become remobilized once they are inundated or transported to freshwater environments by wind, water, or gravity.

Fourth, heavy metals accumulate in the tissues of plants (Datta & Ghosh 1985; Beslaneev & Kuchmazokova 1991) and animals (Collins 1984; Birdsall et al. 1986; Grue et al. 1986). As with soil, contamination of plant tissue occurs up to at least 200 m from a road and is greatest for individuals along roads with high traffic volume.

Fifth, heavy metal concentrations in soil decline over time where use of leaded gasoline has been stopped and surface-water flow carries the metal ions away (Byrd et al. 1983; Tong 1990). After they leave the terrestrial environment, however, the mobilized metals may cause additional harm to aquatic biota. Also, some of the processes of metal demobilization may be reversed rapidly if environmental conditions, such as acidity of the soils, sediments, or water, change (Nelson et al. 1991).

Deicing salts, particularly NaCl but also CaCl<sub>2</sub>, KCl, and MgCl<sub>2</sub>, contribute ions to the soil, altering pH and the soil's chemical composition (Bogemans et al. 1989). As with lead, discontinuation of the use of deicing salts allows plants damaged by salt stress to recover (Leh 1990). The effects on aquatic biota of temporary surges of salt that often accompany runoff from roads to surface and groundwaters have received little study. Deicing salts on roadways elevate chloride and sodium concentrations in streams (Molles & Gosz 1980; Hoffman et al. 1981; Peters & Turk 1981; Mattson & Godfrey 1994) and in bogs, where road salts can alter patterns of succession in aquatic vegetation (Wilcox 1986). Accumulation of salts from chemicals used for road deicing or dust control can disrupt natural stratification patterns and thus potentially upset the ecological dynamics of meromictic lakes (Hoffman et al. 1981; Kjensmo 1997).

Organic pollutants such as dioxins and polychlorinated biphenyls are present in higher concentrations along roads (Benfenati et al. 1992). Hydrocarbons may accumulate in aquatic ecosystems near roads (Gjessing et al. 1984). In one stream along a British highway, numerous contaminants were present at elevated levels in the water column and sediments, including copper, zinc, and various hydrocarbons, but polycyclic aromatic hydrocarbons associated with stream sediments accounted for most of the observed toxicity to aquatic amphipods

(Maltby et al. 1995). Comparatively little research has focused on the questions of the fate and effects of the organic chemicals associated with roads.

Vehicles produce ozone, which increases the concentration of this harmful molecule in the air, especially in areas where vehicle exhaust accumulates (Flueckiger et al. 1984). Roads are also especially important vectors of nutrients and other materials to aquatic ecosystems, because the buffering role normally played by riparian vegetation (Correll et al. 1992) is circumvented through direct runoff of materials in water and sediment where roads abut or cross water bodies. Water moving on and alongside roadways can be charged with high levels of dissolved nitrogen in various forms, and sediment brings a phosphorus subsidy when it reaches surface waters. Road deicing salts are an additional source of phosphorus (Oberts 1986). The degree to which roads directly contribute to eutrophication problems in aquatic ecosystems has been little investigated. Because roads deliver nutrients that originate in the contributing slope area, the nutrient burden is probably largely controlled by surrounding vegetation and land use. An increased density of road crossings of water bodies can be expected to increase delivery of nutrients.

The alteration of the chemical environment by roads results in a number of consequences for living organisms. First, in the terrestrial environment the chemical composition of some woody plants changes in response to pollution. These changes include increased concentrations of chemicals produced by plants, such as terpenoids, which help them resist the toxic effects of pollution (Akimov et al. 1989) and salts (Bogemans et al. 1989), and decreased production of other chemicals, such as soluble protein and chlorophyll *a*, which are necessary for plant function (Banerjee et al. 1983).

Second, organisms may be killed or otherwise displaced as a result of chemical exposure. Virtually all measures of soil biotic diversity and function decline in contaminated soil, including abundance, number of species, species composition, index of species diversity, index of equability, and bulk soil respiration (Muskett & Jones 1981; Guntner & Wilke 1983; Krzysztofak 1991).

Third, the growth (Petersen et al. 1982) and overall physical health (Flueckiger et al. 1984; Moritz & Breitenstein 1985) of many plants is depressed, even to the point of death (Fleck et al. 1988). The sensitivity of plants to pollutants may change during development; for example, seedlings are more sensitive to salt than are adults (Liem et al. 1984), which influences juvenile recruitment. Pollutants may affect plant health by damaging fine roots, mycorrhizae (Majdi & Persson 1989), and leaves (Simini & Leone 1986) and by changing salt concentrations in plant tissues (Northover 1987). Secondary effects on plant health include decreased resistance to pathogens (Northover 1987), causing further declines. In aquatic environments, plant (and animal) assemblages



may change due to direct and indirect responses to nutrient increases and due to growth suppression or mortality caused by other chemicals introduced by roads.

Fourth, plants (Graham & Kalman 1974; Nasralla & Ali 1985; Dickinson et al. 1987; Guttormsen 1993) and animals (Robel et al. 1981; Collins 1984; Harrison & Dyer 1984; Krzysztofiak 1991; Marino et al. 1992), including those cultivated or raised for agriculture, may accumulate toxins at levels that pose health hazards, including those for humans that consume exposed organisms (Jarosz 1994).

Fifth, increased concentrations near roadsides of some pollutants, particularly salt, attract large mammals, putting them more at risk of being killed by vehicles (Fraser & Thomas 1982). Spills of edible products from trucks and trains also attract wildlife to roadsides. Finally, evolutionary processes may be affected through altered selection pressures that result in local differentiation of populations of both plants (Kiang 1982) and animals (Minoranskii & Kuzina 1984).

### Spread of Exotic Species

Roads provide dispersal of exotic species via three mechanisms: providing habitat by altering conditions, making invasion more likely by stressing or removing native species, and allowing easier movement by wild or human vectors. It is often difficult to distinguish among these factors. Soils modified during road construction can facilitate the spread of exotic plants along roadsides (Greenberg et al. 1997). Some exotic plants establish themselves preferentially along roadsides and in other disturbed habitats (Wester & Juvik 1983; Henderson & Wells 1986; Tyser & Worley 1992; Wein et al. 1992). The spread of exotic diseases (Dawson & Weste 1985; Gad et al. 1986) and insects (Pantaleoni 1989; Schedl 1991) is facilitated by increased density of roads and traffic volume. Road construction that alters the canopy structure of forests promotes invasion by exotic understory plants, which affects animal communities (Gaddy & Kohlsaas 1987). Some roadside verges have been invaded by maritime plants because of their ability to tolerate saline soil (Scott & Davison 1982). Feral fruit trees are found preferentially along roadsides, and some populations are maintained solely by seeds in fruit waste thrown from vehicles (Smith 1986).

Exotic species are sometimes introduced along roadsides for the purpose of erosion control (Niordson 1989). Native species are now more widely preferred for this purpose, but Dunlap (1987) argues that in some cases the need for rapid establishment of plant cover requires the use of exotic species.

In another form of deliberate introduction, roads provide easy access to streams and lakes for fishery man-

agers to stock nonnative hatchery fish (Lee et al. 1997), which adversely affect native biota and disrupt aquatic ecosystems in many ways (Allan & Flecker 1993). Unsanctioned, illegal, and unintentional introductions of fishes, mollusks, plants, and other aquatic organisms also occur frequently (Allan & Flecker 1993), and they are facilitated by public road access to water bodies.

The dispersal of a biological agent such as a pathogen along a roadway can affect both terrestrial and aquatic ecosystems far from the road. In northern California and southwest Oregon, for example, vehicle traffic and roadway drainage along logging and mining roads during the wet season disperse spores of an exotic root disease (*Phytophthora lateralis*) that infects the endemic Port Orford cedar (*Chamaecyparis lawsoniana*; Zobel et al. 1985). Transfer of the water-borne spores from forest roads into headwater stream crossings can result in the infection and nearly complete mortality of Port Orford cedars along a much larger network of downstream channel margins and floodplains, even deep inside otherwise roadless areas. The progressive loss of this important conifer species from riparian ecosystems may engender substantial long-term consequences for the integrity of stream biota, including endangered salmon species, for which the Port Orford cedar provides shade, large and long-lasting coarse woody debris, and stabilization of channels and floodplains.

### Changes in Human Use of Land and Water

Roads facilitate increased use of an area by humans, who themselves often cause diverse and persistent ecological effects. New roads increase ease of access by humans into formerly remote areas. Perhaps more important, roads often increase the efficiency with which natural resources can be exported. At least three different kinds of human use of the landscape, made increasingly possible by roads, can have major ecological effects: hunting and fishing, recreation, and changes in use of land and water.

Roads open up areas to increased poaching and legal hunting. Hunting reduces population sizes of many game species, including brown bear (*Ursus arctos*; Camarra & Parde 1990), Iberian lynx (Ferreras et al. 1992), wolves (Fuller 1989), black bear (Manville 1983), and Egyptian mongooses (*Herpestes ichneumon*; Palomares & Delibes 1992). Roads also increase both legal and illegal fishing in streams and lakes. Native fish populations in previously inaccessible areas are often vulnerable to even small increases in fishing effort. Increased fishing then often gives rise to public demand for fish stocking as an attempt to artificially compensate for the effects of unsustainable harvest, at the further expense of native fishes and other species (e.g., Gresswell & Varley 1988).

Visitors increase when roads make areas more accessible, leading to increased passive harassment of animals—such as elk on Mount St. Helens in Washington State (Czech 1991) and the Oregon Coast Range (Witmer & DeCalesta 1985), brown bear in Europe (Del Campo et al. 1990), and mountain goats (*Oreamnos americanus*) in Montana (Pedevillano & Wright 1987)—and damage to plant communities (Matlack 1993).

Roads are often built into areas to promote logging, agriculture, mining, and development of homes or industrial or commercial projects. Such changes in land cover and land and water use result in major and persistent adverse effects on the native flora and fauna of terrestrial (Van Dyke et al. 1986; Karnefelt & Mattsson 1989; P. Seibert 1993) and freshwater ecosystems (Schlosser 1991; Allan & Flecker 1993; Roth et al. 1996).

Numerous studies have demonstrated declines in stream health associated with roads. Because the nature and extent of land use within a region tend to be highly correlated with road networks, however, it is often difficult or impossible to separate the direct ecological effects of roads from those of the accompanying land-use activities. For example, Eaglin and Hubert (1993) reported that trout biomass and streambed habitat quality in Wyoming streams declined in relation to the number of road crossings and to the proportion of area logged in the contributing catchment. Findlay and Houlihan (1997) found that herpetile species diversity in wetlands declined in relation to the density of roads within 2 km of the perimeter. Among streams in the Pacific Northwest, the status or abundance of bull trout populations has been inversely correlated to road density (Rieman et al. 1997; Baxter et al. 1999); these studies used roads as the best available general proxy of cumulative effects associated with land use and human access. On the other hand, some studies (e.g., Roth et al. 1996) have demonstrated correlations of stream biotic integrity with land-use pat-

terns across large catchments but did not investigate the specific roles that roads might play in mediating the causes and effects.

It appears that roads can serve as useful indicators of the magnitude of land-use changes, but it remains unclear to what degree the associated ecological responses result directly from roads themselves. If roads are largely responsible, effects could be ameliorated through altered road design, placement, remediation, or road removal. Strong interactions between roads and land use are likely, however. Forest roads in Idaho, for example, are less prone to erosion when the surrounding landscape remains in natural forest cover (Seyedbagheri 1996).

## Discussion and Conclusions

Roads have diverse and systemic effects on many aspects of terrestrial and aquatic ecosystems. The ecological effects of roads can resonate substantial distances from the road in terrestrial ecosystems, creating habitat fragmentation and facilitating ensuing fragmentation through support of human exploitative activities (Fig. 1a). Habitat deterioration is not widely appreciated as an aspect of ecological fragmentation in aquatic ecosystems. At the scale of an extensive landscape or stream network, however, roads produce a pattern of aquatic habitat loss that differs from the terrestrial pattern yet nevertheless results in the ecological fragmentation of aquatic ecosystems (Fig. 1b). We coin the term *hyperfragmentation* to describe the multidimensional view of ecological fragmentation and habitat loss that emerges when the consequences of roads or any habitat alteration for terrestrial and aquatic ecosystems are considered simultaneously (Fig. 1c). Hyperfragmentation is the result of a spatial footprint of ecological effect that propagates across the landscape differently in freshwater and

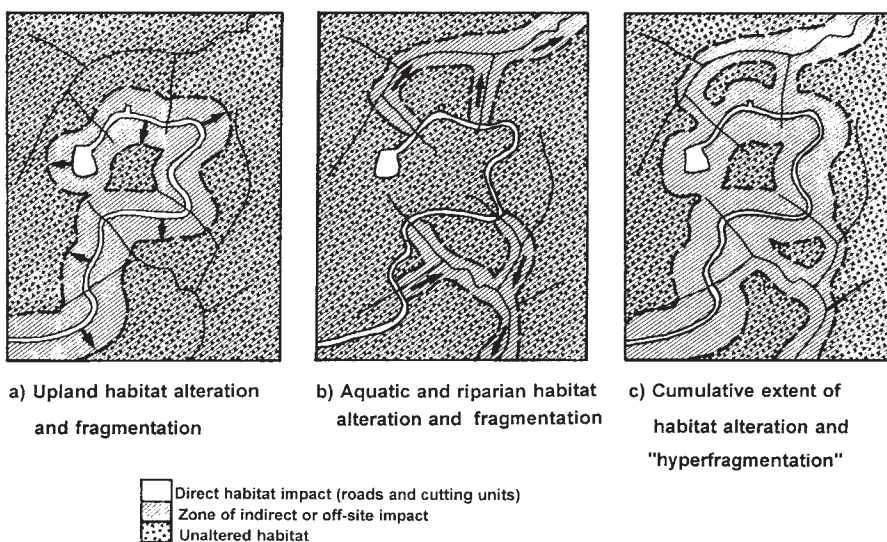


Figure 1. Spatial pattern of direct and indirect habitat alteration caused by human disturbance in a forested watershed: (a) classical forest edge effects contributing to terrestrial habitat fragmentation, (b) downstream-propagating hydrologic and biotic effects leading to large-scale fragmentation of freshwater habitats and populations, (c) combined terrestrial-aquatic view of landscape alteration that we term hyperfragmentation because it considers multiple ecosystem dimensions on the same landscape. Arrows indicate pre-dominant spatial vector of effects.

aquatic ecosystems than in terrestrial systems. Even where only a small percentage of the land's surface is directly occupied by roads, few corners of the landscape remain untouched by their off-site ecological effects. The breadth of these effects cannot be appreciated unless one takes a broadly transdisciplinary view of ecosystems and biological communities.

Road design, management, and restoration need to be more carefully tailored to address the full range of ecological processes and terrestrial and aquatic species that may be affected. Deliberate monitoring is necessary to ensure that projects have robust ecological benefits and minimal adverse effects and that they are cost-efficient relative to their actual benefits (e.g., Weaver et al. 1987). Of course, such assessments require time and money that are usually unavailable. Most funds used to remediate problem roads are earmarked for actual field operations and are not available to support such assessment and monitoring. Few of the experts building roads or "restoring" them are trained to recognize and address the full spectrum of ecological issues that we have identified. Moreover, by their nature roads have systemic ecological effects that, even if recognized, cannot be overcome.

If a broad view of the ecological effects of roads reveals a multiplicity of effects, it also suggests that it is unlikely that the consequences of roads will ever be completely mitigated or remediated. Thus, it is critical to retain remaining roadless or near-roadless portions of the landscape in their natural state. Because of the increasing rarity of roadless areas, especially roadless watersheds, conservation efforts cannot rely entirely on protection of existing natural areas. But neither can conservation efforts depend entirely on tenuous and unexamined assumptions about the capability of site- and species-specific mitigation and remediation measures to reduce the ecological consequences of existing and proposed roads.

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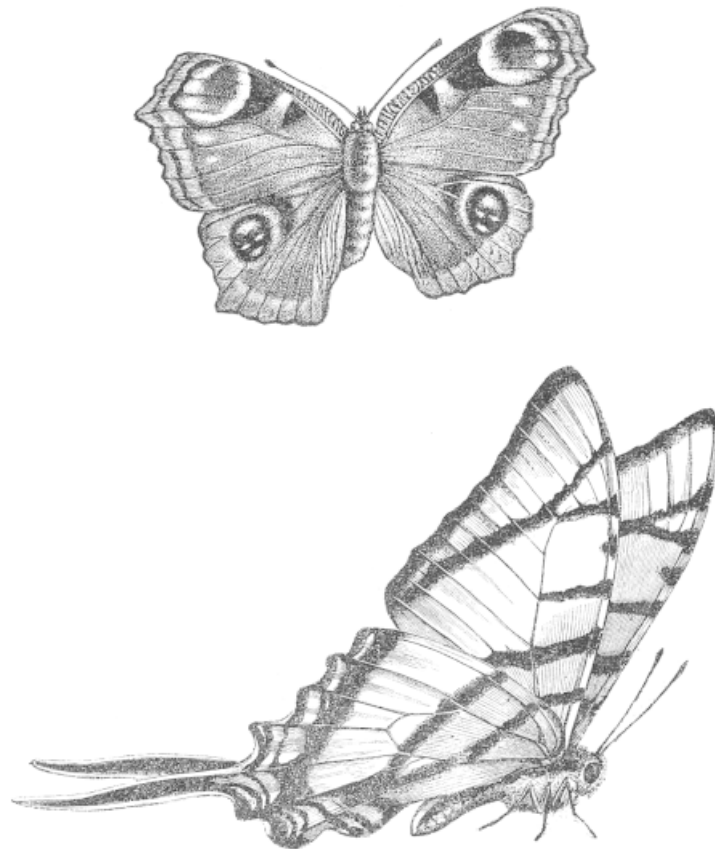
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Guest Editorial, part of a Special Feature on [Effects of Roads and Traffic on Wildlife Populations and Landscape Function](#)

## Effects of Roads and Traffic on Wildlife Populations and Landscape Function: Road Ecology is Moving toward Larger Scales

[Rodney van der Ree](#)<sup>1</sup>, [Jochen A. G. Jaeger](#)<sup>2</sup>, [Edgar A. van der Grift](#)<sup>3</sup>, and [Anthony P. Clevenger](#)<sup>4</sup>

**ABSTRACT.** Road ecology has developed into a significant branch of ecology with steady growth in the number of refereed journal articles, books, conferences, symposia, and “best practice” guidelines being produced each year. The main objective of this special issue of *Ecology and Society* is to highlight the need for studies that document the population, community, and ecosystem-level effects of roads and traffic by publishing studies that document these effects. It became apparent when compiling this special issue that there is a paucity of studies that explicitly examined higher order effects of roads and traffic. No papers on landscape function or ecosystem-level effects were submitted, despite being highlighted as a priority for publication. The 17 papers in this issue, from Australia, Canada, the Netherlands, and USA, all deal to some extent with either population or community-level effects of roads and traffic. Nevertheless, many higher order effects remain unquantified, and must become the focus of future studies because the complexity and interactions among the effects of roads and traffic are large and potentially unexpected. An analysis of these complex interrelations requires systematic research, and it is necessary to further establish collaborative links between ecologists and transportation agencies. Many road agencies have “environmental sustainability” as one of their goals and the only way to achieve such goals is for them to support and foster long-term and credible scientific research. The current situation, with numerous small-scale projects being undertaken independently of each other, cannot provide the information required to quantify and mitigate the negative effects of roads and traffic on higher levels. The future of road ecology research will be best enhanced when multiple road projects in different states or countries are combined and studied as part of integrated, well-replicated research projects.

**Key Words:** *animal movement; animal-vehicle collisions; barrier effect; ecological threshold; gene flow; habitat fragmentation; mitigation; population viability analysis; road ecology; road-effect zone; traffic mortality; traffic noise; traffic volume; transportation planning*

### INTRODUCTION

Humans are responsible for the current unprecedented rate of biodiversity loss across the globe with climate change, pollution, and the loss, fragmentation, and degradation of habitat being the major drivers of extinction (Vitousek et al. 1997). Roads and other linear infrastructure are a major cause of habitat loss, fragmentation, and degradation and are ubiquitous in most landscapes around the world. Worldwide, there are already an estimated 750 million vehicles travelling on approximately 50 million km of public road (T. Langton, *personal communication*), and the road

network and traffic volumes are still increasing, particularly in eastern Europe, China, India, and Latin America.

Linear infrastructure is important for society because it provides connectivity for people. However, linear infrastructure also exerts significant negative effects on adjacent habitats, wildlife populations, communities, and ecosystems. Research about the ecological effects of roads and traffic on the natural environment began in 1925 when Dayton Stoner documented the 225 traffic-killed vertebrates from 29 species that he observed during a 632 mile trip in Iowa, USA (Stoner 1925).

<sup>1</sup>University of Melbourne, <sup>2</sup>Concordia University Montréal, Department of Geography, Planning and Environment, Quebec, Canada, <sup>3</sup>Alterra, Wageningen UR, Netherlands, <sup>4</sup>Western Transportation Institute, Montana State University, USA

The term “road ecology” was first used in German (“Straßenökologie”) in 1981 (Ellenberg et al.), and was later translated into English by Forman et al. (2003) for their book *Road Ecology: Science and Solutions*. Since the mid 1990s, there has been a rapid increase in the number of studies, publications, and symposia, particularly from Europe, North America, and Australia. These include major national and international reports and best practice guidelines (Iuell et al. 2003, Trocmé et al. 2003, National Research Council 2005, Clevenger and Huijser 2009), regular dedicated conferences such as the biennial International Conference on Ecology and Transportation (ICOET), Infra-Eco Network of Europe (IENE), and symposia and special issues of peer-reviewed journals, e.g., *Biological Conservation* (Mader 1990), *Conservation Biology* (Hourdequin 2000), *GAIA* (Jaeger et al. 2005), and *Naturschutz and Landschaftsplanung* (Roedenbeck and Jaeger 2006).

The overall aim of road ecology research is to quantify the ecological effects of roads, with the ultimate aim of avoiding, minimizing, and compensating for their negative impacts on individuals, populations, communities, and ecosystems. This research has demonstrated the numerous and diverse effects of roads and traffic on plants and animals, with most studies focusing at the level of the individual animal. These effects include the loss and fragmentation of habitat, increased rates of wildlife mortality because of collision with vehicles, alterations to light, moisture and wind regimes due to the creation of edges, pollution from traffic, e.g., light, noise, and chemical, and facilitating the spread and dispersal of weeds and feral animals. Roads also affect the aesthetic and recreational quality of landscapes for humans (Di Giulio and Holderegger 2009). Consequently, roads have been described as the single most destructive element in the process of habitat fragmentation (Noss 1993) and their ecological effects are considered “the sleeping giant of biological conservation” (Forman 2002:viii).

Understanding the impacts of roads and traffic at higher levels is necessary for a number of good reasons. Most governments have agreed that conservation of biodiversity is important and therefore road agencies must endeavor to ensure that they are contributing to achieving this goal. Counting the number of dead animals on the side of the road or measuring the size of the ecological road-

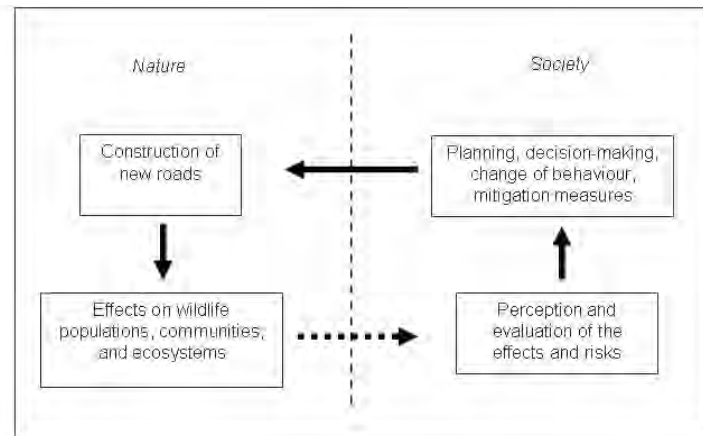
effect zone will not, by itself, inform whether roads and vehicles are endangering the existence of populations or species. The important parameter must be the long-term viability of adjacent populations, and this requires data on the sizes of the populations, vital rates, and level of connectivity among subpopulations. Similarly, a critical question when evaluating mitigation works is the extent to which populations have become more viable, and whether they are now sufficiently viable, not simply how many animals pass through an underpass (van der Ree et al. 2007). The extent to which the results from the numerous local studies can be extrapolated to larger spatial and temporal scales is unknown. Therefore, an important next step is to evaluate how the density and configuration of entire road networks affect the functional relationships within and among ecosystems at the landscape scale. Answers to this question will inform cumulative environmental assessments and transportation planning (Roedenbeck et al. 2007). Roads also affect humans in a range of ways but little research on this topic has been completed (Di Giulio and Holderegger 2009).

Reducing the negative effects of roads and traffic will only be possible if more dialogue is achieved between the scientific community and the planners and political decision makers (Fig. 1). The majority of people in the world live in cities and increasingly, their encounters with wildlife involve animals that have died after collision with vehicles. Novel approaches to engage the public, and hence, governments, are required. A recent example was an award-winning exhibition in the Whyte Museum in Banff, Alberta, Canada in 2006 of images of wildlife using the now famous overpasses and underpasses in Banff National Park. A second example was a creative arts competition as part of the IENE 2010 conference for Hungarian school children to portray the conflict, and solutions, between roads and wildlife (Fig. 2).

#### **ABOUT THIS ISSUE: THE EFFECTS OF ROADS AND TRAFFIC ON POPULATIONS, COMMUNITIES, AND ECOSYSTEMS**

The two main objectives of this special issue of *Ecology and Society* were to (1) highlight the need for studies that document the population, community, and ecosystem-level effects of roads and traffic, and (2) publish studies that document

**Fig. 1.** Society's ability to address the negative effects of road networks on wildlife populations and ecosystems depends on the perception of the ecological effects and risks. As the perception of the effects by society has been severely limited (as indicated by the dotted line), alternative approaches may be required that would be based on more indirect indicators of ecological risk and on the precautionary principle.



these effects. The special issue consists of 17 papers from four countries, i.e., Australia, Canada, the Netherlands, and U.S.A., that all deal to some extent with either population or community-level effects of roads and traffic. It became apparent when compiling the special issue that there is a paucity of road ecology studies that explicitly examined higher order effects of roads. No papers on landscape function or ecosystem-level effects were submitted, despite being highlighted as a priority for publication.

The special issue begins with a synthesis paper (Fahrig and Rytwinski 2009) and ends with an insight paper (Simmons et al. 2010). The synthesis is an appropriate first paper because it assesses the widely held assertion that “there are very few studies that assess the population-level effects of roads and traffic.” The assertion was found to be partly true and partly false; the authors located 79 studies that provide data on population-level effects (abundance and density) but found that in most cases, the population-level effect was ‘hidden’ in many of the papers reviewed. Nevertheless, Fahrig and Rytwinski (2009) found that overwhelmingly, roads and traffic had a negative effect on animal abundance, with negative effects outnumbering positive effects by a factor of five. The final paper in the special issue reviews some of the genetic methods used in road ecology and provides an

insight into how conservation genetics can be better utilized in future studies. Simmons et al. (2010) argue that conservation genetics is a rapidly evolving field and that many of the widely perceived limitations to the use of genetics are either misconceptions or no longer apply. They conclude with strong recommendations that genetic approaches be combined with field studies to increase the inferential strength of whichever study design is adopted (sensu Roedenbeck et al. 2007).

The road-effect zone is the distance from the edge of the road over which significant ecological effects can be detected (Forman and Alexander 1998). Eigenbrod et al. (2009) quantified threshold effects of a motorway on anuran populations in Canada, and Bissonette and Rosa (2009) investigated the effects of a motorway on the composition and abundance of a small-mammal community in the deserts of Utah, USA. Eigenbrod et al. (2009) were the first to quantify the road-effect zone on the species richness and relative abundance of anurans, and found strong negative effects for four of seven species, extending 250–1000 m from the road edge. They conclude that although most anurans are likely to have reduced abundances near motorways, the extent and cause of this relationship will vary among species (Eigenbrod et al. 2009). In contrast, Bissonette and Rosa (2009) found that roadside vegetation in desert environments often provides



**Fig. 2.** Runner up of the "On Dangerous Roads" Competition organized by Varangy Akciócsoport Egyesület for the 2010 Infra-Eco Network of Europe Conference showing an overpass used by wildlife. An ongoing project in the Netherlands is studying the effectiveness of an overpass for amphibians, in combination with fences along the road. This overpass is equipped with a cascading series of small ponds fed with water pumped into the highest pond in the center of the overpass.



suitable habitat for small mammals. Only 2 of 13 species of small mammals were never captured near roads, and the remaining 11 species' numbers were either similar or more abundant near the road than further away.

Vegetation adjacent to roads often provides habitat (e.g., Bissonette and Rosa 2009), and in some landscapes, even the majority of habitat (van der Ree and Bennett 2003). Wildlife that use this habitat will experience traffic noise and may be affected by it. Anthropogenic noise has the potential to severely disrupt the communication of species by acoustic interference or masking. Three studies in this special issue investigate this effect on frogs and birds. Parris and Schneider (2008) found that the Grey Shrike-thrush (*Colluricincla harmonica*) sang at a higher frequency in areas with traffic noise than the Grey Fantail (*Rhipidura fuliginosa*) and that the probability of detecting either species declined substantially with increasing traffic noise and traffic volume. The effects of traffic noise on frogs were assessed by Parris et al. (2009) in an urban landscape

in southeast Australia and by Hoskin and Goosem (2010) in tropical rainforest in northeastern Australia. One species of urban frog in and around Melbourne called at a higher pitch in traffic noise, while the second species studied may also call at a higher pitch, but more data is required to be sure (Parris et al. 2009). *Litoria rheocola* in tropical rainforest also called at a higher pitch when closer to the road, as well as calling at a higher rate when near roads (Hoskin and Goosem 2010). The abundance of some species of rainforest frogs was also lower near roads.

A significant proportion of the road ecology literature is focused on evaluating the use and effectiveness of mitigation measures that aim to restore connectivity for wildlife or reduce rates of animal-vehicle collisions. A review presented at the ICOET conference in 2007 concluded that most studies in the scientific and grey literature had focused almost exclusively on documenting rates of use of wildlife passages, and that few had explicitly evaluated the effectiveness of mitigation measures

at enhancing population viability (van der Ree et al. 2007). In this special issue, five papers have addressed the topic of mitigation of road effects on wildlife in differing perspectives. Thorne et al. (2009) highlight the importance of landscape-scale planning to better integrate the needs of wildlife into regional transportation plans. Using two examples from California, USA, they show how road projects can benefit financially and ecologically when road agencies and conservation groups collaborate early in the planning stages. Approximately 1 – 2 million mammal-vehicle collisions occur annually in North America, causing in excess of 200 human fatalities and over one billion U.S. dollars in property damage each year (references in Huijser et al. 2009). Huijser et al. (2009) reviewed the effectiveness and cost of 13 measures considered effective at reducing collisions with large ungulates and found that for many sections of road, the effectiveness, measured as money saved, exceeds the costs to install the mitigation. The results of their cost-benefit model suggests that there must be many locations in North America where the mitigation measures are cost-effective, and thereby would save society money and improve road safety for humans and wildlife if implemented more often. At a smaller spatial scale, Grosman et al. (2009) combined real data on the movement of moose (*Alces alces*) with agent-based computer simulations to investigate if the removal of salt pools or their relocation from adjacent to the highway to 100 – 1500 m away from the road would result in fewer moose-vehicle collisions. Their model predicted that the removal of salt pools from near the edge of the highway would result in an almost 50% reduction in moose-vehicle collisions (Grosman et al. 2009).

The viability of populations adjacent to wildlife crossing structures is one of the fundamental measures of success of mitigation (van der Ree et al. 2007). Two papers in this special issue explicitly investigated the increase in the viability of a population of wildlife after mitigation (Taylor and Goldingay 2009, van der Ree et al. 2009). Taylor and Goldingay (2009) used population modeling to assess the viability of the Greater Glider (*Petauroides volans*) in Brisbane, a rapidly urbanizing area of Australia. They concluded that even a relatively low rate of dispersal across the road was sufficient to substantially reduce the risk of extinction of the smaller subpopulation isolated by the road. Similarly, van der Ree et al. (2009) used population viability modeling to assess the effectiveness of under-road tunnels installed in 1985

to restore connectivity for the critically endangered Mountain Pygmy-possum (*Burramys parvus*; Mansergh and Scotts 1989). They found that the tunnels reduced, but did not completely eliminate the negative effect of the road, with the density of the population affected by the road still 15% lower than a comparable undivided population nearby (van der Ree et al. 2009).

The majority of studies that assess the use of wildlife crossing structures have utilized two primary methods to detect and record wildlife passage, namely remotely triggered cameras, and/or the detection of tracks in a suitable substrate (van der Ree et al. 2007). Clevenger and Sawaya (2010) have used the suggestions of Simmons et al. (2010) and tested the feasibility of a noninvasive genetic sampling approach to identify the species as well as the sex, individual, and relatedness of different individuals using the crossing structure. The technique, if successful, would be applied at a larger scale to determine the level of genetic fragmentation and natural and anthropogenic factors influencing gene flow. They tested their approach on Black Bears (*Ursus americanus*) and Grizzly Bears (*U. arctos*) at two underpasses in Banff National Park. Hair was collected from 90% of crossing events (determined from cameras), and 70% of hair samples had sufficient DNA for extraction, resulting in the identification of five individual bears at each underpass, and highlighting the potential of this method for population-level analysis of the efficacy of wildlife crossing structures (Clevenger and Sawaya 2010).

There is still a paucity of data on the behavior and movement of animals near roads. Bouchard et al. (2009) evaluated the behavioral response of the Northern Leopard Frog (*Rana pipiens*), a species known to be negatively affected by roads and traffic. They studied the movement of frogs during their spring migration and also undertook short distance translocations of migrating frogs and found frogs near roads with more traffic took longer to move and tended to deviate more from straight-line movements when released near roads (Bouchard et al. 2009). The combination of the Northern Leopard Frog's apparent inability to avoid roads and their slow rate of movement make them highly vulnerable to road mortality. The second study in this special issue on the movement behavior of wildlife near roads was for the Squirrel Glider (*Petaurus norfolcensis*) in southeast Australia (van der Ree et al. 2010). The authors found that the size

of the gap in the canopy was the primary determinant of the rate of crossing in their study, with similar rates of crossing across the dual-roadway with tall trees in the median and across single-lane roads. In this study, traffic volume, i.e., approximately 5000 vehicles per day per roadway of which about 25% occurs at night when the gliders are active, did not appear to greatly influence crossing rates.

The traffic volume on minor roads is expected to continue to increase in areas with high human population densities because existing motorways are nearing capacity and the minor roads are expected to accommodate the excess flows (references in van Langevelde and Jaarsma 2009). Traffic calming is a regional planning approach to concentrate these flows onto a few roads, and ensure low-volume and low-speed roads are maintained. The conclusions of population viability modeling suggest that the results are species specific and depend upon the size of the traffic-calmed area as well as the area and quality of habitat (van Langevelde and Jaarsma 2009).

## **ROAD ECOLOGY: THE ROAD AHEAD**

The research presented in this special feature shows that road ecology is moving toward larger scales. However, it also became evident while compiling this special issue that many higher order, e.g., population, community, ecosystem, or landscape-level, effects remain unquantified. These higher order effects must become the focus of future studies because the complexity and interactions among the effects of roads and traffic are large and potentially unexpected. An analysis of these complex interrelations requires systematic research. Therefore, a promising avenue to further develop the field of road ecology is to establish collaborative links with road and transportation agencies. Experience shows that the level of engagement with each local, state, or national road agency depends largely on the presence of interested people, rather than an institutionalized approach to environmental matters. However, institutional mandates are important as they are often a precondition for interested people to spend their efforts during work hours on these issues. Many road agencies have “environmental sustainability” as one of their goals and the only way to achieve such goals is for them to support and foster long-term and credible scientific research. Every road project is essentially

an experiment and when combined with other road projects, they become replicated. The challenge we face as researchers is to (1) use good scientific approaches to design studies that are scientifically robust and maximize the individual value of each road project within a larger experimental scope; (2) ensure our research is applied and has tangible value for road agencies and for ecological outcomes; (3) address the higher order effects of roads, traffic, and mitigation measures.

This special feature demonstrates that the emerging field of road ecology is confronted with many important unanswered questions. Research needs to address large spatial and temporal scales that are not compatible within most postgraduate programs, i.e., single MSc or PhD theses, or short-term research contracts. The synergistic effects of roads and other factors that operate simultaneously, e.g., agricultural intensification and increased urbanization, have rarely been investigated. However, empirical studies are limited by the delayed response of wildlife to many environmental changes, i.e., there is an extinction debt such that wildlife populations will continue to decline for many years, in the order of decades, before they will reach a new equilibrium (Tilman et al. 1994, Findlay and Bourdages 2000). This lack of knowledge is often used as a justification to build more roads by arguing that not enough is known and more research is needed before road construction may slow down. This constitutes a “fragmentation spiral” (Jaeger 2002), because research has been unable to catch up with the ecological effects of the rapid increase in road densities. This situation is contrary to the precautionary principle and flies in the face of the principles of sustainability. The use of computer models may help overcome these limitations. For example, simulation models have demonstrated that there are thresholds in the effects of road density on the viability of wildlife populations above which populations are prone to extinction (Jaeger and Holderegger 2005, Frair et al. 2008). In addition, a research approach is required that will address the remaining uncertainties that to a large degree are irreducible, e.g., through building on the precautionary principle (e.g., Jaeger 2002). This would open up promising new lines of action for landscape management. For example, the German Federal Environment Agency recently suggested that region-specific limits to control landscape fragmentation should be introduced (Penn-Bressel 2005).

With this issue, we hope to contribute to the field of road ecology and to highlight both its appealing theoretical insights and its high practical relevance. Most importantly, we hope that this special issue will inspire further research in road ecology at the scale of populations, communities, and ecosystems. We are looking forward to these exciting research studies to come.

Responses to this article can be read online at:  
<http://www.ecologyandsociety.org/vol16/iss1/art48/responses/>

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RESEARCH ARTICLE

# Survival and Mortality of Pumas (*Puma concolor*) in a Fragmented, Urbanizing Landscape

T. Winston Vickers<sup>1\*</sup>, Jessica N. Sanchez<sup>1</sup>, Christine K. Johnson<sup>1</sup>, Scott A. Morrison<sup>2</sup>, Randy Botta<sup>3</sup>, Trish Smith<sup>2</sup>, Brian S. Cohen<sup>2</sup>, Patrick R. Huber<sup>4</sup>, Holly B. Ernest<sup>1‡</sup>, Walter M. Boyce<sup>1\*</sup>

**1** Karen C. Drayer Wildlife Health Center, School of Veterinary Medicine, University of California Davis, Davis, California, United States of America, **2** The Nature Conservancy, San Francisco, California, United States of America, **3** California Department of Fish and Wildlife, Valley Center, California, United States of America, **4** Information Center for the Environment, University of California Davis, Davis, California, United States of America

‡ Current address: Department of Veterinary Sciences, University of Wyoming, Laramie, Wyoming, United States of America

\* [twickers@ucdavis.edu](mailto:twickers@ucdavis.edu) (TWV); [wmboyce@ucdavis.edu](mailto:wmboyce@ucdavis.edu) (WMB)



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## Abstract

Wide-ranging large carnivores pose myriad challenges for conservation, especially in highly fragmented landscapes. Over a 13-year period, we combined monitoring of radio collared pumas (*Puma concolor*) with complementary multi-generational genetic analyses to inform puma conservation in southern California, USA. Our goals were to generate survivorship estimates, determine causes of mortality, identify barriers to movement, and determine the genetic and demographic challenges to puma persistence among >20,000,000 people and extensive urban, suburban, and exurban development. Despite protection from hunting, annual survival for radio collared pumas was surprisingly low (55.8%), and humans caused the majority of puma deaths. The most common sources of mortality were vehicle collisions (28% of deaths), and mortalities resulting from depredation permits issued after pumas killed domestic animals (17% of deaths). Other human-caused mortalities included illegal shootings, public safety removals, and human-caused wildfire. An interstate highway (I-15) bisecting this study area, and associated development, have created a nearly impermeable barrier to puma movements, resulting in severe genetic restriction and demographic isolation of the small puma population (n ~ 17–27 adults) in the Santa Ana Mountains west of I-15. Highways that bisect habitat or divide remaining “conserved” habitat, and associated ongoing development, threaten to further subdivide this already fragmented puma population and increase threats to survival. This study highlights the importance of combining demographic and genetic analyses, and illustrates that in the absence of effective measures to reduce mortality and enhance safe movement across highways, translocation of pumas, such as was done with the endangered Florida panther (*P. c. coryi*), may ultimately be necessary to prevent further genetic decline and ensure persistence of the Santa Ana Mountains population.

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## Introduction

Many large carnivores have been extirpated from substantial portions of their historic range, and extant populations are threatened by habitat loss and fragmentation, and conflict with humans [1]. Human population growth expected over the next century exacerbates these threats [2–5], and exurban development will have substantial impacts on habitat that today is still relatively intact [6]. Because large carnivores pose myriad challenges for conservation in urbanizing landscapes, we began a long-term study of pumas (*Puma concolor*) in 2001 in southern California, USA, to provide quantitative insights and guidance for conservation of pumas and other large carnivores in human-dominated habitats.

Pumas, also known as mountain lions, cougars, or panthers, are wide-ranging carnivores that historically occurred throughout the Americas. Humans have extirpated or greatly reduced puma numbers in much of their former range in the past 200 years [2]. The only documented breeding population of pumas remaining in the eastern United States is in Florida, where a small population of federally endangered pumas (Florida panthers—*Puma concolor coryi*) persists, largely because their endangered status spurred intensive management including translocation and genetic introgression [7, 8]. In the western United States, pumas are hunted for sport in several states, but there is considerable controversy and uncertainty about the long-term consequences of hunting on population persistence. For example, a recent study of heavily-hunted and semi-protected puma populations in Utah [9] did not detect a compensatory decrease in natural mortality in response to heavy hunting pressure, and concluded that uncertainties in the functional relationship between natural and anthropogenic mortality could lead to biased conclusions and mismanagement.

In California, pumas are considered a “specially protected mammal” and hunting is prohibited [10]. Despite these protections, recent genetic studies of pumas in southern California show that the genetic viability and long-term persistence of some populations are in jeopardy [11, 12]. The threats facing pumas in southern California—habitat loss, increased conflict with humans, demographic isolation, and genetic restriction [11–15]—mirror the challenges facing large carnivores in urbanizing landscapes around the world [3], and long-term studies intended to guide conservation and management in these settings are difficult and expensive to conduct. We addressed this information gap by conducting a 13-year study of pumas in the California south coast ecoregion, USA, a biodiversity hotspot [16, 17] with a growing population of >20,000,000 people [18].

Sandwiched between the sprawling metropolitan areas of greater Los Angeles and San Diego, much of the available puma habitat in our study area is not protected from new highways and development, and is subject to ongoing habitat loss and fragmentation [15]. Our goals for this study were to generate survivorship estimates and cause-specific mortality data for pumas in this region, and identify options for improving survivorship and facilitating movement within and among conserved and non-conserved areas. This demographic study builds upon and complements our recent genetic analysis [11], and provides the essential ecological context for understanding the causes and potential solutions to the genetic restriction we found in pumas in the Santa Ana Mountains.

## Materials and Methods

### Statement

We operated under Protocol 10950/PHS, Animal Welfare Assurance number A3433-01, with capture and sampling procedures approved in Protocol number 17233 by the Animal Care and Use Committee at the University of California, Davis, and Memoranda of Understanding and

Scientific Collecting Permits from the California Department of Fish and Wildlife (CDFW). Permits and permissions for access to conserved lands where captures and monitoring were conducted were obtained from CDFW, California Department of Parks and Recreation, The Nature Conservancy, United States (U.S.) Fish and Wildlife Service, U.S. Forest Service, U.S. Bureau of Land Management, U.S. Navy / Marine Corps, U. S. Fish and Wildlife Service, Orange County Parks Department, San Diego County Parks Department, Riverside County Parks Department, San Diego State University, University of California—Riverside, Audubon Starr Ranch, Vista Irrigation District, Rancho Mission Viejo / San Juan Company, Sweetwater Authority, California Department of Transportation, the City of San Diego Water Department and Parks Department, and the Irvine Ranch Conservancy. Anesthetic drug combinations used in capture procedures were either teletamine / zolazepam (Telazol) or medetomidine / ketamine at dosages prescribed in the scientific literature.

### Study Area and Population

The study area encompassed the Santa Ana Mountains (a portion of the Peninsular Ranges) and the remainder of the Peninsular Mountain Ranges and surrounding foothills to the east (hereafter referred to as the eastern Peninsular Range). These areas constitute the majority of occupied puma habitat in southern California south of greater Los Angeles (Fig 1). Pumas are the primary large carnivore remaining in the study area since grizzly bears (*Ursus arctos californicus*) were extirpated in the early 1900s [19, 20].



**Fig 1. Puma study area in southern California, USA, and regional context.** The focal area of this study includes the Santa Ana Mountains and the eastern Peninsular Range. Inset shows location within California.

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An extensive and growing network of roads, some carrying more than 250,000 vehicles per day, encircles and fragments the study area [21] (Fig 1). Interstate highway 15 (I-15) connects the greater Los Angeles, Riverside, and San Diego metropolitan areas, and the highway and associated development have been hypothesized to be a barrier to puma movement between the Santa Ana Mountains in the west and the eastern Peninsular Ranges [11, 13, 22, 23]. Therefore, we assigned pumas that were captured or found dead west of I-15 to a putative “Santa Ana Mountains” source population, and those east of I-15 to a putative “eastern Peninsular Range” source population.

Land use varies considerably across the study area, with the eastern Peninsular Ranges generally having less intensive development and more rural, undeveloped, and protected lands. Burdett et al. [15] classified land use and urbanization in the study area into five categories: protected public lands (55% of the study area), private undeveloped (9.5%), rural (14.4%; >16.18 ha per housing unit), exurban (15.7%; 0.68–16.18 ha per housing unit), and suburban/urban (5.4%; <0.68 ha per housing unit). The Santa Ana Mountains have substantial protected public lands, but new highway construction, development, and land use practices tend to be much more intensive immediately adjacent to remaining high quality puma habitat [15].

## Capture and Monitoring Methods

We captured, marked, and monitored radio collared pumas from 2001 through 2013. Pumas were captured primarily using baited cage traps [24], and to a lesser extent using hounds or foot-hold snares [25, 26]. Each captured animal was tattooed in one ear with a unique numerical identifier (“marked”) and a numbered tag was placed in the opposite ear. Age was determined from dental characteristics and body morphometrics as described in Ashman et al. [27] and Laundre et al. [28, 29]. We classified pumas <18 months as kittens, 18–30 months as subadults, and >30 months as adults [30]. We applied Very High Frequency (“VHF”; MOD500 Telonics, Mesa, AZ), and/or Global Positioning System (“GPS”; Simplex P-1D, Televilt, Lindesberg, Sweden; TGW 3580, Telonics, Mesa, AZ; GPS4400S, GPS3300S, and GlobalstarTrack S, Lotek, Ontario, Canada) radio collars to pumas if their body weight exceeded 22.7 kg. GPS locations were collected at varying time intervals from every 5 minutes to every 6 hours depending on specific study objectives.

## Puma Movements

We hypothesized that the Pacific Ocean, Sonoran Desert, major highways, and urban centers would form barriers that constrained pumas in our study area into one or more discrete populations. To test this hypothesis, we examined movements of radio collared pumas from 2001–2013 to determine the degree of interchange within and between the Santa Ana Mountains and eastern Peninsular Range populations, and whether monitored pumas emigrated out of the entire study area. We were particularly interested in determining if ongoing habitat fragmentation had created or hardened existing barriers, and in evaluating puma movements relative to corridors or linkages identified through previous modeling efforts. These included: 1) the east-west “Santa Ana—Palomar Mountains Linkage” across I-15 that connects the Santa Ana Mountains and eastern Peninsular Range puma populations [31]; 2) the “Coal Canyon Corridor” under California State Route 91 (SR-91) linking the Santa Ana Mountains and the Chino Hills to the north [17, 32]; and 3) the “Parque-to-Park Linkage” connecting California and Baja California, Mexico to the south [33].

## Mortality and Survival Analyses

The distribution of radio collared pumas in the populations west and east of the I-15 freeway were compared using the Fisher exact test to determine if they differed by sex or age class,



and a two-sample t-test was used to determine if they differed by average age at entry or exit to the study (in months), or the average number of days monitored (STATA IC 13.0, STATA-Corp, College Station, Texas, USA). A P value of  $\leq 0.05$  was used as the cutoff for significance for all analyses.

Deaths of radio collared pumas from 2001–2013 were detected when VHF or GPS data indicated a lack of movement, and the cause of death was determined by field investigation and necropsy. In addition, we combined mortality data for our marked ( $n = 36$ ) pumas with “unmarked” ( $n = 218$ ) pumas that were confirmed to have died in the study area from 1981–2013 based on CDFW records. Age determination was less precise for unmarked animals due to conditions of carcasses at discovery or variable experience of reporting parties in the aging of pumas. Therefore, we classified unmarked pumas as either subadults ( $\leq 30$  months) or adults ( $>30$  months) [30].

We compared long-term trends in the number of pumas being killed under depredation permits in our dataset to the total number of puma mortalities across all of California during the same time period, as reported by CDFW [34], by plotting 5-year simple moving averages for each dataset. For each calendar year, the number of puma mortalities was averaged for the current year and previous 4 years. This allowed us to smooth short-term fluctuations and visualize long-term trends in the data.

Radio collared pumas entered the study on the date they were first captured, and exited on the date of mortality or the last date of detection by radiotelemetry. The number of days each animal was monitored was calculated as the time between entry and exit dates. Cause of death was determined at necropsy for both marked and unmarked animals unless the state of carcass decomposition precluded definitive diagnosis. In those cases, cause of death was classified as “unknown”. Because numbers of at-risk individuals varied across the course of the study, a formal cause-specific mortality analysis was not possible [35]. However, source population, sex, and age class (at time of mortality) were evaluated in both marked and unmarked populations for associations with the various causes of mortality using the Fisher exact test (STATA IC 13.0, STATA Corp, College Station, Texas, USA).

We estimated survival using the known-fate model in Program MARK (Version 7.1) [36]. We chose a set of 8 models a priori for analysis that included combinations of population, sex, and age class (at the time of collaring) as parameters. Support for each model was assessed using Akaike’s Information Criterion (AIC), corrected for small sample size ( $AIC_c$ ). The *sin* link function was used to run all models. If no model was clearly superior to all others ( $AIC_c$  weight  $>90\%$  and  $\Delta AIC > 2$ ) [36–38], we performed model averaging to reduce the uncertainty in our parameter estimates.

We used a Cox proportional hazards model (STATA IC 13.0) to evaluate the relationship of biologically important covariates (source population, sex, age, and year of mortality) to the length of time pumas survived during the study. Adult age class ( $>30$  months old) and mortality years 2007 and 2008 were used as reference categories in the models. Staggered entry into the study was addressed by including the Andersen-Gill formulation [39, 40]. The Breslow approximation method was used to address tied failure times [41], and Schoenfeld residuals were used to test the proportional hazards assumption that relative risk for each variable of interest was the same for the duration of the study.

## Results

### Puma Monitoring and Movements

Our analyses included 74 pumas that were captured, marked, and radio collared between March 2001 and December 2013 (Table 1). The distribution of these marked pumas in the

**Table 1. Demographic characteristics of radio collared pumas in southern California, USA from 2001–2013.**

Variable	Number of pumas		
	Total	Santa Ana Mountains	Eastern Peninsular Ranges
<b>Sex</b>			
Females	37	17	20
Males	37	14	23
<b>Outcome</b>			
Survived	38	18	20
Died	36	13	23
<b>Age class at entry</b>			
<18 months	19	6	13
18 to 30 months	19	9	10
>30 months	36	16	20
<b>Age class at exit</b>			
<18 months	2	0	2
18 to 30 months	16	7	9
>30 months	56	24	32

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eastern Peninsular Range ( $n = 43$ ) and Santa Ana Mountains ( $n = 31$ ) did not differ significantly by sex, age class, average age at entry or exit to the study, or the average number of days monitored.

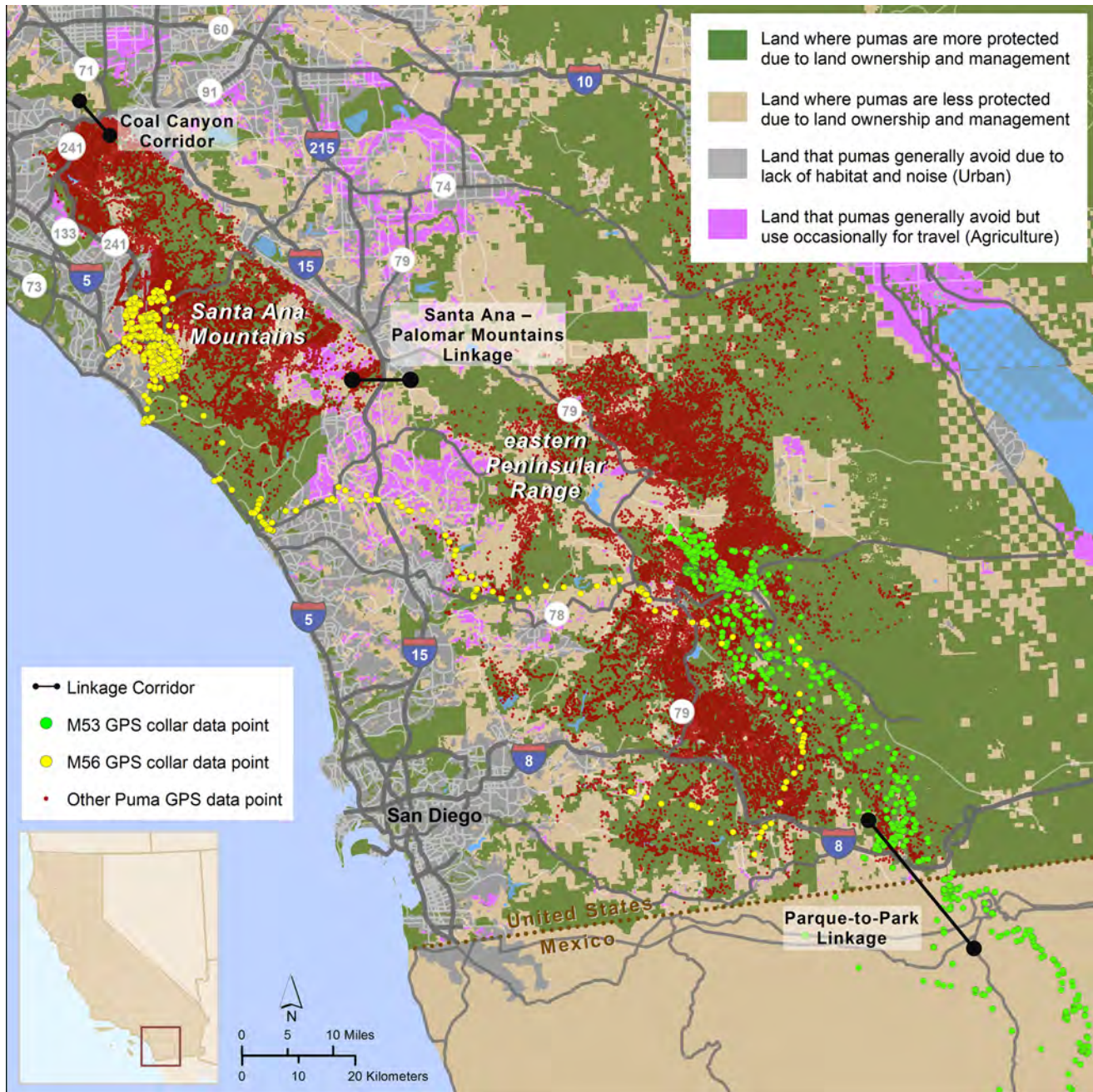
We detected numerous long distance ( $>80$  km) movements by radio collared pumas from 2001–2013, but only one radio collared puma moved out of the overall study area. In 2009, a young adult male (M53) traveled approximately 150 km south from his capture site in the eastern Peninsular Range, utilizing the Parque-to-Park Linkage to cross the U.S.-Mexico border (Fig 2). He reached a point 70 km south of the border before returning to his original location in the U.S. Several other radio collared pumas were detected near, but not across, the U.S.-Mexico border (Fig 2).

Radio collared puma movements between the eastern Peninsular Range and Santa Ana Mountains were limited, indicating the pumas in these regions formed relatively discrete populations. In 2010, a dispersing sub-adult male (M56) crossed I-15 from west to east several miles south of the proposed Santa Ana Mountains—Palomar Mountains Linkage (Fig 2), but he was killed 25 days later for depredating domestic sheep.

None of the radio collared pumas used the Coal Canyon undercrossing beneath SR-91 at the northern tip of the Santa Ana Mountains to move into the Chino Hills to the north (Fig 2). However, two unmarked pumas were killed from 2001–2013 while attempting to cross this major freeway within 3 km of the Coal Canyon undercrossing.

### Puma Mortality

The number of pumas alive ( $n = 38$ ) vs. dead ( $n = 36$ ) by the end of the study did not differ between source populations, sexes, or age class at entrance or exit (Table 1). Though time-at-risk and sample size constraints prevented a formal cause-specific mortality analysis, we report here proportional mortality of both marked and unmarked pumas over the entire study period. Over the course of the entire study period, proportional mortality due to vehicle collisions and depredation permits was greater than for all other causes of mortality. Other known sources of mortality included disease, illegal shooting, arson-caused wildfire, public safety removal, and intraspecific aggression (Table 2). Proportional mortality due to vehicle strikes and



**Fig 2. Puma GPS collar data points collected from 2001–2013 in southern California, USA.** GPS collar data points are overlaid on lands classified (by color) based on their relative levels of puma protection and typical usage. Primary linkages within the study area are noted and GPS collar data points from pumas M53 and M56 are highlighted. Inset shows location within California.

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degradation permits differed between pumas from the eastern Peninsular Range and Santa Ana Mountains populations ( $P = 0.034$ ), but did not differ by sex or age class. In fact, all mortalities of marked pumas due to degradation permits occurred in the eastern Peninsular Range, while 60% of mortalities due to vehicle collisions were in the Santa Ana Mountains (Table 2; Figs 3 and 4). With the exception of vehicle strikes and degradation, the data were too sparse to evaluate relationships between specific causes of mortality and various risk factors.



**Table 2. Proportions and numbers of radio collared pumas that died from different causes in Southern California study areas from 2001–2013.**

Cause of mortality	Total	Santa Ana Mountains	Eastern Peninsular Ranges
Vehicle Strike <sup>a</sup>	0.28 (10)	0.46 (6)	0.17 (4)
Depredation Permit <sup>a</sup>	0.17 (6)	0.00 (0)	0.26 (6)
Killed illegally	0.11 (4)	0.23 (3)	0.04 (1)
Disease suspected	0.11 (4)	0.08 (1)	0.13 (3)
Disease confirmed	0.06 (2)	0.00 (0)	0.09 (2)
Fire	0.06 (2)	0.08 (1)	0.04 (1)
Public safety	0.03 (1)	0.00 (0)	0.04 (1)
Killed by other puma	0.03 (1)	0.00 (0)	0.04 (1)
Capture related	0.03 (1)	0.00 (0)	0.04 (1)
Unknown	0.14 (5)	0.15 (2)	0.13 (3)
Total	36	13	23

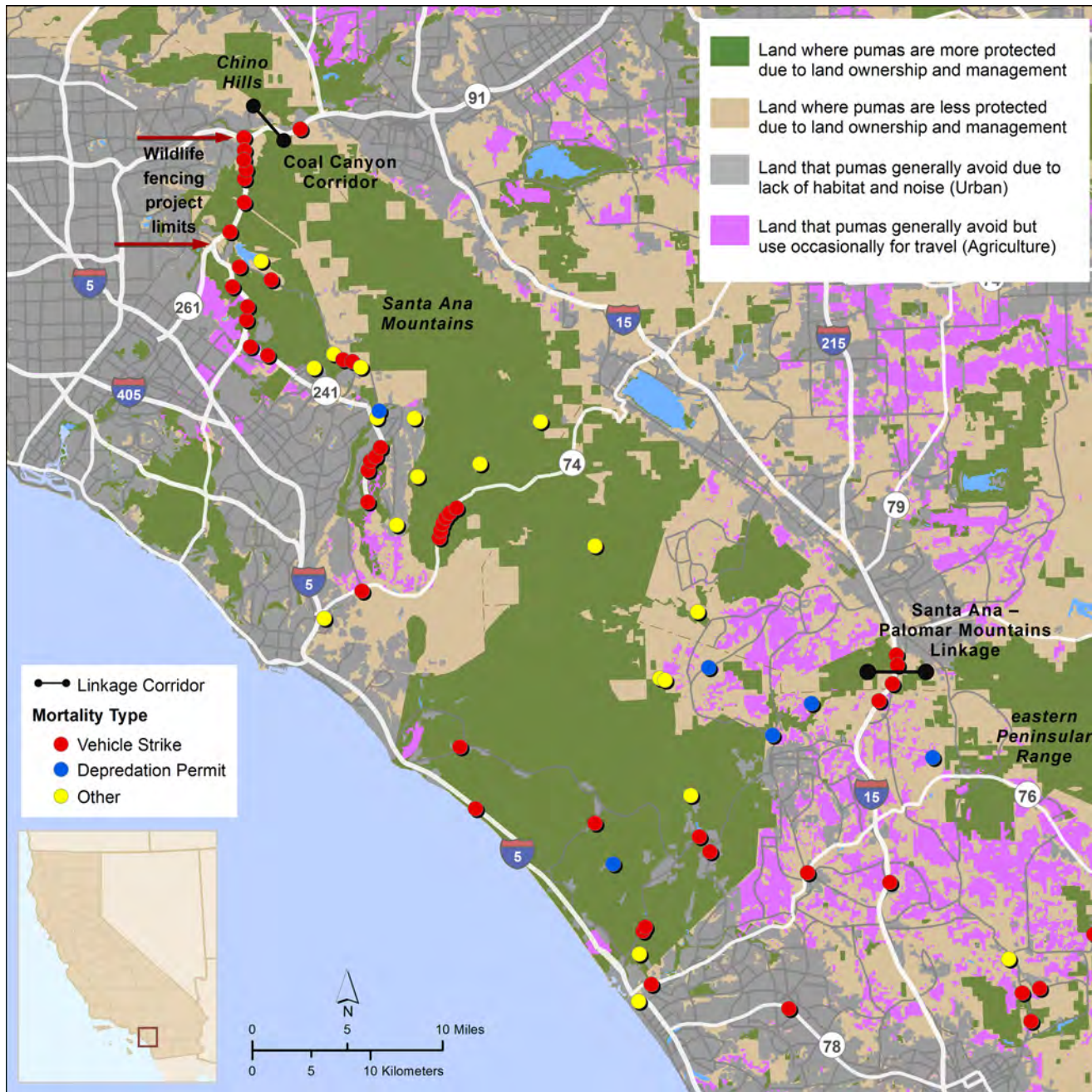
<sup>a</sup> Mortalities secondary to depredation permits and vehicle strikes differed between the two populations ( $P = 0.034$ ; Fisher’s exact test).

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In the combined dataset (marked and unmarked pumas;  $n = 254$ ), proportional mortality due to depredation permits was approximately 3.4 times higher for males than females (54M:16F;  $P = 0.001$ ), while proportional mortality due to vehicle collisions was equal for both sexes (45M:45F). In the combined dataset, proportional mortality varied between the eastern Peninsular Range and Santa Ana Mountains populations ( $P < 0.001$ ). There were more mortalities due to depredation permits in the eastern Peninsular Range ( $n = 62$ , compared to  $n = 11$  in the Santa Ana Mountains), and almost equal numbers of mortalities due to vehicle collisions in the two populations ( $n = 46$  in the eastern Peninsular Range, compared to  $n = 50$  in the Santa Ana Mountains; Fig 5). Mortality varied substantially year by year in the combined dataset, but the trend for mortalities due to depredation permits tended to increase from 1981 to 2004 and then began to decline, before trending upward again through 2013 (Fig 6), a pattern generally similar to that seen in CDFW’s graph of statewide depredation data (<http://www.dfg.ca.gov/wildlife/lion/depredation.html>). In contrast, the trend for deaths due to vehicle collisions increased steadily through 2013, with no decline or downward trend detected after 2004 (Fig 6). Vehicle mortalities occurred throughout the study area (Figs 3 and 4), however the majority of vehicle-related mortalities in the Santa Ana Mountains occurred on California State Highway 241 (SR-241) and SR-74, two highways that traverse puma habitat, and I-15 in the Santa Ana Mountains to Palomar Mountains Linkage area (Fig 3).

### Puma Survival

Survival estimates were calculated using data from the 74 radio collared pumas that were monitored from 2001–2013 for a total of 29,578 puma days (mean = 400, SE = 38 days per animal). Using the known-fate model within Program MARK, the estimated mean annual survival rate was 55.8%, (95% CI = 44.5–65.6%). In the most parsimonious model survival was constant across populations, sexes, and ages (“S(.)”; Table 3). Two models had  $\Delta AIC$  values  $< 2$ : model “S(Sex)” which included sex as a parameter (model likelihood = 0.43), and model “S(Population)” which included population as a parameter (model likelihood = 0.37; Table 3). These models yielded annual survival estimates of 58.6% for females and 52.5% for males across the entire study area, and 56.5% for the Santa Ana Mountains population and 55.4% for the eastern Peninsular Range population across all sexes and age groups (Table 3). Due to the distribution of AICc weights among the top models (Table 3), we performed model averaging of similarly



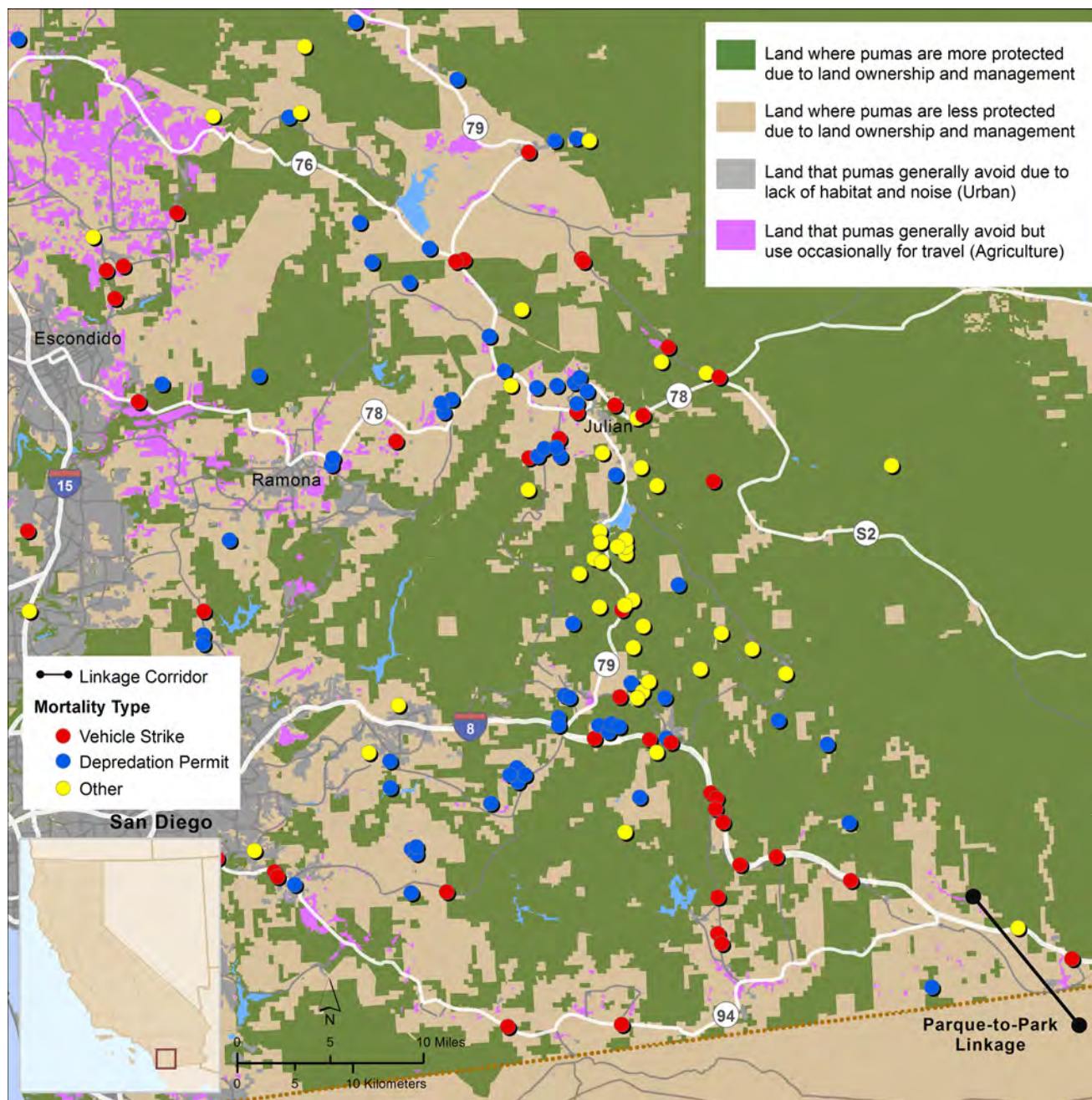
**Fig 3. Sites and causes of puma mortalities in the Santa Ana Mountains, 1981–2013.** The Coal Canyon Corridor and Santa Ana—Palomar Mountains Linkage are noted, as well as the limits of a wildlife fencing project on SR 241. Inset shows location within California.

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parameterized models but did not detect any differences among groups (95% CI of survival estimates overlapped).

Survival rates varied widely among years, and the Cox proportional hazards model identified calendar years 2001, 2003, 2005, 2006, and 2009 as having significantly higher hazard ratios compared to years 2007 and 2008 (Table 4). All other covariates, including source population, sex, and age at entry were not significantly associated with time to death. Evaluation of the proportional hazards assumption for the final model based on a test of Schoenfeld residuals





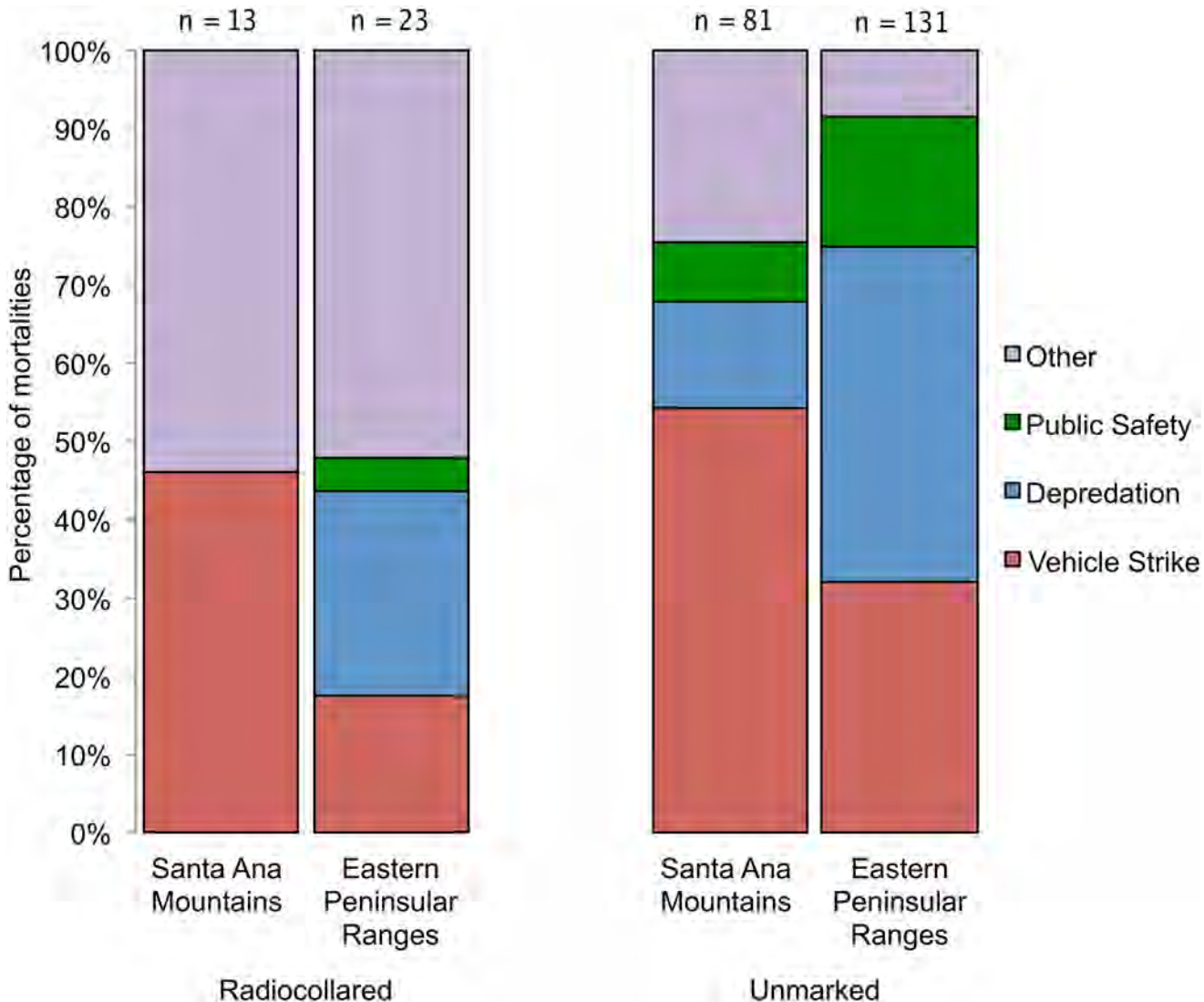
**Fig 4. Sites and causes of puma mortalities in the eastern Peninsular Range, 1981–2013.** Area depicted is generally east of Interstate 15, with the Parque to Park linkage noted. Inset shows location within California.

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indicated that the relative risk for each variable of interest, after including year as a variable in the model, did not differ for the duration of the study ( $P = 0.99$ ).

### Discussion

This 13-year study demonstrates the high risk of mortality for pumas associated with fragmentation and urbanization, and coupled with our genetic analyses [12], we conclude that puma

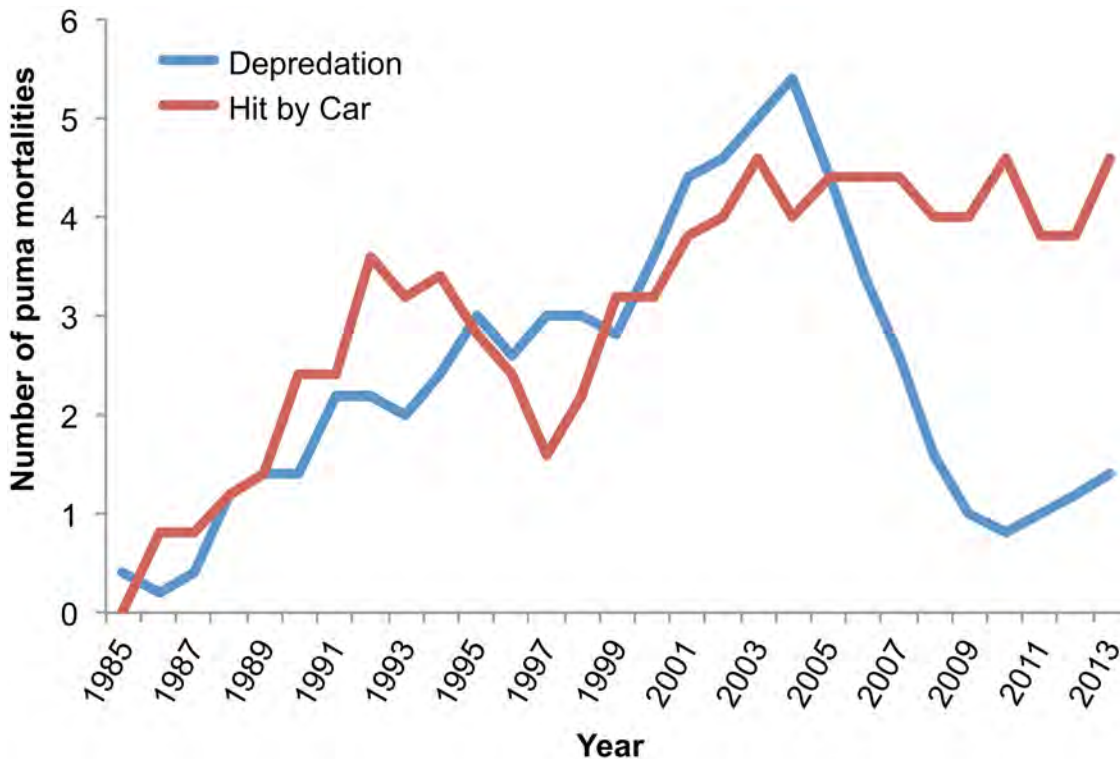


**Fig 5. Percentages of pumas dying from different causes of mortality in southern California, USA.** Mortalities of radiocollared (n = 36; 2001–2013) and unmarked (n = 212; 1981–2013) pumas were assigned to the Santa Ana Mountains or the eastern Peninsular Ranges subpopulation. Six unmarked pumas were not included in this figure because they were found on the I-15 freeway and could not be assigned to a population.

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persistence in this human-dominated landscape is threatened [42–46]. Annual puma survival rates for radio collared pumas in the Santa Ana Mountains (56.5%) and eastern Peninsular Range (55.4%) were very low from 2001–2013, and were similar to those in heavily hunted populations [2, 9, 43]. Indeed, annual survival rates for our study population were lower than rates for pumas in the peri-urban Santa Monica Mountains population northwest of Los Angeles (>75%) [12], and are within the range that is considered a threat to persistence of puma populations [13].

Our movement data (this paper) and our genetic findings [11] support the hypothesis that pumas in the Santa Ana Mountains and eastern Peninsular Range effectively form two subpopulations, bisected by an interstate highway and neighboring development. Our data demonstrate that both subpopulations had low survival; and though proportional mortality is a crude measure of causes of death in a population, the major causes of puma proportional mortality



**Fig 6. Pumas killed secondary to vehicle collisions or depredation permits from 1981–2013 in southern California, USA.** Five year moving average of pumas killed secondary to vehicle collisions or depredation permits (n = 174) in the Santa Ana Mountains and eastern Peninsular Ranges.

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differed between these areas. Depredation permits were the most common proportional mortality factor in the eastern Peninsular Range and primarily affected males, whereas vehicle strikes were the main source of proportional mortality in the Santa Ana Mountains, affecting males and females equally. Conservation biologists have long expressed concern about demographic and genetic isolation of pumas in the Santa Ana Mountains [11, 13], and this study, coupled with our companion genetic study [11], provides a comprehensive view of the fractured demographic and genetic connectivity among pumas in this region.

Ernest et al. [11] concluded that Santa Ana Mountains pumas monitored in this study “had high average pairwise relatedness, high individual internal relatedness, a low estimated effective population size, and strong evidence of a bottleneck and isolation from other populations in California.” Genetic restriction and isolation were pronounced even though limited gene flow

**Table 3. Results of the known-fate model (Program MARK) for survival (S) for radio collared pumas in southern California, USA.**

Model	AICc	ΔAICc	AICc Weights	Model Likelihood	Number Parameters	Deviance
S(.)	397.21	0.00	0.4668	1.00	1	327.25
S(Sex)	398.89	1.68	0.2012	0.43	2	326.93
S(Population)	399.20	1.99	0.1724	0.37	2	327.24
S(Age)	400.24	3.03	0.1026	0.22	3	326.27
S(Population*Sex)	402.69	5.48	0.0301	0.06	4	326.72
S(Population*Age)	403.68	6.48	0.0183	0.04	6	323.70
S(Sex*Age)	405.22	8.01	0.0085	0.02	6	325.24
S(Population*Sex*Age)	414.57	17.37	0.0001	0.00	12	322.52

doi:10.1371/journal.pone.0131490.t003



**Table 4. Variables related to time to death in the Cox proportional hazards model of survival of radio collared pumas in southern California, USA.**

Covariate <sup>a</sup>	Hazard Ratio	SE	Z	P> z	95% CI
<b>Age at Entry<sup>b</sup></b>					
<18 months	0.53	0.28	-1.21	0.23	0.19–1.48
18–30 months	1.56	0.75	0.93	0.35	0.61–3.99
<b>Year at Exit<sup>c</sup></b>					
2001*	149.20	209.78	3.56	0.00	9.48–2347.27
2002	5.16	6.85	1.24	0.22	0.38–69.63
2003*	9.86	8.34	2.71	0.01	1.88–51.73
2004	5.41	6.98	1.31	0.19	0.43–67.91
2005*	12.75	11.51	2.82	0.01	2.18–74.76
2006*	7.10	6.82	2.04	0.04	1.08–46.64
2009*	8.02	7.79	2.14	0.03	1.20–53.77
2010	1.70	1.71	0.53	0.60	0.24–12.16
2011	3.03	4.03	0.84	0.40	0.23–40.89
2012	6.16	6.14	1.82	0.07	0.87–43.44
2013	3.55	3.48	1.29	0.20	0.52–24.23

\*Covariates significant at  $P \leq 0.05$ .

<sup>a</sup>The final model controlled for population and sex which were not significantly associated with time to mortality

<sup>b</sup>Oldest age class (>30 months old) designated as reference category.

<sup>c</sup>Years 2007 and 2008 designated as reference category

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did occur from the eastern Peninsular Ranges into the Santa Ana Mountains. Genetic analysis showed that a male puma (M86) captured in the Santa Ana Mountains was likely born in the eastern Peninsular Ranges, and successfully migrated into the Santa Ana Mountains during our study. This male, and two females (F61 and F89) captured in the Santa Ana Mountains, were the likely parents of four pumas born in the Santa Ana Mountains in 2010–2011 (M91, F92, M93, and M97) [11]. However, this is the only evidence of successful genetic interchange between the two populations during the study period other than an 8 month old kitten (F102) [11] killed by a car in the Santa Ana Mountains in August 2003. In 13 years, none of the pumas radio collared in the eastern Peninsular Range were observed to move west into the Santa Ana Mountains, and the single radio collared male that did move from the Santa Ana Mountains into the eastern Peninsular Range was killed for depredating domestic sheep within weeks of crossing I-15. This suggests that the estimated 17–27 adult pumas in the Santa Ana Mountains [13] have become an insular population, much like the small population of pumas located in the Santa Monica Mountains [12]. The combination of small population size, limited potential for immigration of new individuals (male and female) into the area, female mortality rates that are similar to males, and negative effects of genetic restriction [11], collectively put the Santa Ana Mountains population at risk for demographic collapse [13, 22, 47].

Southern California has been the focus of multiple regional-scale conservation planning efforts aimed at protecting a network of natural habitats, among extensive urban, suburban, and exurban development and a burgeoning population of >20,000,000 people [48]. Pumas have been a focal species for these efforts because of their ecological value, their inherent value to humans, and their utility as surrogates for other wide-ranging taxa in conservation planning [13, 22, 42, 49–52]. Despite some concerted conservation efforts (e.g. [14]), this study shows that pumas are currently subject to high levels of human-caused mortality, and that wildlife corridors that facilitate safe movement through the landscape are lacking or insufficient. These

threats will only grow worse without further action. For example, additional urban development is underway or proposed on both the east and west sides of I-15 in the Santa Ana–Palomar Mountains Linkage (Figs 2 and 3) [53, 54], and 14,000 new homes and associated highways will be constructed at the south end of SR-241 in the center of puma habitat in the Santa Ana Mountains [55].

Conserving core habitat areas and functional wildlife corridors has been the main focus of conservation efforts for pumas in southern California [15, 31, 32, 56, 57] and coordinated regional action in the form of targeted investment in habitat protection is especially urgent to maintain viability of the Santa Ana Mountains population. However, our analysis highlights that land protection alone will not be sufficient to ensure puma persistence in the region. Also important will be directed focus on improving road infrastructure to facilitate safe wildlife crossings, and reducing depredation conflicts that precipitate puma deaths. Options for enhancing movements across I-15 and other highways include protection of additional lands on both sides of the highway, improving or adding large culverts, adding exclusionary fencing [58] such as that currently being constructed on SR 241 (Fig 3) [59], and possibly constructing vegetated overpasses for wildlife use [60, 61]. Strategies to reduce mortalities stemming from depredation permits include education activities to promote wider use of predator-proof enclosures for their domestic animals during the crepuscular periods and at night [62–65]. A focus on land protection, roadway and wildlife crossing design, and landowner outreach will be critical for persistence of puma in southern California, and may well be a formula for conserving large carnivores in highly populated and fragmented landscapes generally.

The combination of long term field monitoring of radio collared animals coupled with genetic analyses was critical for understanding puma biology and providing directions for conservation efforts in southern California. The movement of puma M86 across I-15 from the eastern Peninsular Ranges may aid in the genetic rescue of the Santa Ana population, but only if his offspring survive and reproduce. To date, only one of his four known offspring are still alive in the wild—a female with two dispersal-age offspring, and evidence points towards pumas being less likely to successfully navigate this human-dominated landscape in the future. In the absence of effective measures to reduce mortality and enhance safe movement across highways, translocation of pumas, such as was done with the Florida panther [66], may ultimately be necessary to prevent further genetic decline and assure persistence of the Santa Ana Mountains population.

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## Author Contributions

Conceived and designed the experiments: TWV WMB RB SAM PRH TS HBE. Performed the experiments: TWV WMB RB HBE JNS. Analyzed the data: TWV WMB JNS CKJ BSC HBE PRH RB. Contributed reagents/materials/analysis tools: JNS CKJ HBE SAM BSC. Wrote the paper: TWV JNS CKJ SAM RB TS BSC PRH HBE WMB.

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RE: [Federal Register Volume 84, Number 232 (Tuesday, December 3, 2019)]  
[Notices]  
[Pages 66268-66269]  
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DEPARTMENT OF TRANSPORTATION  
Federal Highway Administration  
Environmental Impact Statement: San Diego and Orange Counties,  
California  
AGENCY: Federal Highway Administration, U.S. Department of  
Transportation.  
ACTION: Notice of Intent.

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SUMMARY: The Federal Highway Administration (FHWA), on behalf of the California Department of Transportation (Caltrans), is issuing this notice to advise the public that a Draft Environmental Impact Statement (Draft EIS) will be prepared for a proposed highway project in Orange County and San Diego County, California.

January 8, 2020

To Whom It May Concern

Please accept this letter as comment on the Draft Environmental Impact Statement that will be prepared in relation to the proposed highway project as presented in this publication in the Federal Register. I would request that my comments be considered during the development of the project Draft EIS.

Comments:

As a wildlife veterinarian and researcher who has conducted scientific studies for over a decade in the south Orange County region where the proposed project is planned, I have significant concerns with the negative impacts that several of the proposed alternatives may have on mountain lion (*Puma concolor*) and other wildlife movement and connectivity. My special expertise and knowledge relates to mountain lions in that area, but their movement patterns can illuminate the patterns of numerous other wild species as well.

It is well established by multiple peer reviewed studies and published reports to government agencies (1-4) that mountain lions in the Santa Ana Mountain Range are seriously genetically restricted and have unusually low annual survival rates, with the number one source of mortality being collisions with cars (5). This has resulted in a population under serious threat of extirpation within less than two decades if inbreeding depression begins to reduce reproductive success in the population (3). As a result of the aforementioned studies, the Santa Anas mountain lion population has been petitioned for listing under the California Endangered Species Act, and its status is currently being studied intensively by our research group at the University of California–Davis, as well as by the California Department of Fish and Wildlife. Connectivity across highways has emerged as the most important factor in restriction of



connectivity, and extensive study has been done and is ongoing by our group and collaborators that is related to this issue across the region (4, 6-7, Vickers unpublished data).

The majority of the mountain lion deaths from vehicle collisions in the last two decades have been on the SR 241 Toll Road, but SR 74 and other regional highways that are less busy have also been sites of mountain lion mortalities. The toll road agency has built additional fencing on SR 241 in one 6 mile section to reduce the rate of vehicle collisions, and that has been quite successful in that goal, but other sections of both SR 241, as well as sections of SR 74, remain a danger to mountain lions and other wildlife.

In the area of the proposed project, movement of mountain lions between habitat patches is already compromised in both the north-south and east-west directions by existing housing and roads, with more approved and under construction in Rancho Mission Viejo. Connections between Chiquita Canyon and Bell Canyon habitat areas north of SR 74, and habitat areas to the south of SR 74 are already affected negatively by increasing traffic on SR 74 itself and expanding development in Ranch Mission Viejo, including Los Patrones Parkway. Though passageway structures for wildlife and fencing are present on Los Patrones Parkway, to my knowledge movement studies have not been done with GPS collars to determine if that roadway is having any barrier effect on east-west movement.

Mountain lions must move north and south in the region of the proposed project in order to utilize habitat specifically set aside for conservation. Increasing restriction of access to those habitats is anathema to the effort and expense of conserving those habitat areas originally and maintaining their function for wildlife. Thus any project that is built in that region should be extremely sensitive to negative impacts on mountain lions and other wildlife. Our studies of the impacts of SR's 241, 74, 78, 79, 76, and 67, and large freeways such as SR 91 and I-15, all confirm that essentially any significant highway can be both a barrier and a mortality source. Preliminary results from studies underway by our research team and other UC Davis and University of Southern California researchers, as well as those by other researchers, suggest that the light, noise, and other aspects of highways can have negative impacts on wildlife numbers and diversity near the highways. Thus highways can exert negative effects at some level even when adequate wildlife passageways and fencing are well designed. This should be kept in mind when considering the different alternatives in the Environmental Impact Statement.

As such, all of the Alternatives should be closely evaluated to ascertain that they would not further fragment the mountain lion population in the Santa Ana Mountains and put it at further risk via increased road mortality, or worsen its genetic connectivity.

The Alternatives listed in the Federal Register notice are:

**Alternative 1/No Build Alternative; taking no action.**

**Alternative 13; connect SR 241 to I-5 via a connection from Los Patrones Parkway to La Novia Avenue, I-5 widening and improvements, and the addition of HOT lanes in each direction on I-5**

**Alternative 17; connect SR 241 to I-5 via a connection from Los Patrones Parkway to Avenida Vaquero, I-5 widening and improvements,**

and the addition of HOT lanes in each direction on I-5  
Alternative 14; connect SR 241 to I-5 via a connection from  
Los Patrones Parkway to Avenida Pico, I-5 widening and improvements,  
and the addition of HOT lanes in each direction on I-5  
Alternative 11; add I-5 general purpose lanes from I-405 to  
San Diego County  
Alternative 12; add I-5 HOT/toll lanes from I-405 to San Diego  
County  
Alternative 9; connect Ortega Highway and Antonio Parkway to  
Avery Parkway and SR 73  
Alternative 18; connect SR-241 to SR-73 and extend Crown  
Valley Parkway to SR 241  
Alternative 21; extend Los Patrones Parkway to Avenida La Pata  
and add HOT lanes in each direction on I-5  
Alternative 22; extend Los Patrones Parkway to Avenida La Pata  
Alternative 23; extend I-5 managed lanes from SR 73 to  
Basilone Road or from Avenida Pico to Basilone Road (depending on the  
design option)

In my view, several of the alternatives would have minimal negative impact on the Santa Ana Mountains mountain lion population. These include Alternatives 1, 11, 12, and 23c and 23d.

In my view, Alternatives 9, 13, 14, 17, 18, 21, and 22 all would potentially disrupt some mountain lion movement through this already fragmented landscape, and further disrupt local gene flow in this imperiled species unless structural plans are such that permeability is assured. All of these alternatives place the highway footprint in lands that currently host many wildlife species including mountain lions and others. Some of the named alternatives would potentially have a negative effect on subsequent major north-south or east-west movement. Alternative 18 for instance would cut a major habitat block (Chiquita Canyon) into 3 pieces, and Alternatives 14, 17, 21, and 22 would all erect another barrier to north-south movement.

In my view, Alternative 21's hot lanes could be added to I-5 without mountain lion habitat disruption, but Alternative 21's extension of Los Patrones Parkway to Avenida La Pata would likely have some detrimental impact on the local mountain lion population.

In my view, of the Alternatives that involve construction of new wide highway segments south of SR 74, Alternative 13 would appear to be least disruptive of large wildlife habitat patches, but like the other Alternatives south of SR 74, some barrier effect on north-south movement of mountain lions may occur unless extraordinary design elements are included that maximize safe travel potential and eliminate mortality potential, but that also eliminate other negative impacts of sound, light, etc from vehicles and infrastructure along the highway. These can include freeway light shielding and design, berms and walls to reflect sound and light away from the habitat, and other measures.

I feel that it is critical that any Alternative that is accepted by the various agencies involved, and the public, keep the interests of wildlife on an even par with transportation improvement in the list of goals of any project.

Thank you,

T. Winston Vickers, DVM, MPVM  
Associate Research Veterinarian  
Karen C. Drayer Wildlife Health Center, School of Veterinary Medicine  
University of California, Davis  
949-929-8643  
[twickers@ucdavis.edu](mailto:twickers@ucdavis.edu), [twinstonvickers@gmail.com](mailto:twinstonvickers@gmail.com)

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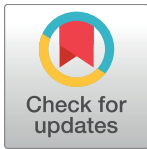
RESEARCH ARTICLE

# Residential development alters behavior, movement, and energetics in an apex predator, the puma

Yiwei Wang<sup>1,2</sup>, Justine A. Smith<sup>2,3\*</sup>, Christopher C. Wilmers<sup>2</sup>

**1** San Francisco Bay Bird Observatory, 524 Valley Way, Milpitas, CA, United States of America, **2** Center for Integrated Spatial Research, Environmental Studies Department, University of California, Santa Cruz, CA, United States of America, **3** Department of Environmental Science, Policy, and Management, Mulford Hall, University of California, Berkeley, CA, United States of America

\* [jsmith5@berkeley.edu](mailto:jsmith5@berkeley.edu)



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## Abstract

Human development strongly influences large carnivore survival and persistence globally. Behavior changes are often the first measurable responses to human disturbances, and can have ramifications on animal populations and ecological communities. We investigated how a large carnivore responds to anthropogenic disturbances by measuring activity, movement behavior, and energetics in pumas along a housing density gradient. We used log-linear analyses to examine how habitat, time of day, and proximity to housing influenced the activity patterns of both male and female pumas in the Santa Cruz Mountains. We used spatial GPS location data in combination with Overall Dynamic Body Acceleration measurements recorded by onboard accelerometers to quantify how development density affected the average distances traveled and energy expended by pumas. Pumas responded to development differently depending on the time of day; at night, they were generally more active and moved further when they were in developed areas, but these relationships were not consistent during the day. Higher nighttime activity in developed areas increased daily caloric expenditure by 10.1% for females and 11.6% for males, resulting in increases of 3.4 and 4.0 deer prey required annually by females and males respectively. Our results support that pumas have higher energetic costs and resource requirements in human-dominated habitats due to human-induced behavioral change. Increased energetic costs for pumas are likely to have ramifications on prey species and exacerbate human-wildlife conflict, especially as exurban growth continues. Future conservation work should consider the consequences of behavioral shifts on animal energetics, individual fitness, and population viability.

## Introduction

Habitat conversion is a primary driver of species extinctions and increases exposure of wildlife to anthropogenic disturbances [1]. These disturbances influence many integral animal behaviors (e.g., foraging, mating, and movement) [2] and transform species interactions [3±4].

Christopher C Wilmers. 6. University of California, Santa Cruz, [www.ucsc.edu](http://www.ucsc.edu), Dr. Yiwei Wang. 7. Midpeninsula Regional Open Space District, [www.openspace.org](http://www.openspace.org), Dr. Christopher C Wilmers. No funders played a role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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Conversion to low-density development at the wildland-urban interface is the fastest growing type of land use change in the continental United States [5] and is expected to continue expanding in the coming decades [6]. Although many species, including mammalian apex predators, continue to live at the wildland-urban interface [7], these regions may prove to be population sinks due to the increased risk of human-caused mortality or from the costs of adopting behavioral adaptations in response to human disturbances [8].

Behavioral changes by animals often provide the first measurable indication that individuals are responding to anthropogenic disturbance [9±11]. These behavioral responses can alter energetic budgets with important effects on individual fitness that may lead to population and community level changes. Movement behavior in particular carries rich information about where, when, and how an animal interacts with its surroundings, providing insight into the relationship between internal state and environmental factors [12]. Technological advances with GPS and accelerometer tracking devices now allow scientists to link animal movement behavior to caloric expenditure, which greatly increases our understanding of how animal energetics are impacted by human development at the landscape level. With the integration of accelerometers and traditional biologgers, we can monitor how natural and anthropogenic landscape structures change behavioral patterns and energy allocation in wild animals [13], with far ranging conservation implications for species living at the wildland-urban interface.

Large carnivores are frequently the first species to be lost from ecosystems as humans transform and develop landscapes [14]. Despite this, comparatively little is known about the behavioral and energetic responses of predators to development that could eventually lead to their local extirpation [15]. Large carnivores often respond to human disturbance and persecution through behavioral modifications much like prey species respond to predators [10]. Pumas (*Puma concolor*) have demonstrated behavioral responses to human developments by avoiding roads, moving quickly through developed areas, and changing temporal feeding patterns [8,16]. As human development continues to fragment previously intact landscapes, it becomes increasingly vital to understand how large carnivores adjust their behavior and energetic responses to anthropogenic perturbations. Only by better understanding these relationships can we implement protective policies that reduce human-wildlife conflict and promote their continued co-existence with humans [17].

Here we examined how human development alters daily behavior and energetics of pumas in the Santa Cruz Mountains of central California. We investigated the extent to which proximity to houses affected puma movements and daily activity budgets. These behavioral differences translate into differential energetic costs that progressively accumulate over time, which may have lasting repercussions on individual fitness [18]. We also investigated whether habitat type and time of day influenced how pumas responded to human development. In order to link behavior change to energetic impacts, we evaluated how human development affected the daily movement patterns and caloric expenditures of pumas using GPS tracks, which we calibrated using accelerometer data from a much finer temporal scale. Lastly, we explored the extent to which puma prey demands are altered in human-modified habitats and discuss potential consequences for recruitment of future generations.

## Methods

### Study species and area

Pumas are territorial, apex predators which live throughout diverse habitats in the Americas [19]. Individuals are primarily nocturnal and solitary, although females will typically raise and accompany cubs for up to 15±21 months after birth. In our study area in the Santa Cruz Mountains of California, pumas predominantly feed on black-tailed deer (*Odocoileus*



*hemionus columbianus*, 90% by biomass), but occasionally on other species, including wild boars (*Sus scrofa*), raccoons (*Procyon lotor*) and house cats (*Felis catus*) [20].

Our 1,700 km<sup>2</sup> study area encompasses a diverse landscape ranging from dense, urban development to large tracts of intact and relatively undisturbed native vegetation. Puma home ranges contain both protected and developed lands, with an average home range housing density of  $21.7 \pm 3.0$  SE houses/km<sup>2</sup> (range  $4.6 \pm 51.5$ ) [8]. Even pumas that regularly move through or near residential areas also use nearby protected areas, allowing for comparison of movement behavior across a disturbance gradient within individual pumas. The vegetation is primarily forested (e.g., woodlands, hardwood and conifer forests) and shrubland (e.g., scrub and chaparral) habitats. It is bisected by a large freeway and further crisscrossed by numerous other smaller roads providing access to rural houses and developments. The climate is Mediterranean, with precipitation concentrated between November and April, and elevation ranges from sea level to 1155m.

## Data collection

We captured 22 wild pumas (11 males, 11 females) from June 2010–March 2013 using trailing hounds, cage traps, or leg hold snares. Each animal was tranquilized using Telazol at a concentration of 100mg/mL ( $3.3 \pm 6.0$  mg/kg estimated body weight) and outfitted with a GPS/VHF collar (3.7 kg; Model GPS Plus 1D, Vectronics Aerospace, Berlin, Germany). Six of the 22 animals were also equipped with a custom-built archival 3-axis accelerometer sampling continuously at 64Hz when activated [21]. The tri-axial accelerometer was mounted such that the x-axis was parallel to the anterior-posterior plane of the animal, the y-axis to the transverse plane, and the z-axis to the dorsal-ventral plane.

Accelerometers on pumas were programmed to record at a duty-cycle of 2 days on and five days off to maximize battery life. The GPS was programmed to acquire locations every 15 minutes during a 24-hour intense sampling period starting from noon one day each week. The Animal Care and Use Committee at UC Santa Cruz approved all animal-handling procedures (Protocols Wilmc0709 and Wilmc1101).

## Data processing

During each 15-minute GPS sampling interval, we assigned one behavioral state (active or inactive) to each collared individual and considered these states to be mutually exclusive. We considered any distance greater than 70m between successive 15 minute GPS fixes to be an active period, and a distance smaller than 70m to be an inactive period. We used accelerometer measurements to determine the distance cutoff between activity states as follows. We used a random forest algorithm described in Wang et al. [22] to categorize 2-second increments of accelerometer measurements into mobile or non-mobile behaviors. These were then aggregated into 15-minute observation periods to match the GPS sampling periods. After inspecting the data visually, we identified 10% activity (i.e., 10% of accelerometer measurements categorized as mobile out of 15 minutes) as the cutoff between active and inactive periods. Because of the strong linear relationship ( $r = 0.89$ ) between accelerometer defined activity and the distance traveled between GPS fixes, 10% activity recorded by accelerometers corresponded to 70 meters between GPS fixes.

## Environmental and anthropogenic measurements

Our study animals inhabit a landscape primarily comprised of forested or shrubland habitats interspersed with developed areas. To examine how human development and habitat type affected puma behavior, we collected spatial information on buildings and habitat types

surrounding each puma GPS location. Using the Geographic Information Systems program ArcGIS (v.10, ESRI, 2010), we digitized house and building locations manually from high-resolution ESRI World Imagery basemaps for rural areas and with a street address layer provided by the local counties for urban areas. For each puma GPS position recorded, we calculated the distance in meters to the nearest house. We placed circular buffers with 150m radii around each GPS location and used the California GAP analysis data [23] to categorize the local habitat as either predominantly forested or shrubland. We chose a buffer size of 150m based on a previous analysis of puma movement responses to development [24]. We also classified the time each GPS location was recorded as diurnal or nocturnal based on sunset and sunrise times.

## Markov chains

We modeled puma behavior sequences as discrete-time Markov chains, which are used to describe activity states that depend on previous ones [25]. Here, we used first-order Markov chains to model a dependent relationship between the succeeding behavior and the preceding behavior. First-order Markov chains have been successfully used to describe animal behavioral states in a variety of systems, including sex differences in beaver behavior [26], behavioral responses to predators by dugongs [27], and impacts of tourism on cetacean behavior [28+29]. Because we were modeling behavior transitions with respect to spatial characteristics, we recorded the states of the puma (active or inactive) in the 15 minutes prior to and succeeding each GPS acquisition. We populated a transition matrix using these preceding and succeeding behaviors and examined whether proximity to houses influenced the transition frequencies between preceding and succeeding behavior states. Transition matrices are the probabilities that pumas remain in a behavioral state (active or inactive) or transition from one behavior state to another.

We built multi-way contingency tables to evaluate how sex ( $S$ ), time of day ( $T$ ), proximity to house ( $H$ ), and habitat type ( $L$ ) affected the transition frequency between preceding ( $B$ ) and succeeding behaviors ( $A$ ). Because high-dimensional contingency tables become increasingly difficult to interpret, we first used log linear analyses to evaluate whether sex and habitat type influenced puma behavior patterns using two three-way contingency tables (Before  $\times$  After  $\times$  Sex, abbreviated as BAS). Log linear analyses specifically test how the response variable is influenced by independent variables (e.g., sex and habitat) by using Likelihood Ratio Tests to compare hierarchical models with and without the independent variable [25]. We found that there were strong sex differences in activity patterns because adding  $S$  to the model greatly increased the goodness-of-fit ( $G^2$ ) compared to the null model ( $\Delta G^2 = 159.8$ , d.f. = 1,  $P < 0.0001$ ), which assumed that succeeding behaviors only depend on preceding ones. Therefore, we evaluated data from male pumas separately from those of female pumas.

We then used another three-way contingency table for each sex to evaluate whether behavior patterns differed between habitats ( $L$ ). We found that including habitat type significantly improved model fit for male ( $\Delta G^2 = 7.9$ , df = 1,  $P < 0.005$ ) but not female pumas ( $\Delta G^2 = 3.18$ , df = 1,  $P = 0.0744$ ). Thus we evaluated three sets of data: all females, males in forests, and males in shrublands. For each dataset, we created four-way contingency tables (Before  $\times$  After  $\times$  House  $\times$  Time) to evaluate how development and time of day affected behavioral transitions using the likelihood ratio methods described above.

Our null model ( $BA$ ,  $BHT$ ) is built such that succeeding behaviors ( $A$ ) are only affected by behaviors in the previous time steps ( $B$ ) and independent of proximity to houses and time of day. We tested whether including additional factors (proximity to house and time of day) improved model fit by comparing the null model with hierarchically more complex models. For example, the effects of proximity to housing on succeeding behaviors are evaluated by

comparing the goodness-of-fit ( $G^2$ ) values for the null model and the model containing an interaction between succeeding behaviors and houses (*BAH*, *BHL*). We also tested the interaction between proximity to houses and time of day by comparing the saturated model (*BAHT*), which fits the data fully, to a less complex model without the interaction term (*BAH*, *BAT*, *BHT*). Finally, we selected the best fitting model by minimizing the Akaike Information Criterion (AIC) estimate.

### Behavioral budgets

We tested whether transition matrices differed when pumas were close to houses or roads using the Z test for proportions [30]. We also estimated the amount of time pumas spent in each behavioral state by conducting an eigenanalysis on the transition matrix. Because Markov chains are ergodic matrices, we used the left eigenvector of the transition matrix to estimate the proportion of time pumas spent in each state [25]. We compared these values using a Z test of proportions and calculated 95% confidence intervals using the Wilson's score test [31].

### Puma travel and energetic costs

For each puma, we identified all 24-hour intensive sampling periods during which GPS points were recorded every 15 minutes. At a fix rate of 4 times an hour, up to 96 GPS points are recorded throughout the day, equating to a total of 95 travel segments (straight lines between consecutive points). We removed any days from analyses that were missing more than 10% (i.e., 9 points) of potential GPS fixes. We determined the linear length of all travel segments and calculated the total daily distance ( $D$ ) in km traveled by pumas by summing all travel segments and correcting for any missing GPS fixes using the formula:

$$D_{total} = D_{summed} \times 95/n \tag{1}$$

in which  $n$  represents number of actual recorded segments. Next, we calculated the minimum cost of transport ( $COT$ , W/kg) expended daily for each puma by adapting the equation developed by Taylor et al. [32]:

$$COT = \sum_i^n 10.7(wt)^{-0.316} \times v_i + 6.03(wt)^{-0.303} \tag{2}$$

in which  $wt$  is the weight (kg) of the animal when captured and  $v_i$  is the velocity of travel (m/s) between consecutive GPS points.  $COT$  has the units Watts/kg, which we converted to kcal/kg by applying the conversion factor 4.1868 Watt = 1 cal/s.

Lastly, we estimated the minimum number of black-tailed deer, the primary prey of pumas in our area, needed to sustain each puma given their daily minimum  $COT$ . We calculated the daily deer biomass ( $DB$ ) needed to fulfill each puma's prey requirements using Eq 3 [33]:

$$DB \left( \frac{kg}{day} \right) = \frac{COT (kcal)}{1890 \left( \frac{kcal}{kg} \right) \times 0.86 \times 0.88} \tag{3}$$

in which 1890 kcal represents the caloric content in each kg of wet deer tissue [34], and this value is then modified by multiplying it by the conversion efficiency (0.86) and the proportion of deer in a puma's diet there estimated as 88% [20]. Finally, we used Eq 4 to convert the daily deer biomass into an estimate of the yearly deer requirements [33]:

$$\frac{Deer}{year} = \frac{DB \left( \frac{kg}{day} \right) \times 365 \text{ days}}{36.5 \text{ kg} \times 0.79} \tag{4}$$

in which 36.5 kg is the average weight of a black-tailed deer doe [35] and 0.79 is the edible proportion of the deer [34].

It is broadly understood that the energetic estimates generated using the equation developed by Taylor et al. [32] are the minimum estimates for *COT*. Even at 15-minute GPS sampling intervals, animals can deviate greatly from straight-line travel paths, thus expending many more kcals than estimated. In contrast, Overall Dynamic Body Acceleration (ODBA) measurements recorded by accelerometer collars, which sums the dynamic acceleration of the subject across three dimensions, provide a more precise measurement of energetic expenditure because it takes measurements at a rate of 64Hz [36]. Not all pumas were outfitted with accelerometer collars and we were unable to use ODBA alone to estimate energetic budgets. Instead we recorded ODBA values from two wild pumas whose accelerometers were active concurrent to the GPS intensive sampling periods. Using those values, we calculated the correlation between *COT* estimates from ODBA measurements and those estimated using velocities generated from intensive GPS sampling by Eq 2. This resulted in a correction factor that we applied to the energetic estimates of each puma in the study.

## Development influences on puma movement

To quantify puma exposure to human development, we used ArcGIS (v. 10.1, ESRI, 2012) to create buffers of 150m around all GPS points within each 24-hour intensive GPS sampling period. We then calculated the number of houses encompassed within each buffer polygon and also recorded the time of day. For each day, we recorded the average housing density individual pumas were exposed to and the average distance pumas traveled between successive GPS locations during both nocturnal and diel periods. We hypothesized that pumas would use more calories by moving faster and further through areas with more houses in order to minimize their exposure to development [24,37]. However we also predicted that this relationship might be affected by time of day because pumas may prefer to stay hidden if they are in more developed areas during the day.

We used linear mixed effects models using restricted maximum likelihood estimation with the average diurnal and nocturnal calories burned between successive GPS points as the dependent variable. To select the best model, we used a top-down model selection approach to compare models with no random terms, with random intercepts, and with both random intercepts and slopes [38]. We started by fitting a linear model that included the full complement of fixed effects terms: sex of the puma (male coded as 1 and female as 0), time of day (day coded as 1 and night as 0), the average number of houses (log-transformed to account for all distributions being bound at zero), the interactions between sex and time of day, and the interaction between time of day and housing. In a second model, puma identity was included as a factor in the model to allow for random intercepts. For the third model, we also tested whether individual pumas responded to time of day, the log average number of houses, and their interaction differently by including random slopes for those terms. We used AIC to compare the three models to determine the optimal model structure. We examined the residuals for our final model visually to identify any obvious deviations from normality.

To quantify the difference in puma energetic expenditure between areas with low and high housing density, we calculated the average caloric expenditure by individual pumas in the top and bottom housing density quartiles of their home range for both days and nights. To maximize statistical power, only pumas with a minimum of 20 day and 20 night measurements were included in this analysis. We added day and night averages to get total daily difference in caloric expenditure. We calculated the percentage increase in calories used as the total daily difference between caloric expenditure for high and low housing density divided by the

average daily caloric expenditure for the individual puma. In order to conceptualize variation of human disturbances for individual pumas, we classified average housing density in the top and bottom quartiles into the following categories described by Theobald [5]: rural (greater than 0.0 and up to 0.062 houses per hectare), exurban (greater than 0.062 and up to 1.236 houses per hectare), suburban (greater than 1.236 and up to 9.884 houses/hectare), or no housing. We used the package *nlme* [39] in R (v. 3.0.2, R Core Team, 2013) for all analyses.

## Results

### Log linear analyses

We recorded 78,242 GPS locations for 22 pumas, comprised of 6,967 behavioral transitions (e.g. active to inactive) for males in shrubland habitats, 11,379 transitions for males in forested habitats, and 21,977 transitions for females in all habitats. Log linear analyses revealed that both proximity to houses and time of day influenced puma activity levels, but this effect differed by sex, and by habitat type for males. Proximity to houses and time of day had a significant positive effect on the number of behavior transitions of male pumas in forests (Table 1). However, for males in forests, support for the interaction term (proximity to houses × time of day) was ambiguous because the two models had a ΔAIC of less than 0.2, indicating that they were statistically indistinguishable [40]. AIC comparison revealed that the best models for all female pumas and males in shrublands included the proximity to houses, time of day, and an interaction between the two (Table 1). This indicates that the time of day determined how pumas altered their movement patterns near development, which we discuss next.

**Table 1. Results of log-linear analysis for all puma behavioral transition models.**

Study Group	Model <sup>ab</sup>	ΔAIC <sup>c</sup>	Components added <sup>a</sup>	ΔG <sup>2</sup> , df, P-value
Males, Forests	Null (BA, BHT)	72.0		84, 6, $\emptyset$
	Previous Location × House (BAH, BHT)	63.8	BAH	71.8, 4, 0.002
	Previous location × Time (BAT, BHT)	2.2	BAT	10.2, 4, <0.001
	Previous location × Time + Previous location × House (BAT, BAH, BHT)	0.01	BAT	4.01, 2, 0.001
			BAH	4.01, 2, 0.045
Time × House (BAHT)	0.00	TH	0, 0, 0.135	
Males, Shrubland	Null (BA, BHT)	53.4		65.4, 6, $\emptyset$
	Previous Location × House (BAH, BHT)	54.0	BAH	62, 4, 0.002
	Previous location × Time (BAT, BHT)	8.4	BAT	16.4, 4, <0.001
	Previous location × Time + Previous location × House (BAT, BAH, BHT)	11.5	BAT	15.5, 2, <0.001
			BAH	15.5, 2, 0.64
Time × House (BAHT)	0.00	TH	0, 0, <0.001	
Females, All habitat	Null (BA, BHT)	90.8		102.8, 6, $\emptyset$
	Previous Location × House (BAH, BHT)	66.6	BAH	76.4, 4, <0.001
	Previous Location × Time (BAT, BHT)	41.3	BAT	49.3, 4, <0.001
	Previous Location × Time + Previous location × House (BAT, BAH, BHT)	24.5	BAT	28.5, 2, <0.001
			BAH	28.5, 2, <0.001
Time × House (BAHT)	0.00	TH	0, 0, <0.001	

<sup>a</sup> A: Succeeding behavior; B: Previous behavior; T: Time; and H: Number of Houses.

<sup>b</sup> In null models, effects of time and number of houses were assumed to be independent of behavioral transitions. Succeeding behaviors (A) are only dependent upon preceding behaviors (B), and not on time of day (T) or proximity to housing (H). Subsequent models which incorporate the housing and time covariates and their interactions are listed below the null.

<sup>c</sup> ΔAIC values are in comparison to the top model for each study group.

<https://doi.org/10.1371/journal.pone.0184687.t001>



## Behavioral budgets

All puma behavioral transitions showed contrasting responses to housing depending on the time of day (Fig 1). At night, all pumas regardless of sex or habitat were less likely to remain inactive, more likely to remain active, and more likely to transition between behavioral states near houses. In contrast, male and female pumas were more likely to stay inactive near houses during the daytime. However, male pumas in forests were also less likely to remain active near houses in the forest during the day whereas male pumas in shrublands were unaffected.

Both male and female pumas were generally more active at night than during the day. Male pumas near houses at night were active 26.9% and 21.1% of the time in forested and shrubland habitats, respectively, compared with 17.2% and 13.2% when they weren't close to human structures (Fig 2). Females were active 13.3% of the time when near houses at night, compared with only 7.5% when further away (Fig 2). In the daytime, puma activity was generally low, with females and males in forests exhibiting no difference in activity level in relation to proximity to houses (Fig 2). However, males in shrubland habitats were less likely to be active near houses (2.8%) than when far from houses (8%) during the day.

## Energetic costs

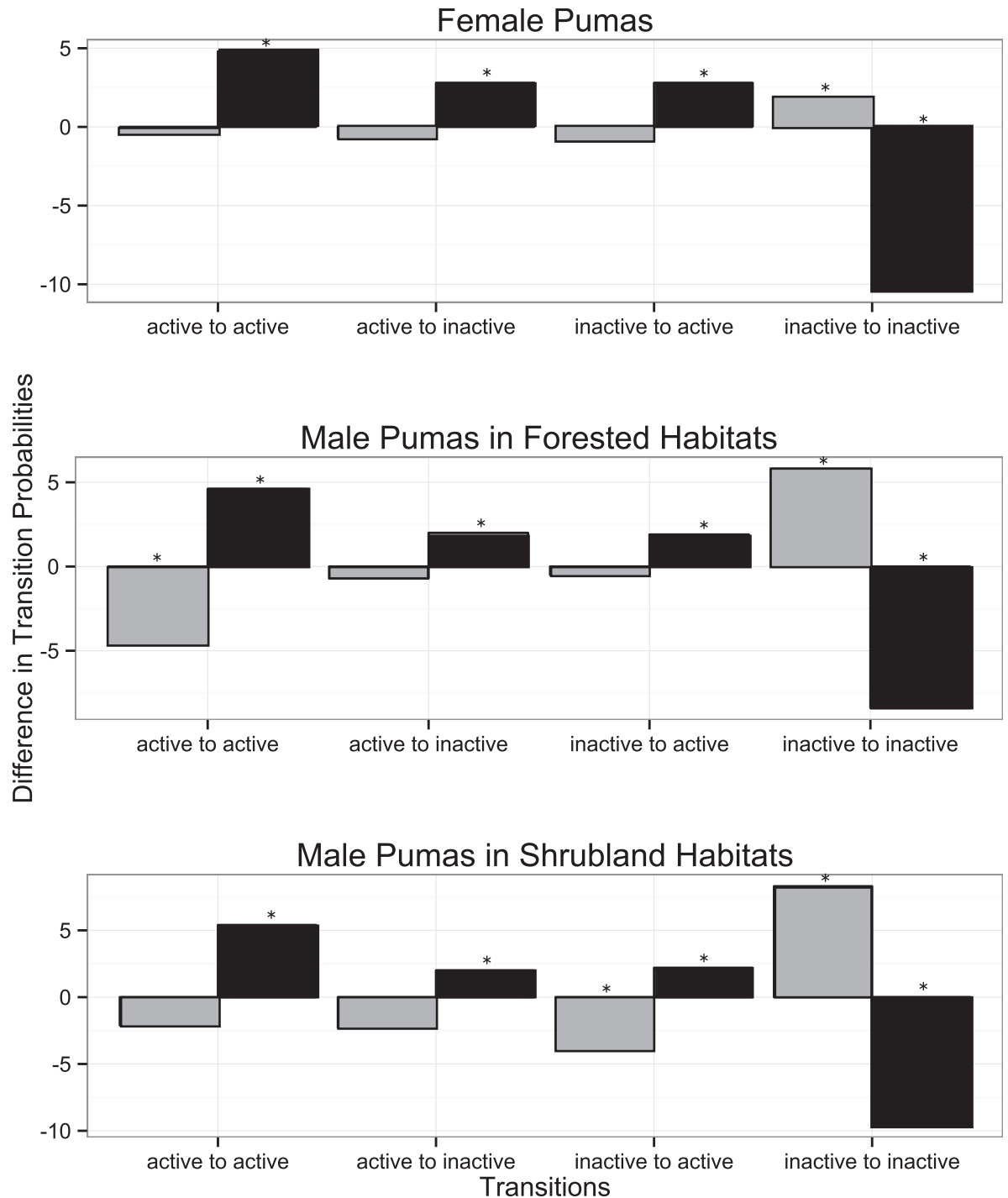
Our COT estimates based on ODBA measurements from accelerometers for pumas 16M and 28F showed that our energetic expenditure estimates from GPS movement data greatly underestimated caloric intake. Applying the COT formula from Taylor et al. [32] to the intensive GPS sampling period, we estimated that 16M expended 2,492 and 2,296 kcals over two days and that 28F expended 1,793 kcals. In contrast, our COT estimates from ODBA for the same three days were about  $2 \pm 2.5$  times higher at 6,079 and 5,492 kcals, and 3,608 kcal, respectively. We used the results from a linear regression between the COT values calculated using 15 min GPS and ODBA measurements (intercept = 8.21, slope = 1.88;  $r = 0.75$ ) to apply corrections factor to all puma energetic calculations.

We used 19 pumas (10 males and 9 females) to evaluate movement activities and energetics over 369 24-hour intense sampling periods (216 for females and 153 for males) (Table 2). Male pumas, averaging  $53.3 \text{ kg} \pm 7.82 \text{ kg}$  (SD), traveled a mean of  $7.43 \text{ km} \pm 2.2 \text{ km}$  daily and expended  $5,145 \text{ kcal} \pm 542 \text{ kcal}$  (after factoring the correction factor). Females, averaging  $39.8 \text{ kg} \pm 2.73 \text{ kg}$ , were more sedentary and traveled a mean of  $4.12 \text{ km} \pm 0.5 \text{ km}$  daily and expended  $4,760 \text{ kcal} \pm 555 \text{ kcal}$ . If a puma only subsisted on a diet of black-tailed deer, we calculated that a male puma would need to kill a minimum average of 45.5 doe equivalents/year and that a female puma would need to kill 42 doe equivalents/year.

## Development influences on puma energetics

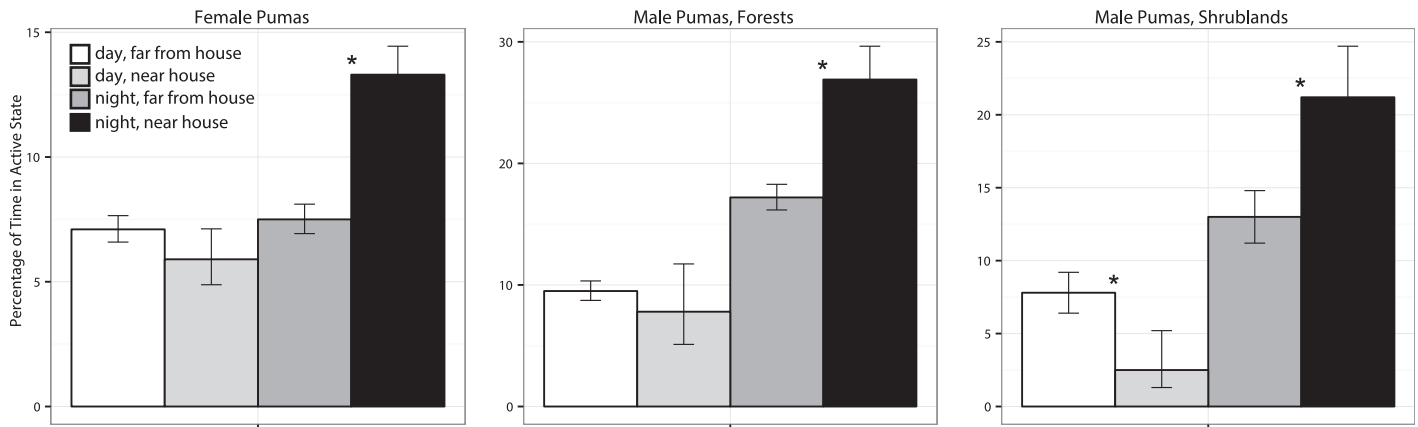
We found that the model structure that included random intercepts and slopes for Puma ID minimized AIC values and fit the data better compared to a fixed-effects model ( $\Delta\text{AIC} = 632$ ) and the model with random intercepts only ( $\Delta\text{AIC} = 23.4$ ). The final model included all original fixed effects terms for sex, time, the log-transformed number of houses, the interaction between sex and time, and the interaction between time and number of houses (Table 3). As expected, males burned more calories than females during both nocturnal and diurnal hours (Fig 3). However, the influence of increased housing density on puma energetic expenditures differed depending on time of day, with pumas burning more calories between GPS points in more developed areas during nocturnal hours but not during diurnal hours.

Average daily caloric expenditure for individual pumas was consistently higher on days when pumas were in high housing density areas than in low housing density areas, constituting a  $434.3 \pm 130.3 \text{ SE kcal}$  increase for females and a  $513.3 \pm 83.1 \text{ SE kcal}$  increase for males



**Fig 1. The effect of proximity to houses on the daytime (gray) and nighttime (black) transition probabilities between activity states for female pumas, male pumas in forested areas, and male pumas in shrubland habitats.** Difference in transition probabilities is calculated as probability of transitioning between states when pumas are  $\leq 150\text{m}$  from buildings subtracted by the probability of transitioning between states when pumas are  $> 150\text{m}$  from buildings. A positive value means pumas are more likely to engage in those transitions when close to buildings than when further away. Asterisks above columns represent significant differences between transition probabilities close and far from houses ( $P < 0.05$ ).

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**Fig 2. Proportion of time spent active for female pumas, male pumas in forests, and male pumas in shrublands  $\leq 150\text{m}$  from buildings during the day (light gray) or night (black bars) and  $>150\text{m}$  from buildings during the day (white) or night (dark grey bars).** Asterisks between paired columns represent significant differences between activity levels near houses and far from houses ( $P < 0.05$ ). Error bars represent 95% confidence intervals.

<https://doi.org/10.1371/journal.pone.0184687.g002>

(Table 4). These differences in average daily caloric expenditure were equivalent to a mean total percentage increase of  $10.1 \pm 3.1$  SE% of daily kcals used by individual females and  $11.6 \pm 1.8$  SE% of daily kcals used by males. When the increase in daily calories is converted to the extra number of deer required annually by each puma, females would need to kill an additional 3.4 deer annually to meet higher energetic requirements, and males would need to kill 4.0 more deer.

**Table 2. Mean ( $\pm$  standard error) of daily distanced traveled, daily caloric expenditure, and projected annual deer requirements of 9 female (F) and 10 male (M) pumas.**

Puma ID	Days monitored	Daily distance (m)	Daily kcal/kg	Deer/year
7F	42	3236 $\pm$ 378	97.8 $\pm$ 0.6	36.3 $\pm$ 0.2
11F	22	3935 $\pm$ 489	104.5 $\pm$ 0.8	35.2 $\pm$ 0.3
18F	8	4001 $\pm$ 939	119.3 $\pm$ 1.7	40.0 $\pm$ 0.6
19F	35	3927 $\pm$ 495	107.9 $\pm$ 0.8	39.9 $\pm$ 0.3
23F	38	4389 $\pm$ 373	133.3 $\pm$ 0.8	48.0 $\pm$ 0.3
24F	15	3966 $\pm$ 462	145.0 $\pm$ 1.0	47.7 $\pm$ 0.3
25F	14	4493 $\pm$ 941	138.2 $\pm$ 2.0	48.1 $\pm$ 0.7
28F	24	4111 $\pm$ 606	129.9 $\pm$ 1.2	41.6 $\pm$ 0.4
29F	18	5060 $\pm$ 511	124.8 $\pm$ 1.0	42.2 $\pm$ 0.3
Female total	216	4132 $\pm$ 176	118.9 $\pm$ 1.1	41.6 $\pm$ 0.3
16M	12	10760 $\pm$ 1140	96.2 $\pm$ 1.5	50.4 $\pm$ 0.8
17M	8	4297 $\pm$ 706	95.0 $\pm$ 1.0	40.2 $\pm$ 0.4
22M	29	9830 $\pm$ 1091	91.2 $\pm$ 1.4	52.0 $\pm$ 0.8
26M	28	6743 $\pm$ 810	103.0 $\pm$ 1.2	39.6 $\pm$ 0.5
27M	22	6853 $\pm$ 1000	99.5 $\pm$ 1.4	43.4 $\pm$ 0.6
31M	10	7047 $\pm$ 1298	94.8 $\pm$ 1.8	46.1 $\pm$ 0.9
34M	17	6504 $\pm$ 727	90.1 $\pm$ 1.0	47.1 $\pm$ 0.5
35M	19	4215 $\pm$ 484	97.3 $\pm$ 0.7	38.8 $\pm$ 0.3
36M	6	9192 $\pm$ 1874	96.4 $\pm$ 2.6	49.4 $\pm$ 1.3
37M	2	8877 $\pm$ 3	98.23 $\pm$ 0.1	48.4 $\pm$ 0.0
Male total	153	7334 $\pm$ 373	96.3 $\pm$ 0.6	45.0 $\pm$ 0.5

<https://doi.org/10.1371/journal.pone.0184687.t002>

**Table 3. Results of final mixed effects model to predict puma activity.**

Model Parameter	$\beta$	SE	t	P
Sex	5.50	2.84	1.94	0.069
Time	-0.66	0.78	-0.85	0.395
Number of Houses (log-transformed)	1.21	0.28	4.26	< 0.001
Sex X Time	-3.10	0.97	-3.21	0.001
Time X Number of Houses	-1.45	0.49	-2.95	0.003

<https://doi.org/10.1371/journal.pone.0184687.t003>

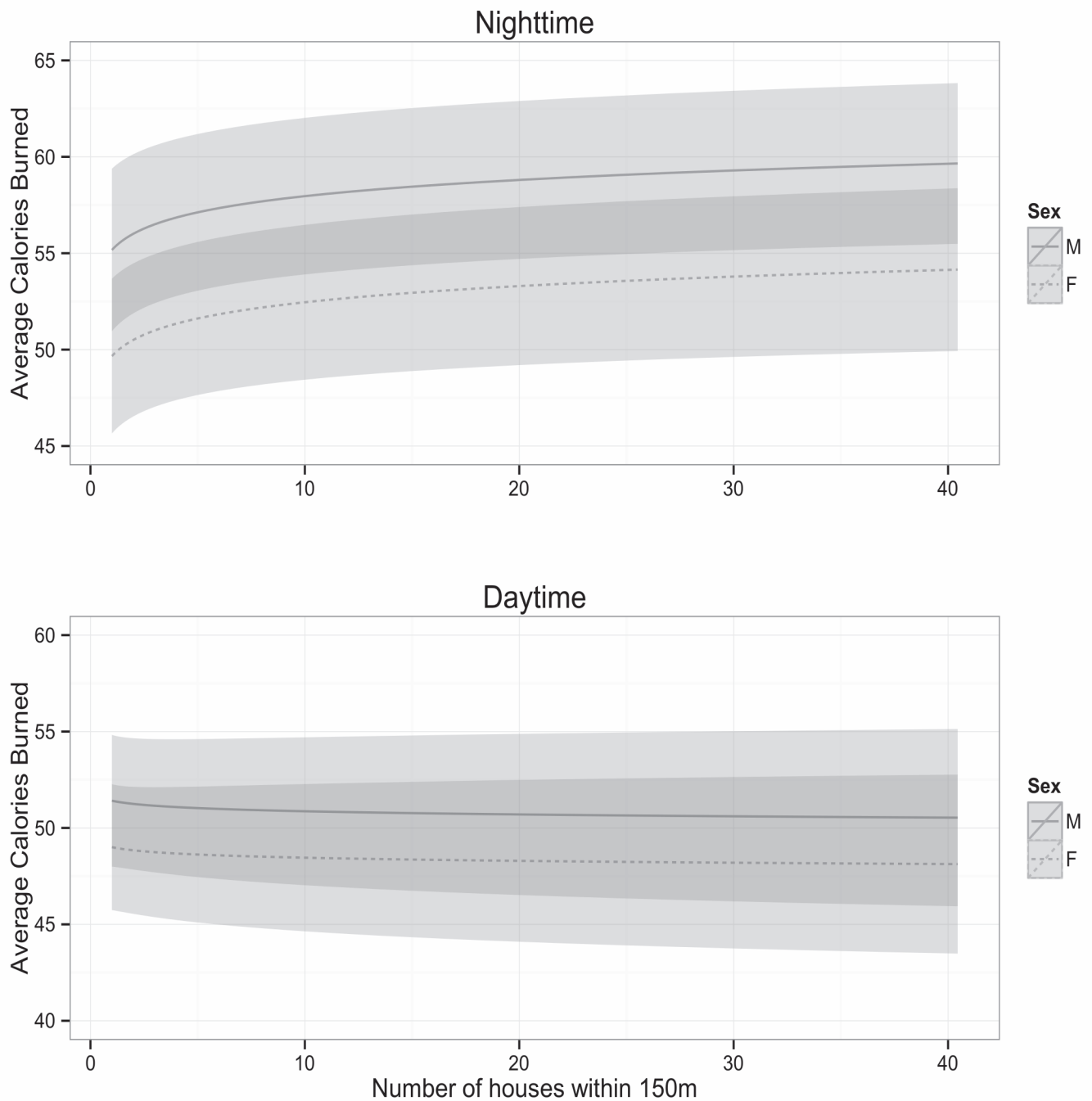
## Discussion

This study explores how housing development influences puma behavior and energetics in a fragmented landscape. Our results suggest a clear relationship between proximity to houses and puma movement activity. This effect was modulated by the time of day, whereby pumas were more likely to be active and remain active when within 150m of development at night. We also found that pumas were more likely to transition between behavioral states when close to houses. These activity shifts may reflect discomfort with being in close proximity to humans and domestic animals or reaction to other abiotic disturbances from these sources, such as light pollution or human-associated sounds [41].

As we predicted, there was a significant positive relationship between distance traveled and the number of houses surrounding each puma's travel path. This pattern resulted in greater metabolic demand associated with higher densities of residential development. Both male and female pumas moved further and expended more calories in developed areas at night but not during the day, providing evidence that puma response to development was strongly influenced by the time of day. Although pumas only increased their movement activity near houses at night, we found that this still resulted in increased net energetic expenditure. Increases in distance traveled are unlikely to be influenced by deer availability, as occupancy of deer is ubiquitous across our study site in both developed and protected areas [20].

The increases in caloric expenditure we observed could in part explain observed increases in puma kill rate in developed areas [8]. To compensate for the higher energetic costs of living in developed areas alone, we found that pumas would need to kill on average a minimum of 3.4 and 4.0 more deer annually for female and male pumas, respectively. This estimated increase is likely conservative, as we have previously found that pumas in the most developed parts of our study area kill over 20 more deer per year than pumas in less disturbed areas [8]. Higher kill requirements based on increased movement may exacerbate other behavioral influences on energetics, including changes in feeding rates and handling time of prey [8] and altered diet composition [20].

Although pumas in our study area are not legally harvested, human-caused mortality is the leading cause of death for collared pumas. Hence, even in the absence of puma hunting, which is illegal in California, high human-induced mortality rates due to depredations give pumas strong incentive to alter their behaviors to minimize contact with people. Pumas fear humans in this human-dominated ecosystem, demonstrated by immediate responses to human stimuli [41], altered feeding behavior [8,24,41], reduced occupancy of developed areas [7], and strong avoidance of development when engaged in reproductive behaviors [24]. As large tracts of land increasingly transition from undeveloped to exurban development, non-lethal human disturbances will likely continue to alter puma behavior. As demonstrated here, changes in puma movement behavior has energetic consequences. The cumulative energetic cost of all behavior change in human-dominated systems is likely to exceed even the substantial estimated energetic requirements reported here.



**Fig 3. Predicted curves bounded by 95% confidence intervals relating the average calories expended between 15-minute GPS points and the average number of houses in a 150m radius around locations in nighttime and daytime.** Predictions for males are indicated by the solid line and females are indicated by the dashed line.

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Increased energetic requirements are likely to disproportionately impact females with kittens, given their higher energetic demands [34]. Kittens older than 6 months follow their mothers to kill sites to feed [42]; if these locations are close to development, their feeding times



**Table 4. Caloric difference between time spent in high and low housing density areas relative to each puma.**

Puma Sex	Puma ID	Difference in kcals (day) <sup>a</sup>	Difference in kcals (night) <sup>a</sup>	Total Difference (kcal)	Increase in Daily Calories (%) <sup>b</sup>	Change in annual deer consumption	Bottom 25% Housing Density <sup>c</sup>	Top 25% Housing Density <sup>c</sup>
Female	23F	-754.5	809.5	55.1	1.1	0.4	Rural	Suburban
	11F	94.1	19.8	113.9	2.9	0.9	No Housing	Exurban
	28F	128.7	128.3	256.9	5.7	2.0	No Housing	Exurban
	7F	124.9	206.3	331.2	8.3	2.6	No Housing	Exurban
	19F	509.1	10.5	519.6	12.3	4.0	No Housing	Rural
	25F	54.7	736.1	790.9	16.2	6.2	No Housing	Exurban
	29F	21.2	951.3	972.6	24.4	7.6	No Housing	Exurban
Male	26M	-23.5	328.6	305.1	7.2	2.4	No Housing	Exurban
	22M	114.9	288.1	403.0	7.5	3.1	No Housing	Rural
	17M	418.8	40.2	459.0	11.8	3.6	No Housing	Exurban
	27M	63.0	408.4	471.4	10.9	3.7	No Housing	Rural
	35M	2.8	543.6	546.3	12.9	4.3	No Housing	Exurban
	16M	343.1	551.9	895.0	19.3	7.0	Rural	Exurban

<sup>a</sup> Differences are calculated from average caloric expenditure during days and nights spent in the top and bottom quartiles of housing density per puma.

<sup>b</sup> Increase in daily calories are measured as the total increase in caloric expenditure divided by individual average daily caloric expenditure.

<sup>c</sup> Housing density classifications are derived using categories described in Theobald (2005).

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may decline in response to disturbances [8]. Additionally, females may choose daytime resting locations further away from kill sites in developed areas, thus reducing the energetic gains kittens receive from carcasses. Although we could not track kitten survival during our study, most female pumas we tracked had kittens and lived in home ranges that encompassed developed areas. Future studies that measure kitten recruitment will shed light on the added energetic and survival costs of raising kittens in human-modified landscapes.

Our approach of using GPS and accelerometer data allowed us to obtain more accurate estimates of energetic use and requirements, which were likely underestimated in previous studies using GPS or telemetry data alone. The average activity levels of our study animals (20.8%) was relatively low compared to Beier et al.'s [37] estimates of 25% diel activity for pumas in southern California. This discrepancy may be due to methodological differences; Beier et al. [37] used the radio-telemetry to estimate the locations of animals, which is characterized by lower precision and sampling in comparison to GPS data. Pumas tracked in our study have some of the lowest travel distances (4±7 km/day) of any pumas studied, traveling less than half as far as those monitored by other studies [34,43]. However, despite their relatively short travel distances, our corrected estimates of puma energetic expenditures (average of 4,760 kcal for females and 5,145 kcal for males) was nearly twice as high as those of Laundré [34] (average of 2,420 kcal for females and 3,144 kcal for males), which suggests that previous estimates of puma energetics from GPS or radio-tracked animals have considerably underestimated true field energetics. Metabolic costs derived solely from minimum COT equations or telemetry-only tracking studies may woefully underestimate true large predator hunting costs due to their inability to account for additional energy demand associated with topographic complexity, substrate type, intermittent locomotion, maneuvering, feeding and weather [13,44,45].

Incorporating calibrated accelerometer datasets alongside GPS locations, as demonstrated here for pumas, allows for significantly finer-scale reconstruction of behavioral and energy budgets. Our accelerometer-corrected estimates for minimum annual deer consumption (42

deer/yr for females without kittens and 45.5 deer/yr for males) are likewise much higher than those predicted by Laundré [34] (14.9 deer/yr for females and 19.4 deer/yr for males). Instead, our estimates are similar to the field-estimated kill rates of  $25 \pm 84$  deer/yr for pumas in our population [8].

Our study provides evidence that behavioral responses to human disturbance have energetic consequences to individuals. While previous research had focused primarily on how urbanization and development affect the persistence or declines in wildlife populations, more studies now examine the behavioral responses of these species as they adapt to increased human presence [8,46]. Understanding how animal motivations and behaviors are altered by human influences can shed light on why some species can continue to persist in human dominated landscapes while others become extirpated [47,48]. New technologies such as accelerometers can reveal much more than whether or not an animal is in an area, but elucidate how successfully the individual is able to move, feed, and reproduce [49]. Increasing awareness of the consequences of human-induced behavioral change in wildlife can contribute to more robust wildland-urban interface planning and reductions in human-wildlife conflict.

Currently, exurban or low density development is the fastest growing type of land-use change in the United States [50]. As low density development fragments previously intact landscapes, it could pose significant challenges to survival for wildlife due to cumulative effects of increased non-lethal human disturbance. By incorporating energetic measurements from accelerometers, we showed the substantial consequences of these changes in behavior on energetic costs and requirements. Changes in movement activity and behavior can provide the first indications of predator energetic responses to development. Large carnivores such as pumas occupy pivotal roles in ecosystems, and changes to their behaviors can lead to demographic effects that reverberate throughout the ecological community. In addition, as energetic needs increase with development, large carnivores may switch to domestic or synanthropic prey sources, exacerbating conflict with humans and threatening carnivore survival and population persistence. For all large carnivores, accounting for human-induced behavioral change should play a larger role in any conservation management strategy.

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## Author Contributions

**Conceptualization:** Yiwei Wang, Christopher C. Wilmers.

**Data curation:** Yiwei Wang.

**Formal analysis:** Yiwei Wang, Justine A. Smith.

**Funding acquisition:** Yiwei Wang, Christopher C. Wilmers.

**Investigation:** Yiwei Wang.

**Methodology:** Yiwei Wang, Justine A. Smith, Christopher C. Wilmers.

**Project administration:** Yiwei Wang, Christopher C. Wilmers.

**Resources:** Yiwei Wang, Christopher C. Wilmers.

**Software:** Yiwei Wang, Justine A. Smith.

**Supervision:** Yiwei Wang, Christopher C. Wilmers.

**Visualization:** Yiwei Wang, Justine A. Smith.

**Writing ± original draft:** Yiwei Wang, Justine A. Smith.

**Writing ± review & editing:** Yiwei Wang, Justine A. Smith, Christopher C. Wilmers.

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**BEFORE THE CALIFORNIA FISH AND GAME COMMISSION**

**A Petition to List the Southern California/Central Coast  
Evolutionarily Significant Unit (ESU) of Mountain Lions as  
Threatened under the California Endangered Species Act (CESA)**



A Mountain Lion in the Verdugo Mountains with Glendale and Los Angeles in the background.  
Photo: NPS

Center for Biological Diversity and the Mountain Lion Foundation  
June 25, 2019



## Notice of Petition

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) and Division 3, Chapter 1.5, Article 2 of the California Fish and Game Code (Sections 2070 *et seq.*) relating to listing and delisting endangered and threatened species of plants and animals.

### I. SPECIES BEING PETITIONED:

Species Name: Mountain Lion (*Puma concolor*). Southern California/Central Coast Evolutionarily Significant Unit (ESU)

### II. RECOMMENDED ACTION: Listing as Threatened or Endangered

The Center for Biological Diversity and the Mountain Lion Foundation submit this petition to list mountain lions (*Puma concolor*) in Southern and Central California as Threatened or Endangered pursuant to the California Endangered Species Act (California Fish and Game Code §§ 2050 *et seq.*, “CESA”). This petition demonstrates that Southern and Central California mountain lions are eligible for and warrant listing under CESA based on the factors specified in the statute and implementing regulations. Specifically, petitioners request listing as Threatened an Evolutionarily Significant Unit (ESU) comprised of the following recognized mountain lion subpopulations:

1. Santa Ana Mountains
2. Eastern Peninsular Range
3. San Gabriel/San Bernardino Mountains
4. Central Coast South (Santa Monica Mountains)
5. Central Coast North (Santa Cruz Mountains)
6. Central Coast Central

Alternatively, as detailed in the petition, in the event the Commission determines that these six populations collectively either do not comprise a single Southern California/Central Coast ESU or otherwise do not meet the criteria for listing as Threatened, petitioners request the Commission consider whether any of these populations, singularly or in combination, comprise one or more ESUs and meet the criteria for listing as Threatened or Endangered pursuant to CESA.

III. AUTHORS OF PETITION:

Tiffany Yap, D.Env/PhD  
Brendan Cummings  
Center for Biological Diversity  
1212 Broadway, Suite 800  
Oakland, California 94612  
(510) 847-5838  
[tyap@biologicaldiversity.org](mailto:tyap@biologicaldiversity.org)  
[bcummings@biologicaldiversity.org](mailto:bcummings@biologicaldiversity.org)

J.P. Rose  
Center for Biological Diversity  
660 South Figueroa Street, Suite 1000  
Los Angeles, California 90017  
(213) 785-5406  
[jrose@biologicaldiversity.org](mailto:jrose@biologicaldiversity.org)

I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.

Signature:  \_\_\_\_\_ Date: 6/25/19 \_\_\_\_\_

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## Executive Summary

The Center for Biological Diversity and the Mountain Lion Foundation submit this petition to list mountain lions (*Puma concolor*; cougar, puma) in Southern and Central Coastal California as “threatened” or “endangered” pursuant to the California Endangered Species Act (CESA) (California Fish and Game Code §§ 2050 et seq.). Following Section 670.1, Title 14, California Code of Regulations, petitioners present scientific information regarding life history, population trend, range, distribution, abundance, kind of habitat necessary for survival, factors affecting the ability to survive and reproduce, degree and immediacy of threat, impact of existing management efforts, suggestions for future management, availability of sources and information, and a detailed distribution map.

Specifically, petitioners request listing as a “threatened species” an evolutionarily significant unit (ESU) comprised of the following recognized mountain lion subpopulations:

1. Santa Ana Mountains
2. Eastern Peninsular Range
3. San Gabriel/San Bernardino Mountains
4. Central Coast South (Santa Monica Mountains)
5. Central Coast North (Santa Cruz Mountains)
6. Central Coast Central

As demonstrated in this petition, mountain lions in these areas comprise an ESU (referred to as the “Southern California/Central Coast ESU”) and meet the statutory definition of a “threatened species.”

The California Fish and Game Commission has long recognized that ESUs can be designated and listed under CESA, and this interpretation of CESA has been upheld by the courts. *See California Forestry Assn. v. California Fish & Game Com.* (2007) 156 Cal.App.4th 1535, 1540 (“Consistent with the policy of the CESA, we will hold that the term ‘species or subspecies’ includes evolutionarily significant units”); *Central Coast Forest Assn. v. Fish & Game Com.* (2018) 18 Cal.App.5th 1191, 1197, fn. 4 [“CCFA IP”] (“An ESU is included within the term ‘species or subspecies’ in sections 2062 and 2067.”). While the ESU concept has primarily been applied to fish, the Commission recently listed an ESU of a mammal, the Pacific Fisher, as a “threatened species.” *See* 14 C.C.R. 670.5(b)(6)(J) (“Fisher (*Pekania pennant*) Southern Sierra Nevada Evolutionarily Significant Unit”).

Under CESA, a “threatened species” is “a native species or subspecies of a ... mammal... that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts . . . .” Cal. Fish & Game Code § 2067. An animal is an “endangered species” when it is “in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease.” Cal. Fish & Game § 2062.

Certain populations of the Southern California/Central Coast mountain lion ESU are already “in serious danger of becoming extinct” (e.g. Santa Ana and Santa Monica mountains), and if assessed separately, would individually meet the definition of an “endangered species.” When considered as a whole, the Southern California/Central Coast ESU is not at imminent risk of extinction but still faces significant and growing threats that ultimately threaten the viability of the entire ESU; it consequently meets the definition of a “threatened species.”

Currently, there is no reliable estimate of mountain lion abundance in California. In 1984 the California Department of Fish and Wildlife (CDFW) estimated between 4,000-6,000 adult mountain lions in the state (Mansfield and Weaver 1984). However, CDFW acknowledges that this estimate is outdated and likely overestimates mountain lion abundance. CDFW is currently undertaking a large-scale research effort to estimate mountain lion numbers throughout California.

While reliable absolute abundance estimates are unavailable, recent genetic research has led to estimates of effective population size for California mountain lion populations.<sup>1</sup> These estimates highlight the genetic isolation among California mountain lion populations and raise significant concerns for the continued viability of mountain lions in Southern California and along the Central Coast.

Researchers have recently identified 10 genetically distinct mountain lion populations in California (Figure ES-1) (derived from Gustafson et al. 2018). Nine of these populations occur almost exclusively in California, while one is centered in Nevada but extends into the northeastern corner of California.

The abundance of mountain lions in the North Coast and inland populations (Western Sierra Nevada, Eastern Sierra Nevada, and the genetic cluster centered in the state of Nevada) is not well established; however, these populations are better connected than Southern California and Central Coast mountain lions, and they show relatively high levels of genetic diversity. Gustafson et al. (2018) suggest that these four populations may comprise an ESU. While these populations should be monitored and managed to ensure their continued viability, petitioners do not seek protection of these populations as an ESU under CESA at this time.

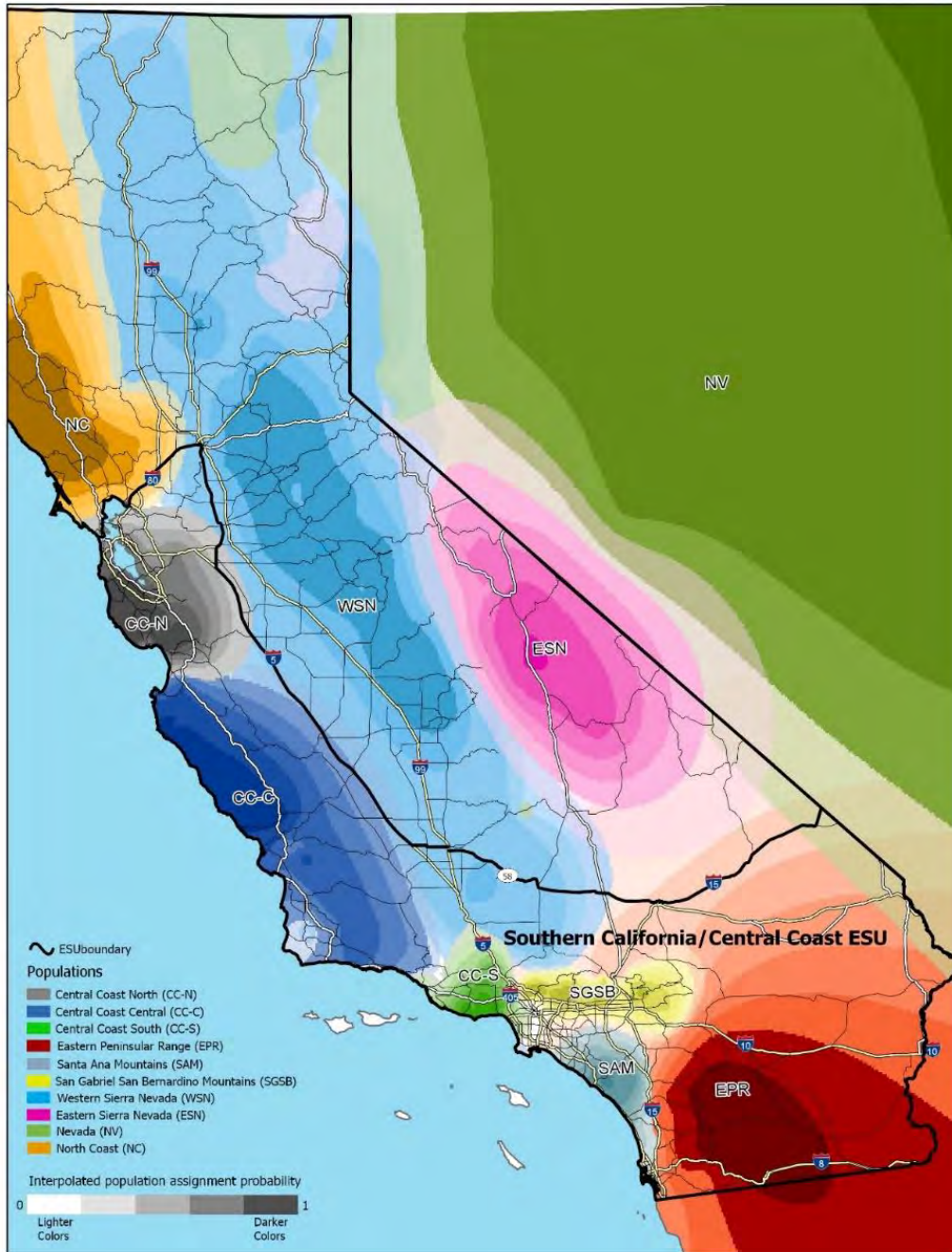
Considering the genetic source-sink dynamics among the remaining six populations, petitioners demonstrate that the populations along the Central Coast and in Southern California collectively comprise an ESU that warrants protection under CESA.<sup>2</sup> The Southern California/Central Coast ESU is comprised of six genetically distinct mountain lion populations: Central Coast North (CC-N, which includes mountain lions in the Santa Cruz Mountains and East Bay), Central Coast

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<sup>1</sup> At its simplest, effective population size is the number of animals contributing offspring to the next generation. It is an important measure of the genetic health of a population.

<sup>2</sup> As explained *infra* at Section 3.0, these remaining populations can be grouped into one or several potential ESUs. Petitioners believe that for purposes of listing under CESA, treating them as a single ESU is supported by the best available science. Moreover, a single ESU also is the most pragmatic from a management perspective, as recovery of the individual populations ultimately depends upon maintaining and/or reestablishing connectivity between them. *See CCFA II*, 18 Cal.App.5th 1191, 1237 (“[T]he nature of the ESU designation is such that genetics alone are not determinative: One must look beyond genetics to questions of policy to determine which populations to include in an ESU.”)(quotations omitted).

Central (CC-C), Central Coast South (CC-S, which includes the mountain lions in the Santa Monica Mountains), San Gabriel/San Bernardino Mountains (SGSB), Santa Ana Mountains (SAM), and Eastern Peninsular Range (EPR) (Gustafson et al. 2018).



**Figure ES-1.** Map of genetically distinct mountain lion populations and major roadways in California based on data collected from 1992-2016 (the division and status of these populations could change over time and with further research). The black lines show the proposed Southern California/Central Coast ESU boundary. Derived from Gustafson et al. (2018). Genetics data source: Kyle Gustafson, PhD, Department of Biology and Environmental Health, Missouri Southern State University, and Holly Ernest, DVM, PhD, Department of Veterinary Sciences, Program in Ecology, University of Wyoming, Laramie. Roads data source: ESRI.

The boundary of the Southern California/Central Coast ESU is proposed in Figure ES-1, and includes mountain lions that occur south of the San Francisco Bay and I-80, west of I-5 to the intersection of I-5 and SR-58, south of SR-58 to I-15, south of the I-15 from the SR-58 intersection to the California-Nevada border, and, for the purposes of CESA, as far south as the California-Mexico border. These boundaries are recommended as they include virtually all mountain lions associated with the six populations comprising the ESU and are also unambiguous and readily discernable for purposes of management. We recommend including mountain lions in the Tehachapi and Sierra Pelona Mountains south of SR-58 in this ESU. While most mountain lions sampled from this region share some genetic affinities with Western Sierra Nevada (WSN) animals, many also show genetic connections with CC-S, SAM, EPR and SGSB mountain lions. This area serves not just as a connecting link between mountain lion populations comprising the Southern California/Central Coast ESU, but also between this ESU and all other California mountain lions and is therefore essential for the overall genetic health of mountain lions in the state.

While Southern California and Central Coast mountain lions face a multitude of threats, the greatest challenges stem from habitat loss and fragmentation and the consequent impact on their genetic health. Most of the populations comprising the ESU have low genetic diversity and effective population sizes, which puts them at increased risk of extinction (Ernest et al. 2003; Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016; Gustafson et al. 2018; Benson et al. 2019). The populations most at risk are the SAM, CC-S, SGSB, and CC-N populations. Due to extreme isolation caused by roads and development, the SAM and CC-S, populations exhibit high levels of inbreeding, and, with the exception of the endangered Florida panther, have the lowest genetic diversity observed for the species globally (Ernest et al. 2014; Riley et al. 2014; Gustafson et al. 2018; Benson et al. 2019). The SGSB and CC-N similarly have low observed genetic diversity and effective population sizes, and they reside in areas of significant isolation and habitat fragmentation, which also puts them at increased risk (Gustafson et al. 2018). And although the CC-C and EPR populations have slightly higher levels of genetic diversity and effective population sizes, high rates of development, habitat loss and fragmentation, and human-caused mortalities in both areas could lead to a similar fate of isolation, genetic drift, low effective population size, and increased risk of extinction in the foreseeable future.

Although minimum viable effective population size has been found to vary depending on the species (Frankham 1995; Traill et al. 2010), general conservation management practice over the past few decades has followed a 50/500 rule, under which an effective population size of 50 is assumed sufficient to prevent inbreeding depression in the short term (over the duration of five generations) and an effective population size of 500 is sufficient to retain evolutionary potential in perpetuity (Traill et al. 2010; Frankham et al. 2014). It is clear that Central Coast and Southern California mountain lion populations are genetically compromised and face significant risk of extinction in both the short- and long-term. Five of the six populations have effective population sizes well below 50 (from lowest to highest: CC-S, SGSB, SAM, CC-N, EPR), and one population (CC-C) is just barely above that threshold at  $N_e = 56.6$  (Table ES-1) (Gustafson et al. 2018).



**Table ES-1.** Effective population size from Gustafson et al. (2018) and estimated total adult population of Central Coast and Southern California Mountain Lion Populations.

<b>Population</b>	<b>Effective Population Size (<math>N_e</math>)</b>	<b>Estimated Total (Adult) Population (<math>N</math>)<sup>1</sup></b>
Central Coast North (CC-N)	16.6	33-66
Central Coast Central (CC-C)	56.6	113-226
Central Coast South (CC-S)	2.7 <sup>2</sup>	5-10
Santa Ana Mountains (SAM)	15.6 <sup>3</sup>	31-62
San Gabriel/ San Bernardino Mountains (SGSB)	5	10-20
Eastern Peninsular Range (EPR)	31.6	63-126
<b>Total</b>		<b>255-510</b>

<sup>1</sup>Calculations are based on the estimated ratio of effective to total adult population size ( $N_e/N$ ) of Florida panthers being 0.25 to 0.5 (Ballou et al. 1989). This ratio was used in the USFWS Florida Panther Recovery Plan (USFWS 2008). Petitioners recognize that these derived population estimates, while informative, are not definitive and will likely be superseded by new population estimates being developed by CDFW.

<sup>2</sup>Benson et al. (2019) calculated an  $N_e$  of 4 for the Santa Monica Mountains population within the CC-S. Applying the Ballou et al. (1989) factors would lead to an estimate of 8-16 mountain lions in this area, which is roughly consistent with current estimates of this well-monitored population.

<sup>3</sup>Several studies provide  $N_e$  calculation for the SAM population. Ernest et al. (2014) calculated an  $N_e$  of 5.1 and Benson et al. (2019) calculated an  $N_e$  of 6. Applying the Ballou et al. (1989) factors to the most recent calculation would lead to an estimate of 12-24 mountain lions in the SAM, which is roughly consistent with current estimates.

Although low effective population sizes standing alone are cause for conservation concern for Southern California and Central Coast mountain lion populations, there are other human-caused factors that further limit their long-term persistence. Habitat loss and fragmentation due to roads and development have led to extreme levels of isolation and high mortality rates. With low genetic diversity and high risk of inbreeding depression due to genetic isolation, vehicle strikes on roads, increased conflicts with humans that lead to depredation kills, high levels of intraspecific strife likely due to limited space and lack of connectivity, rodenticide and other environmental toxicant poisoning, and impacts of more frequent human-caused wildfires and climate change, the small isolated mountain lion populations of Southern California and the Central Coast will likely not persist without the restoration and enhancement of functional connectivity between populations and large blocks of heterogeneous habitats.

Loss of mountain lions in Southern California and the Central Coast would be devastating not just for the mountain lions themselves but also the many species that directly and indirectly rely on them. These top predators are important ecosystem engineers that facilitate healthy ecosystems and allow biodiversity to thrive (Ripple and Beschta 2006; Ripple and Beschta 2008;

Ripple et al. 2014; Ruth and Elbroch 2014; Barry et al. 2019; Elbroch and Quigley 2019). As keystone species mountain lions help support plant recruitment in riparian areas, stabilize stream banks, and sustain healthy habitats for a myriad of aquatic and terrestrial species, including plants, invertebrates, fish, amphibians, reptiles, birds, and mammals (Ripple and Beschta 2006; Ripple and Beschta 2008; Ripple et al. 2014). Their kills are also an important source of food for multiple terrestrial and avian scavengers (Ruth and Elbroch 2014; Barry et al. 2019; Elbroch and Quigley 2019).

Existing laws and regulations have proven to be inadequate to protect Southern California and Central Coast mountain lions. Although the California Wildlife Protection Act of 1990 (Proposition 117) prohibits hunting of mountain lions and has funded the acquisition of important habitat for preservation, the Act alone does not ensure that core habitats and connectivity are protected from development, highways, or other threats. Moreover, numerous mountain lions are killed each year pursuant to depredation authorizations issued under this regime, and there is no limit to the number of depredation permits a property owner can request or any limit to the number of depredation permits which can be issued for any population. And while CDFW has proactively issued a bulletin detailing a new depredation policy for mountain lions in the CC-S and SAM that requires property owners to first implement non-lethal measures prior to being issued a kill permit, this policy does not apply to other vulnerable populations.

Other environmental laws also are insufficient. State and local agencies continue to interpret the California Environmental Quality Act (CEQA) as allowing for the construction of highways and other development in mountain lion habitat and essential corridor areas without adequate mitigation despite severe impacts of such projects on mountain lions. Agencies likewise have generally interpreted CEQA and the federal National Environmental Policy Act as not requiring implementation of connectivity measures when projects fragment or destroy mountain lion habitat. And perhaps most importantly, Caltrans lacks a clear affirmative mandate to design, build, or improve crossings for mountain lions on existing highways, despite the undisputed role of transportation infrastructure in preventing connectivity and gene flow.

Future human population growth and associated development will further diminish and fragment remaining mountain lion habitat, driving Southern California and Central Coast mountain lions closer to extinction and undermining any chance of recovery. Should state and local agencies continue to build and expand roads and highways and permit construction in wildlife habitat and corridors without ensuring adequate habitat connectivity, the genetic health of mountain lion populations will continue to decline while the number of mountain lions killed by vehicle strikes and other human activity will increase.

Ultimately, without a reversal of these trends, mountain lions will disappear from Southern and Central Coastal California in the coming decades, representing a loss of the species from a significant portion of its range in the state. Nevertheless, most of the threats facing mountain lions can be halted or sufficiently reduced if CDFW is provided with adequate resources and all relevant state and local agencies sufficiently prioritize mountain lion conservation in their decision-making. Legal protection of mountain lions under CESA, along with the attention and resources that such listing will generate, can help ensure the long-term survival of this iconic and ecologically significant species in Southern and Central Coastal California.

# The Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lions Warrants Listing as Threatened under the California Endangered Species Act (CESA)

## 1 Introduction

This petition summarizes available scientific information regarding the natural history of mountain lions, their distribution and abundance in California, population trends and threats, describes the proposed ESU, and discusses the limitations of existing management measures in protecting the species. As demonstrated below, mountain lions in Southern California and along the Central Coast meet the criteria for protection as a threatened species under the California Endangered Species Act (CESA), and would benefit greatly from such protection.

## 2 Life History

### 2.1 Species Description



Adult female mountain lion (left) and kittens (right). Photos: NPS.

The mountain lion (*Puma concolor*) is also commonly called a puma (from the Inca language Quechua) or cougar (corrupted from *cuguacuarana* from the indigenous Guarani people in Paraguay, Argentina, Bolivia, and Brazil). Adults are large, slender cats with short, muscular limbs and a long tail that is about one third of the animal's total length. Their hind limbs are longer than their fore limbs, which makes them highly adapted for jumping through rugged terrain or pouncing on their prey. They have tawny pelage that can be lighter/whitish on their belly and the undersides of their legs and they have areas of white around the muzzle, throat and chest. They have black fur on the backs of their rounded ears, the tip of their tail, and outlining their muzzle. Their eyes are a grayish brown to golden color, and the nose is pink with a black outline.

Adult body size and weight can vary depending on the geographic range (Iriarte et al. 1990). Mountain lions are smaller and weigh less near the equator and are larger and heavier towards the poles, which likely reflects the size of available prey and the presence of sympatric carnivores (Iriarte et al. 1990). Males are typically larger than females. Males generally weigh 55-65kg with a length of 2.2-2.3m from the nose to the tip of the tail, and females generally weigh 35-45kg with a length of 2.0-2.1m (Currier 1983).

Mountain lion kittens are born weighing approximately 400g, and their eyes and ear canals remain closed for one to two weeks after birth (Currier 1983). They have light coats with dark spots and a white muzzle, chest, and belly. Like the adults, they have black fur on the backs of their rounded ears, the tip of their tail, and outlining their muzzle. Their eyes are initially blue, change to mostly brown within four months, and then change to a golden color at around nine months (Currier 1983). The dark spots on their coat start to fade at 12-14 weeks of age, presumably when a kitten starts to accompany its mother on hunts, but the spots are still distinguishable until the animal is about one year old (Currier 1983). Adult weight is typically reached between the second and fourth year.

## 2.2 Taxonomy and Population Genetics

The mountain lion is in the order Carnivora and is a member of the cat family Felidae. Unlike the large, roaring cats of the subfamily Pantherinae (e.g., lions, tigers, and leopards), mountain lions are categorized with small, purring cats in the subfamily Felinae (e.g., bobcats, lynxes, ocelots, cheetahs, and jaguarundi). Their scientific name is *Puma concolor*, formerly called *Felis concolor*. Based on molecular and morphological features, it is thought that mountain lions share a common ancestor with cheetahs (*Acinonyx jubatus*) and jaguarundi (*Puma yaguaroundi*).

Mountain lion fossil records in North America date back 300,000 years (Pierce and Bleich 2003); however, they were likely extirpated during a massive extinction event at the end of the Pleistocene, which eliminated about 80% of large vertebrates in North America (Culver et al. 2000; Caragiulo et al. 2013). Genetic studies suggest that after this extinction event, a small number of Central and South American mountain lions migrated north and repopulated North America (Culver et al. 2000; Caragiulo et al. 2013). As a result, existing North American mountain lions exhibit founder effects and have less genetic diversity compared to mountain lions in Central and South America (Culver et al. 2000; Caragiulo et al. 2013).

There is some debate regarding the number of subspecies of mountain lions. Two subspecies are “tentatively” recognized by the International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC) Cat Specialist Group: *Puma concolor concolor* (Linnaeus, 1771) in South America and *Puma concolor couguar* (Kerr, 1792) in North and Central America and possibly northern South America west of the Andes Mountains (Kitchener et al. 2017). However, there are various studies that suggest the divergence of multiple subspecies of mountain lions. About 30 subspecies of mountain lions throughout the Americas have been referenced in the literature, with about 15 subspecies in North America (Young and Goldman 1946; Currier 1983; Pierce and Bleich 2003).

Based on more recent genetic analyses of mitochondrial DNA (mtDNA) from mountain lions throughout the Americas, Caragiulo et al. (2013) found that the mountain lions they sampled could be separated into three broad groupings: North America, Central America, and South America, with North American mountain lions having the least variation in mtDNA compared to populations in Central and South America. Although that study genotyped 601 specimens, the distribution of sampling within the broad geographic range was limited compared

to a study conducted by Culver et al. (2000), which analyzed mtDNA from 315 mountain lions sampled from more locations throughout the species' geographic distribution. Culver et al. (2000) found six phylogeographic groupings or subspecies throughout the Americas.

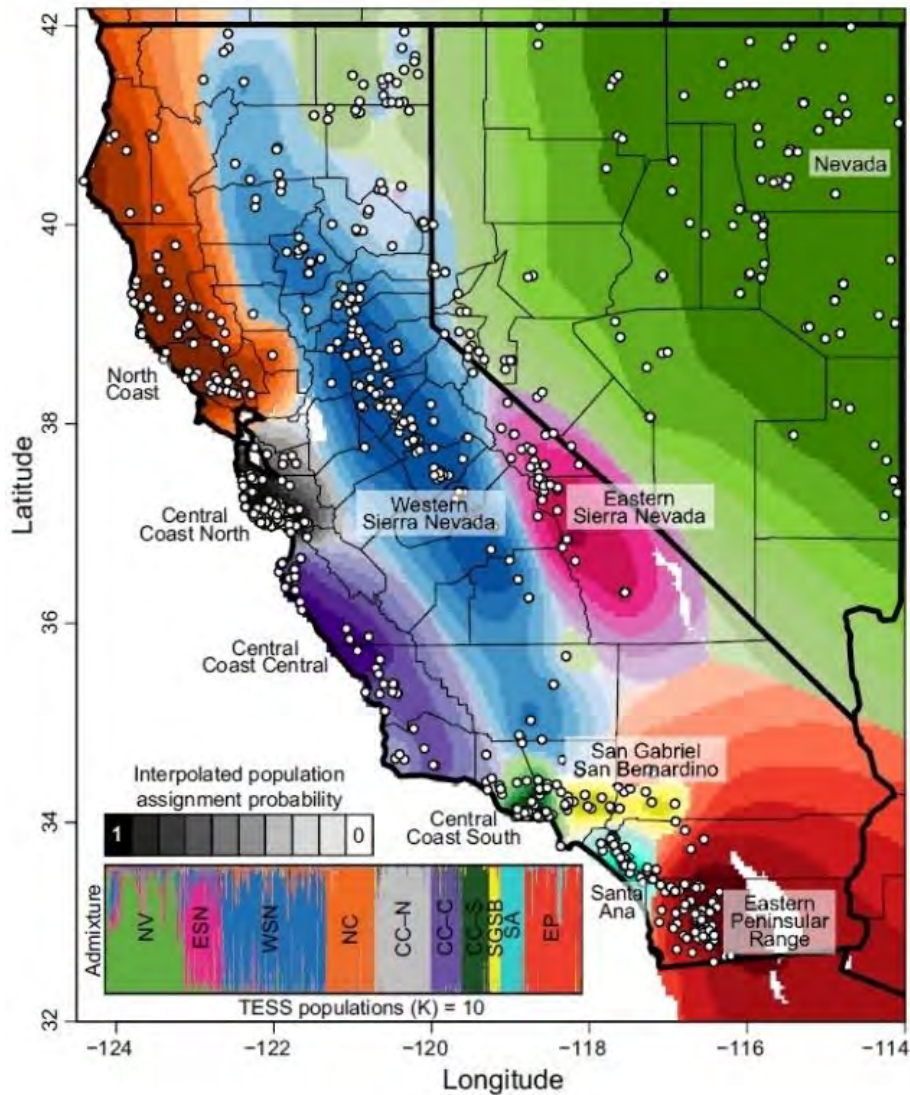
Despite this ongoing debate, the United States Fish and Wildlife Services (USFWS) has long recognized mountain lion subspecies under the federal Endangered Species Act (ESA). Two of these subspecies have been protected under the ESA due to low population sizes: the eastern cougar (*Puma concolor cougar*), which was listed as endangered and is now thought to be extinct, with the last recorded occurrence in 1938 (USFWS 2018), and the endangered Florida panther (*Puma concolor coryi*), which is an isolated population that is now restricted primarily to the cypress swamps of southern Florida. In addition, the California mountain lion (*Puma concolor californica*) was recognized by USFWS in response to a 1994 petition by the Mountain Lion Foundation to list the population of California mountain lions in the Santa Ana Mountains as endangered, as those populations that occur within most of California, southern Oregon, western Nevada, and northern Baja California, Mexico (USFWS 1994). Additionally, the California Department of Fish and Wildlife (CDFW) recognizes the Yuma Puma (*Puma concolor browni*) as a (sub)species of special concern that occurs in the desert plains and low mountains along the Colorado River in southeastern California, southwestern Arizona, northeastern Baja California, Mexico, and northwestern Sonora, Mexico (CDFW 1990).

In California, researchers have recently identified 10 genetically distinct mountain lion populations in California and Nevada, nine of which have core areas in California (Figure 1) (Gustafson et al. 2018). In the study, 992 mountain lions from throughout California and Nevada were genotyped using 42 microsatellite loci to identify regional populations and evaluate functional connectedness between the populations (Gustafson et al. 2018). The divergence of these populations is likely the result of habitat fragmentation caused by roads and development (Ernest et al. 2003; Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Gustafson et al. 2017; Gustafson et al. 2018; Benson et al. 2019). According to Gustafson et al. (2018), mountain lions in the North Coast and inland populations (Nevada, Eastern Sierra Nevada, Western Sierra Nevada) appear to be better-connected than those in the south and along the central coast, with relatively larger effective population sizes and higher levels of genetic diversity. The authors suggest that these populations may comprise an evolutionarily significant unit (ESU). Considering the genetic source-sink dynamics among the remaining populations (Gustafson et al. 2018), petitioners demonstrate that the populations in Southern California and along the Central Coast collectively comprise an ESU (referred to as the “Southern California/Central Coast ESU”). See *Section 3.0 Southern California and Central Coast Mountain Lions Comprise and Evolutionarily Significant Unit* for more discussion.

The Southern California/Central Coast ESU is comprised of six genetically distinct mountain lion populations: Central Coast North (CC-N, which includes mountain lions in the Santa Cruz Mountains), Central Coast Central (CC-C), Central Coast South (CC-S, which includes mountain lions in the Santa Monica Mountains), San Gabriel/San Bernardino Mountains (SGSB), Santa Ana Mountains (SAM), and Eastern Peninsular Range (EPR) (Figure 1) (Gustafson et al. 2018). Most of these populations appear to be struggling with low genetic diversity and effective population sizes, which puts them at increased risk of extinction (Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Gustafson et al. 2018;



Benson et al. 2019). The populations struggling the most include the SAM, CC-S, SGSB, and CC-N populations. Although the CC-C and EPR have slightly higher levels of genetic diversity and effective population sizes, high rates of development in both areas could lead to a similar fate of isolation, genetic drift, low effective population size, and increased risk of extinction in the foreseeable future.



**Figure 1.** Map of genetically distinct mountain lion populations in California. The Central Coast North (CC-N), Central Coast Central (CC-C), Central Coast South (CC-S), San Gabriel/San Bernardino (SGSB), Santa Ana Mountains (SAM), and Eastern Peninsular Range (EPR) mountain lion populations should be considered an evolutionarily significant unit (ESU). Each color represents a genetically distinct mountain lion population. White dots are individual animals sampled. Source: Gustafson et al. (2018).

Although discrete populations have been identified in Southern California mountain ranges, other mountain lions have been regularly observed outside of the CC-S, SAM, SGSB, and EPR core areas, including transient and resident mountain lions in the Mojave and Colorado deserts and along the Lower Colorado River (*i.e.*, Yuma mountain lion [*Puma concolor browni*], a recognized subspecies of special concern). These populations presumably occur in low

densities due to limited resources, such as lower prey abundance/vulnerability or less suitable habitat. In fact, Kucera (1998) states that habitat within the Yuma mountain lion range is generally considered to be of low or no suitability for mountain lions. Relatively low density populations are inferred by the larger ranges of mountain lions in desert environments; four individual Yuma mountain lions had home ranges of 389km<sup>2</sup> to 1621km<sup>2</sup>, which is much larger than other California mountain lion home ranges (Grigione et al. 2002; Riley et al. 2014; Zeller et al. 2017; see *Section 2.5 Habitat Requirements* for more details) but similar to those estimated for other desert mountain lions (Kucera 1998). This petition considers these low-density transients and resident lions as included within the Southern California/Central Coast ESU.

### 2.2.1 Effective Population Size and Extinction Risk

It has been established that genetic factors play a critical role in extinction risk. Inbreeding depression, loss of genetic diversity, and accumulation of deleterious mutations can lead to elevated extinction risk due to reduced reproductive fitness and evolutionary potential (*i.e.*, the ability to adapt to change) (Spielman et al. 2004; Frankham 2005; Traill et al. 2010). Effective population size ( $N_e$ ) is a key metric used to assess a population's genetic viability and its chances of long-term persistence. Effective population size is an estimate of the size of an idealized population that would lose heterozygosity (*i.e.*, genetic diversity) at the same rate as the observed population; it indicates a population's rates of inbreeding and genetic drift (changes in allele frequencies over generations based purely on chance). A lower effective population size indicates a higher risk of inbreeding depression. Factors that affect effective population size include census population size (*i.e.*, the total number of individuals within a population), breeding sex ratio, variance in reproductive success, and population density. Several characteristics of these mountain lion populations, including small census population size, low density, female-biased sex ratios, and skewed male reproductive success, reduce effective population size, which suggests that these populations have an increased risk of inbreeding depression and extinction (Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Gustafson et al. 2018; Benson et al. 2019).

The minimum effective population size for a population to persist has been debated (*e.g.*, Jamieson and Allendorf 2012; Frankham et al. 2014). Although minimum viable effective population size has been found to vary depending on the species (Frankham 1995), general conservation management practice over the past few decades has followed a 50/500 rule, which purports that an effective population size of 50 is sufficient to prevent inbreeding depression in the short term (over the duration of five generations) and an effective population size of 500 is sufficient to retain evolutionary potential in perpetuity (Frankham et al. 2014). In a 2012 review, Jamieson and Allendorf (2012) concluded that the 50/500 rule is a useful guiding principle in conservation management when genetic concerns are likely to affect the short- and long-term viability of populations. However, Frankham et al. (2014) later revised the 50/500 rule and recommended an effective population size of 100 to limit the loss of total fitness to <10% in the short-term and an effective population size of 1,000 to retain evolutionary potential for fitness in perpetuity, while recognizing that fragmented populations should be evaluated on a case-by-case basis.

Whether the 50/500 or 100/1,000 rule is considered, it is clear that Central Coast and Southern California mountain lion populations are genetically imperiled and face extinction in both the short- and long-term. Five of the six populations have effective population sizes well below 50 (from lowest to highest, according to Gustafson et al. 2018: CC-S, SGSB, SAM, CC-N, EPR), and the remaining population (CC-C) is just barely above that threshold at  $N_e = 56.6$  (Table 1) (Ernest et al. 2014; Riley et al. 2014; Benson et al. 2016a; Gustafson et al. 2018; Benson et al. 2019). Although the ratio of effective to total adult population size ( $N_e/N$ ) varies by species, the effective population size is often much lower than the total adult population size (Frankham 1995). Several studies indicate that the  $N_e/N$  in wild vertebrate populations ranges from 0.2 to 0.5 (Ballou et al. 1989; Mace and Lande 1991; Spong et al. 2000; Laundré and Clark 2003). Ballou et al. (1989) estimated the  $N_e/N$  to be 0.25-0.5 in their population viability assessment of the Florida Panther, which aligns with other studies on big cats (Frankham 1995; Spong et al. 2000). This range was used in the USFWS’s Florida Panther Recovery Plan (USFWS 2008), and, if applied to the Central Coast and Southern California mountain lion populations, the total number of mountain lions in the areas combined would be 255 to 510 individuals (Table 1). This is well below the recommended minimum viable population size of at least 5,000 adult individuals for the long-term persistence of a population (Frankham 1995; Reed et al. 2003; Traill et al. 2010).

**Table 1.** Effective population size and estimated total adult population of Central Coast and Southern California Mountain Lion Populations from Gustafson et al. (2018).

<b>Population</b>	<b>Effective Population Size (<math>N_e</math>)</b>	<b>Estimated Total (Adult) Population (N)<sup>1</sup></b>
Central Coast North (CC-N)	16.6	33-66
Central Coast Central (CC-C)	56.6	113-226
Central Coast South (CC-S)	2.7 <sup>2</sup>	5-10
Santa Ana Mountains (SAM)	15.6 <sup>3</sup>	31-62
San Gabriel/ San Bernardino Mountains (SGSB)	5	10-20
Eastern Peninsular Range (EPR)	31.6	63-126
<b>Total</b>		<b>255-510</b>

<sup>1</sup>Calculations are based on the estimated ratio of effective to total adult population size ( $N_e/N$ ) of Florida panthers being 0.25 to 0.5 (Ballou et al. 1989). This ratio was used in the USFWS Florida Panther Recovery Plan (USFWS 2008). Petitioners recognize that these derived population estimates, while informative, are not definitive and will likely be superseded by new population estimates being developed by CDFW.

<sup>2</sup>Benson et al. (2019) calculate an  $N_e$  of 4 for the Santa Monica Mountains population within the CC-S. Applying the Ballou et al. (1989) factors would lead to an estimate of 8-16 mountain lions in this area, which is roughly consistent with current estimates of this well-monitored population.

<sup>3</sup>Several studies provide  $N_e$  calculation for the SAM population. Ernest et al. (2014) calculated an  $N_e$  of 5.1 and Benson et al. (2019) calculated an  $N_e$  of 6. Applying the Ballou et al. (1989) factors to the most recent calculation would lead to an estimate of 12-24 mountain lions in the SAM, which is roughly consistent with current estimates

Habitat loss and fragmentation due to roads and development have led to extreme levels of isolation in these populations, which have lowered their effective population sizes and, ultimately, their ability to survive and reproduce with a diverse gene pool (Ernest et al. 2014; Riley et al. 2014; Benson et al. 2016a; Gustafson et al. 2018; Benson et al. 2019). However, re-establishing gene flow among isolated subpopulations of a species can increase effective population size and reduce extinction risk (Frankham et al. 2014). Thus, the implementation of wildlife crossing infrastructure at existing barriers along with the preservation of intact, heterogeneous habitats would facilitate connectivity among Central Coast and Southern California mountain lion populations and significantly improve their chances of long-term survival.

### 2.2.2 Central Coast North (CC-N) Mountain Lion Population

In a statewide study, Gustafson et al. (2018) found that the CC-N population clustered genetically with the CC-C and CC-S populations. The population exhibited evidence of a previous genetic bottleneck and was found to have low genetic diversity and a low effective population size ( $N_e = 16.6$ ). There is some evidence, though weak, that suggests the CC-N population is a source population, with limited gene flow with the other Central Coast populations and the Western and Eastern Sierra Nevada populations (Gustafson et al. 2018). CDFW has identified that the Santa Cruz Mountains population, which occurs within the CC-N area, is struggling due to fragmentation from roads and development as well as lack of protected habitat (Dellinger 2019). The low genetic diversity and effective population size threaten both the short- and long-term survival of the CC-N population.

### 2.2.3 Central Coast Central (CC-C) Mountain Lion Population

The CC-C mountain lion population has been found to exhibit a previous genetic bottleneck (Gustafson et al. 2018). It has intermediate levels of genetic diversity and the highest effective population size ( $N_e = 56.6$ ) among the Central Coast and Southern California populations (Gustafson et al. 2018). Although this effective population size exceeds the older standard of 50 to prevent in-breeding depression in the short-term, it falls well below the recommended newer standard of 100 and is insufficient for the long-term persistence of the population. This population was found to be clustered genetically with the CC-N and CC-S populations and identified as a source population with limited gene flow with other Central Coast populations, the Western and Eastern Sierra Nevada populations, and the SGSB population (Gustafson et al. 2018). Although the CC-C population appears to be the healthiest population in the Central Coast and Southern California, the lack of sufficient protected lands and high rates of development and habitat fragmentation in the area threaten the persistence of this population (Dellinger 2019).

### 2.2.4 Central Coast South (CC-S) Mountain Lion Population

The CC-S mountain lion population has been found to exhibit a prior genetic bottleneck, with low genetic diversity and an extremely low effective population size ( $N_e = 2.7$  to 4) (Riley et al. 2014; Benson et al. 2016a; Gustafson et al. 2018; Benson et al. 2019). This population was

found to be clustered genetically with the CC-N and CC-C populations and identified as a genetic sink population, with limited gene flow from mountain lions along the Central Coast and in the Sierra Nevada (Gustafson et al. 2018).

A recent population viability analysis focused on the Santa Monica Mountains population, a subpopulation within the CC-S that has been severely isolated due to roads and development, found that if the population remains isolated with little or no immigration (similar to what is currently being observed in the area), the population could experience high levels of genetic erosion, with 40-57% loss of predicted heterozygosity within 50 years (Benson et al. 2016a). When considering just demographic processes with little or no immigration and no inbreeding depression, the population was predicted to have a 15-22% chance of extinction within 50 years (Benson et al. 2016a; Benson et al. 2019). However, if inbreeding depression occurs, which is a strong possibility given the predicted substantial loss of genetic diversity and the documentation of father-daughter, grandfather-granddaughter, and grandmother-grandson inbreeding within the population (*e.g.*, Riley et al. 2014)<sup>3</sup>, population growth will likely decline and chances of extinction within 50 years is predicted to be 99.7%, with a median time to extinction of 15.1 years (Benson et al. 2016a; Benson et al. 2019).

### 2.2.5 Santa Ana Mountains (SAM) Mountain Lion Population

The SAM mountain lion population has been found to have the lowest genetic diversity of all populations in California, with levels nearly as low as the endangered Florida panther (Ernest et al. 2014; Gustafson et al. 2017; Gustafson et al. 2018; Benson et al. 2019). This population is also estimated to have a low effective population size ( $N_e = 5.1$  to 15.6) and high levels of relatedness and inbreeding (Ernest et al. 2014; Gustafson et al. 2018; Benson et al. 2019). The SAM population was found to be a genetic sink population, with limited gene flow with the EPR population (Gustafson et al. 2018). In a 16-year study (2001-2016) seven migrants (out of 146 sampled animals), were detected via genetics and GPS collar tracking to have crossed the I-15 between the EPR and SAM (three males from the EPR to SAM, four males from the SAM to the EPR); only one migrant is known to have reproduced (Gustafson et al. 2017). Low genetic diversity and effective population size in the SAM are indicative of a genetic bottleneck that is estimated to have occurred 40-80 years ago, around the time when urban development and multi-lane highway construction boomed in Southern California (Ernest et al. 2014; Gustafson et al. 2018). This population was also found to be largely disconnected from all the other California populations, along with the EPR population.

A recent population viability analysis found that if the population remains isolated with little or no immigration (similar to what is currently being observed in the area), the population could experience further genetic erosion, with 28-49% loss of predicted heterozygosity within 50 years (Benson et al. 2019). When considering just demographic processes with little or no immigration and no inbreeding depression, the population was predicted to have a 16-21% chance of extinction within 50 years. However, to avoid inbreeding depression in wild populations, loss in heterozygosity should be less than 5-10% over 100-200 years (Soule et al. 1986; Benson et al. 2016a), which suggests that inbreeding depression in the SAM population is

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<sup>3</sup> Inbreeding has been documented in the SMM population in Riley et al. 2014 and in ongoing studies by the NPS. More information from the NPS is available here: <https://www.nps.gov/samo/learn/nature/puma-profiles.htm>



a strong possibility. In addition, evidence of potential inbreeding depression has been observed in the population (*e.g.*, kinked tails coupled with low genetic diversity, Figure 2, Ernest et al. 2014). When inbreeding depression was considered in the population viability analysis, population growth will likely decline and chances of extinction within 50 years is predicted to be 100%, with a median time to extinction of 11.7 years (Benson et al. 2019).



**Figure 2.** Two SAM mountain lions with a kink at the base of the tail (A) and near the tip of the tail (B). These individuals had among the lowest genetic diversity measured in the study. Source: Ernest et al. 2014.

#### 2.2.6 San Gabriel/San Bernardino Mountains (SGSB) Mountain Lion Population

According to Gustafson et al. (2018), the SGSB mountain lion population exhibits extremely low genetic diversity and effective population size ( $N_e = 5$ ), though the sample size from SGSB was low. They were also found to be a sink population, with limited gene flow with populations in the Western Sierra Nevada, CC-C, and the EPR (Gustafson et al. 2018). Although genetic studies on this population are limited, patterns of isolation, loss of genetic diversity, and low effective population size are similar to those of the SAM and CC-S populations and likely indicate a high risk of extinction. Not only is the population's long-term survival at stake, but the geographic location of the SGSB population is paramount. Despite only limited gene flow between the SGSB population and the Western Sierra Nevada, CC-C, and EPR, this population represents a critical linkage between mountain lion populations in the northern, central coast, and southern mountain ranges of California (Gustafson et al. 2018). Restoration and enhancement of connectivity is key for the continued survival of the SGSB population as well as the Central Coast and Southern California mountain lion populations.

#### 2.2.7 Eastern Peninsular Range (EPR) Mountain Lion Population

Gustafson et al. (2018) found that the EPR population exhibits a prior genetic bottleneck. Although the population was found to have a higher effective population size than the other Southern California mountain lion populations ( $N_e = 31.6$ ), this is still well below the older standard of 50 to prevent in-breeding depression in the short-term and is insufficient for the long-term persistence of the population. In addition, the EPR population was found to be largely disconnected from all the other California populations, with limited gene flow and low connectivity with the SAM and SGSB populations (Gustafson et al. 2018). With continued development in San Diego, Riverside, and Imperial Counties, the EPR population could have a

similar fate of isolation, genetic drift and inbreeding, and risk of extinction as the other Central Coast and Southern California populations.

As mentioned previously, there are records for mountain lions outside of the core mountain ranges in Southern California, which are likely transients or residents of smaller populations. For example, the Yuma mountain lion has been recognized by CDFW as a subspecies of special concern, and likely occurs in low density in the desert plains and low mountains of the Colorado River Valley. Genetic studies on the Yuma mountain lion are limited, and no samples were obtained from that area for the study conducted by Gustafson et al. (2018). However, the low densities of transients and smaller populations in areas where roads and development threaten connectivity make them part of the EPR and larger Southern California population, and as such, they are considered a conservation concern and are included in this petition.

### 2.3 *Reproduction and Growth*



Dens are often in rocky outcrops (left) or in dense vegetation (right). Photos: NPS.

Mountain lions are polygamous breeders, and mates likely locate each other with auditory and olfactory signals (Currier 1983). They may reproduce at any time of year, though seasonal pulses have been documented and the timing of reproduction may be affected by prey abundance or climate (Pierce and Bleich 2003). In North America, kitten births are most common between April and September (Currier 1983; Beier 1995; Pierce and Bleich 2003).

Pairs generally mate for about 2-5 days (Beier et al. 1995), though there are instances in which pairs have been recorded traveling together for up to 16 days (Seidensticker et al. 1973). During this time they vocalize frequently, travel little, will sometimes share a kill, and copulate up to 70 times per day (Seidensticker et al. 1973; Beier et al. 1995; Pierce and Bleich 2003). Female estrous cycles last an estimated 4-12 days, and it is hypothesized that numerous acts of copulation stimulate ovulation and improve chances of successful fertilization (Pierce and Bleich 2003, Kitchener 1991). If the litter is born dead or removed within 24 hours of birth, females will go into estrous within a few weeks (Currier 1983). In addition, competing males have been

known to commit infanticide<sup>4</sup>, presumably to trigger estrous in females, though scientists are still investigating what drives this behavior.

Gestation lasts 82-96 days (Young and Goldman 1946; Currier 1983). Litter size ranges from 1-6, though 2-4 kittens per litter are typical (Pierce and Bleich 2003; Beier et al 2010; Riley et al. 2014). Females average larger litters during their first year of reproduction and tend towards smaller litters when they are older (Pierce and Bleich 2003). The sex ratio of litters has generally been found to be equal (Pierce and Bleich 2003). Females keep their kittens in dens located in rocky terrain or in dense vegetation that provide cover (Young and Goldman 1946), and they may move their young to several different dens until the young are weaned at about 2-3 months old (Pierce and Bleich 2003). Denning mountain lions have been found to avoid roads and stay at a distance from human disturbance four times greater (~600m) than non-reproductive mountain lions (~150m) (Wilmers et al. 2013).

Females care for their young for 1-2 years, at which point the mother comes into estrous and either abandons the cubs or acts aggressively towards them to prevent them from following her, as older males will kill cubs (Young and Goldman 1946; Seidensticker et al. 1973; Currier 1983; Beier 1995; Pierce and Bleich 2003). Newly independent young have been found to stay in the area where the mother leaves them for 2-3 weeks, and then disperse away from the direction their mother left (Beier 1995). Typically 50% of females stay in their natal range and 50% disperse while all males disperse, and siblings sometimes travel for a short time together (Pierce and Bleich 2003; Logan and Sweanor 2010). Subadult mountain lions may disperse up to 500km from their natal home ranges as they explore and establish their own territories (Pierce and Bleich 2003).

Mountain lions reach sexual maturity at 2-4 years of age. Although they are rarely known to mate until they have an established home range, transient males may occasionally breed with resident females (Hornocker 1970; Seidensticker et al. 1973; Currier 1983).

#### 2.4 *Diet and Foraging Ecology*



Mountain lion cub feasting on a deer kill in the Santa Monica Mountains. Photo: NPS.

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<sup>4</sup> Infanticide has been documented in the Santa Monica Mountains mountain lion population. More information from the NPS is available here: <https://www.nps.gov/samo/learn/nature/puma-profiles.htm>



Large ungulates, especially deer, are the preferred prey of mountain lions, making up about 70% of their diet (Currier 1983; Iriarte et al. 1990). Hornocker (1970) estimated that the average adult mountain lion consumes 860-1,300kg of large prey annually. However, mountain lions are opportunistic predators, and they have been documented eating a wide variety of other large and smaller prey, including moose, elk, wild horses, burros, pronghorn, bighorn sheep, mountain goats, wild hogs, coyotes, bobcats, porcupines, badgers, rabbits, raccoons, rodents, turkeys, and livestock (Currier 1983; Iriarte et al. 1990; Garcelon unpublished data).

Their diet can vary by prey availability, prey vulnerability, the presence of sympatric carnivores, the season, and the age and sex of the mountain lion (Currier 1983; Iriarte et al. 1990; Knopff et al. 2010; Allen et al. 2014a). For example, deer have been found to make up >90% of the diet in mountain lions in the Santa Monica Mountains and in Northern California (Allen et al. 2014a; Riley et al. 2014), while in Florida wild hogs were found to be the most common prey (Maehr et al. 1990), and in northwestern Sonora, Mexico bighorn sheep were found to be the primary prey (Rosas-Rosas et al. 2003). These observed patterns were likely due to the availability of different prey in different geographic regions. A study conducted in Alberta, Canada, Knopff et al. (2010) found that while adult females were more likely to kill small ungulates (*e.g.*, deer), adult males were more likely to kill larger ungulates (*e.g.*, elk), and subadults relied on both small ungulates and nonungulate prey (*e.g.*, beavers, snow hares). A similar pattern was found in a mountain lion population in the Greater Yellowstone Ecosystem, in which older, larger individuals hunted larger prey and younger, smaller individuals hunted smaller prey (Elbroch and Quigley 2019). In addition, mountain lions were found to prey upon female ungulates in the spring before and during the birthing period, and they would more often prey upon male ungulates in the fall during the rut, highlighting that prey vulnerability may play a role in mountain lion predation (Knopff et al. 2010).



Mountain lion preying on a coyote in Joshua Tree, California. Photo: Brendan Cummings

Mountain lions roam through expansive home ranges in search of prey, often hunting between dusk and dawn. Although they are generally most active at dusk and dawn, their peak activities have been observed to shift to more nocturnal patterns when they are closer to human

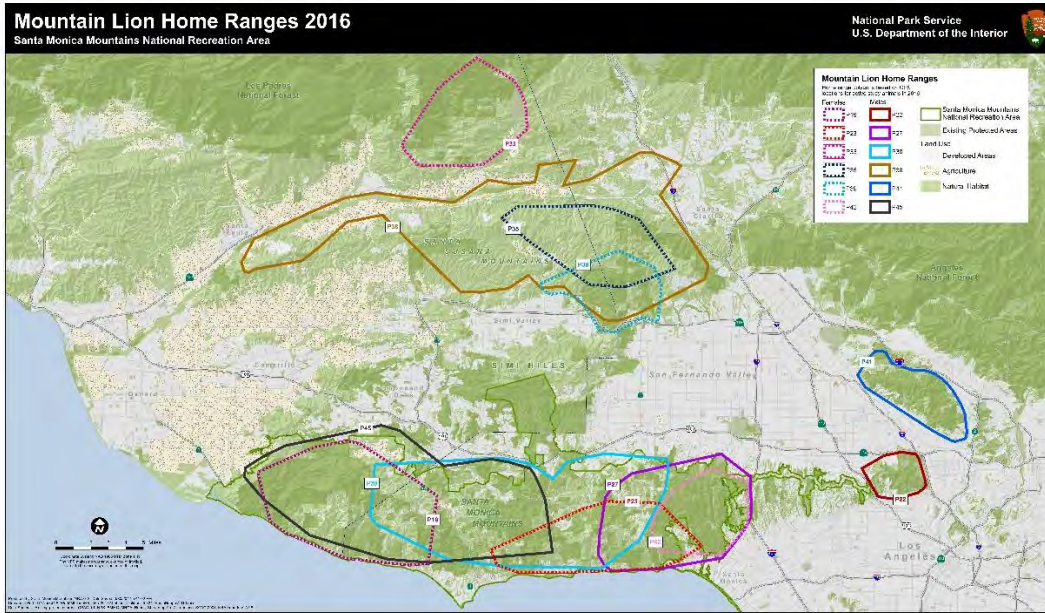
disturbance (Van Dyke et al. 1986). Mountain lions are primarily solitary animals and will repeatedly move and wait as they stalk and ambush their prey (Beier et al. 1995). Once within close proximity, mountain lions will lunge at their prey and kill the animal by crushing the trachea and suffocating it or by breaking its neck at the base of the skull with a bite (Currier 1983; Pierce and Bleich 2003). Instead of eating their kill right away, mountain lions drag their kill to a secluded spot to feed. They cover it with brush and other debris and return to feed at night for up to five days (Currier 1983; Beier et al. 1995). However, the presence or perceived presence of humans has been found to reduce overall feeding time (Smith et al. 2015; Smith et al. 2017).

Deer kill rates vary depending on the sex of the mountain lion, whether or not the female has cubs, and surrounding human land use. Male kill rates have been found to range from 35 to 47 ungulates per year, regardless of housing density (Anderson, Jr. and Lindzey 2003; Cooley et al. 2008; Knopff et al. 2010; Smith et al. 2015). However, kill rates for females differ depending on human disturbance. In lower density housing areas, kill rates of solitary females and females with kittens have been found to be 52-60 and 57-68 ungulates per year, respectively, while females in high density housing areas were found to have a kill rate of 81 ungulates per year (Anderson, Jr. and Lindzey 2003; Cooley et al. 2008; Knopff et al. 2010; Smith et al. 2015). This pattern could be driven by reduced time spent at kill sites in more developed areas, indicating that females are not consuming as much of each carcass and therefore need to kill more prey (Smith et al. 2015). This may reflect a trade-off made by females to choose feeding sites closer to human-disturbed areas and expend more energy killing prey in order to reduce potential encounters with males that pose a threat to themselves or their kittens (Benson et al. 2016b). Another factor that may be contributing to higher kill rates in developed areas is that mountain lions expend more energy traveling faster and farther in human-dominated landscapes and therefore require increased caloric intake compared to mountain lions away from developed areas (Wang et al. 2017).

## 2.5 *Habitat Requirements*

Mountain lions are primarily solitary (except in certain situations, such as when breeding, when females are rearing cubs, or when dispersing with siblings), territorial cats that occur in low density. They require large areas of relatively undisturbed habitats with adequate connectivity to allow for dispersal and gene flow. They have large home ranges that include heterogenous habitats. In the United States these often consist of pine forests, riparian and oak woodlands, streams, chaparral, and grasslands, though they are also known to occur in desert habitats (e.g., Figure 3).





**Figure 3.** Home ranges of mountain lions being actively studied in 2016 by NPS in and near the Santa Monica Mountains. Source: NPS.

Mountain lions have been found to utilize different habitats within a 24-hour period (Dickson and Beier 2002; Dickson et al. 2005; Dickson and Beier 2006; Kertson et al. 2011; Zeller et al. 2017). Riparian habitats were found to be preferred over grasslands and human-disturbed areas during the day, which likely represents the animals resting in areas with understory vegetation for cover (Dickson and Beier 2002; Dickson et al. 2005). However, nocturnal movement patterns showed that mountain lions utilize a broad range of habitats as they travel through their home ranges and hunt (Dickson et al. 2005). Although riparian vegetation was the highest ranked habitat for nocturnal use, usage of riparian areas was not statistically different from the use of scrub, chaparral, grasslands, or woodlands (Dickson et al. 2005).

Nocturnal patterns of movement and stasis suggest that mountain lions generally avoid areas with human disturbance (*i.e.*, residential developments and two-lane paved roads) and use a variety of habitats to stalk and pursue their prey (Dickson and Beier 2002; Dickson et al. 2005). In addition, Dickson and Beier (2006) found that when mountain lions were traveling or hunting, they preferred canyon bottoms and gentle slopes and used steeper slopes and ridgelines to a lesser extent. And Benson et al. (2016b) found that mountain lions tend to choose feeding sites on steeper slopes in habitats with dense understory vegetation, such as chaparral, scrub, and upland forest. Although mountain lions will use moderately disturbed areas as they travel and hunt (Wilmers et al. 2013; Gray et al. 2016), occupancy is lower in developed areas and they are more likely to use developed areas if they border open spaces (Wang et al. 2015). Thus, mountain lions require a habitat mosaic that provides sufficient room to roam away from human-disturbed areas and connected to expansive, intact, heterogeneous habitats (Beier 1995; Dickson and Beier 2002; Dickson et al. 2005; Kertson et al. 2011; Zeller et al. 2017).

Home range size can vary depending on geographic area, season, sex, reproductive status, and prey density (Currier 1983; Grigione et al. 2002; Riley et al. 2014). Males generally have

much larger home ranges than females, and females with cubs tend to have even smaller home ranges (Beier et al. 1995; Grigione et al. 2002). Male home ranges tend to include partially or entirely overlapping female home ranges, and to a limited extent, they may partially overlap with other male home ranges (Figure 3) (Seidensticker et al. 1973; Currier 1983; Pierce and Bleich 2003). Mountain lions mark their home ranges with scrapings in the ground, often containing urine or feces (Seidensticker et al. 1973). Males make scrapings more often than females (Allen et al. 2014b), and females may only make scrapings when they are in estrous (Seidensticker et al. 1973; Currier 1983; Pierce and Bleich 2003).

Seasonal variation in home range size can differ depending on geographic area. Grigione et al. (2002), found strong influences of seasonality in average mountain lion home ranges in the Sierra Nevada mountains, with much larger home ranges in the summer (541km<sup>2</sup> for females, 723km<sup>2</sup> for males) compared to those in the winter (349km<sup>2</sup> for females, 569km<sup>2</sup> for males). These patterns likely reflect the abundance and distribution of deer – during the winter deer would be concentrated at lower elevations, which allowed mountain lions to reduce their home ranges, while in the summer deer could disperse to higher elevations and the mountain lions would expand their ranges accordingly (Grigione et al. 2002). However, seasonal variation was not as pronounced and had the reverse trend in Coastal California mountain ranges, including in the SAM, where the average area of winter home ranges was slightly larger (100km<sup>2</sup> for females, 350km<sup>2</sup> for males) than summer home ranges (90km<sup>2</sup> for females, 300km<sup>2</sup> for males) (Grigione et al. 2002). These differences were not statistically significant, and this pattern is likely due to the moderate year-round climate in the coastal ranges, where prey abundance and distribution does not exhibit as extreme shifts as those in the Sierra Nevada (Grigione et al. 2002). This generally aligns with Zeller et al. (2017), who found that mountain lion home ranges in the SAM and EPR ranged from 41-497 km<sup>2</sup>, with mean home range sizes of 188km<sup>2</sup> for females and 316 km<sup>2</sup> for males. And Riley et al. (2014) found that CC-S mountain lions had home ranges similar in size to the SAM and EPR mountain lions, with female home ranges being 100-200km<sup>2</sup> and male home ranges being 300-500 km<sup>2</sup>. According to the Santa Cruz Puma Project, in the Santa Cruz Mountains female home ranges are on average about 100 km<sup>2</sup> and male home ranges are about 230 km<sup>2</sup> (Santa Cruz Puma Project 2015). Although studies are limited regarding the home range size of the CC-C and SGSB mountain lions, given their close proximity and similar seasonality to other Central Coast and Southern California populations, they are likely similar.

## 2.6 *Survivorship and Mortality*

According to the National Park Service (NPS), mountain lions can live up to 13 years in the wild. As a top carnivore with no natural predators, conspecifics and humans are the main drivers of mountain lion survivorship and mortality. Although studies regarding kitten (<18 months), subadult (18-30 months), and adult (>30 months) survivorship are limited, some long-term studies of radio-collared mountain lions on the CC-S, SAM, and EPR provide valuable insights for these Central Coast and Southern California populations (Beier and Barrett 1993; Riley et al. 2014; Vickers et al. 2015).

In a study conducted in the CC-S area (which encompasses the Santa Monica Mountains, Simi Hills, and Santa Susana Mountains) that included 42 mountain lions from 2002 to 2012, Riley et al. (2014) found an annual adult survival of  $\geq 75\%$ , though Benson et al. (2016a) found

lower subadult survival rates. Although adult survival in the CC-S is similar to previous studies conducted in California and the southwestern US (Beier 1993; Logan and Sweanor 2001), it is higher than what was found in the SAM and EPR populations during the same time period. From following 74 radio-collared mountain lions from 2001 to 2013, Vickers et al. (2015) found an annual survival rate across all age groups of 56.5% and 55.4% in the SAM and EPR, respectively.



In the Santa Monica Mountains: Female mountain lion P-23 hunted down a deer on Mulholland Drive (left). In 2018 she was killed by a vehicle strike on Malibu Canyon Road. An uncollared mountain lion killed by a vehicle strike on Malibu Canyon Road in 2004 (right). Photos: NPS

Vehicle strikes, depredation kills, and intraspecific strife (including male aggression towards conspecifics and infanticide) are the primary causes of mortality in the Central Coast and Southern California populations (Beier 1993; Riley et al. 2014; Vickers et al. 2015). Other known causes of death in California mountain lion populations include rodenticide poisoning, disease, poaching/illegally killing, starvation/abandonment, public safety removal, and human-caused wildfires (Beier 1993; Riley et al. 2014; Vickers et al. 2015). Causes of mortality will be discussed more in depth in *Section 5.0 Abundance and Population Trends* and *Section 6.0 Factors Affecting Ability to Survive and Reproduce*.

### **3 Southern California and Central Coast Mountain Lions Comprise an Evolutionarily Significant Unit**

#### *3.1 CESA Provides for Listing of ESUs*

CESA defines an “endangered species” as a species or subspecies of animal or plant that is in serious danger of becoming extinct through either all or “a significant portion” of its range. (Cal. Fish & Game Code § 2062.) A “threatened species” is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts. (Cal. Fish & Game Code § 2067.) CDFW has concluded—and appellate courts have upheld—that the term “range” is construed to refer to the range of a species or subspecies *within* California, not the worldwide range of the species or subspecies. (*California Forestry Assn. v. California Fish & Game Com.* (2007) 156 Cal.App.4th 1535, 1550-551.) This means that a species or subspecies which may not be endangered in other states or countries may still be endangered within California. Courts also have confirmed that the phrase “significant portion” of

a range authorizes CDFW to designate certain populations of a species or subspecies as “evolutionarily significant units” or “ESUs” and list such populations as endangered under CESA. (*Id.* at 1549; *Central Coast Forest Assn. v. Fish & Game Com.* (2018) 18 Cal.App.5th 1191, 1236-37 [“CCFA IP”].) In other words, ESUs are a population of a species or subspecies “that is considered distinct for purposes of conservation.” (*Central Coast Forest Assn. v. Fish & Game Com.* (2012) 211 Cal.App.4th 1433, 1439 fn 5 [depublished] [“CCFA P”].)

CDFW has confirmed that the use of ESUs to evaluate the status of species pursuant to CESA is appropriate.<sup>5</sup> In the *Status Review of Fisher*, CDFW designated fishers in northern California and the southern Sierra Nevada as two separate ESUs based upon the reproductive isolation of these fisher populations and the degree of genetic differentiation between them. In designating these ESUs, CDFW highlighted the need to maintain “geographically widespread and genetically diverse” populations of the species.

### 3.2 *Southern California and Central Coast Mountain Lions are Significantly Reproductively Isolated from Other Populations and Form an ESU*

Southern California and Central Coast mountain lion populations could be grouped into one or several potential ESUs. However, petitioners believe that for purposes of listing under CESA, treating the CC-N, CC-C, CC-S, SAM, SGSB, and EPR populations as a single Southern California/Central Coast ESU is both supported by the best available science and makes sense from a management perspective. Gustafson et al. (2018) suggest that the North Coast and inland populations (Nevada, Eastern Sierra Nevada, and Western Sierra Nevada) may form an ESU (hereinafter “North Coast/Inland ESU”) given that they were found to be genetically diverse and well-connected. Due to extreme isolation and high levels of human-caused mortalities, functional connectivity between Southern California and Central Coast mountain lion populations and the healthier North Coast/Inland ESU has become severely impaired (Gustafson et al. 2018, see further discussion in *Section 2.2 Taxonomy and Population Genetics* and *Section 6.0 Factors Affecting Ability to Survive and Reproduce*). There is a tenuous link made up of small mountain ranges (*i.e.*, Tehachapi and Sierra Pelona Mountains) that connect the North Coast/Inland ESU with the proposed Southern California/Central Coast ESU. Thus, although there is some (limited) connectivity between the North Coast/Inland ESU and the proposed ESU, as a practical matter under current management the two ESUs are functionally isolated.

Southern California and Central Coast populations have lower levels of genetic diversity and are relatively disconnected from each other compared to North Coast and inland populations. The Central Coast populations form a genetic cluster while the SAM and EPR populations form a second, less connected genetic cluster (Figure 4) (Gustafson et al. 2018). The SGSB population, though isolated, is most genetically similar to the Western Sierra Nevada, CC-C, and EPR populations, which indicates that it is an important intersection for statewide genetic connectivity (Figure 4) (Gustafson et al. 2018).

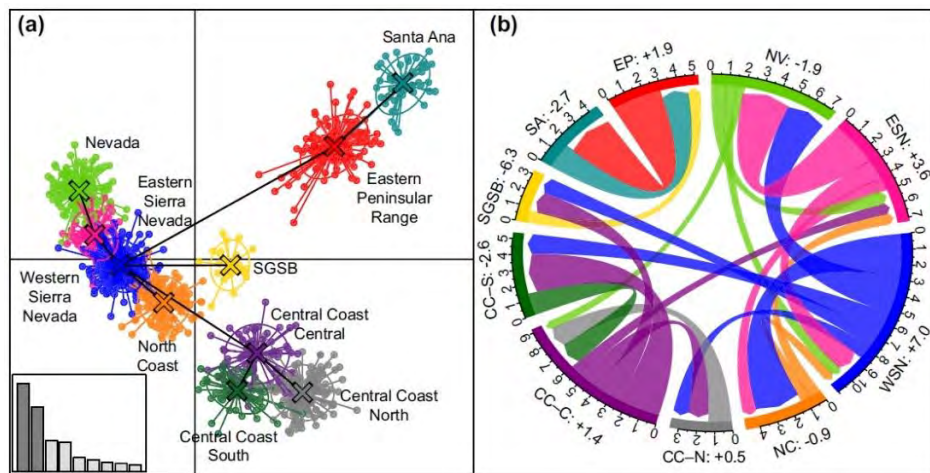
Genetic source-sink dynamics are informative in determining gene flow among the populations and how they are connected. Five genetic source populations were identified: the

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<sup>5</sup> California Department of Fish and Wildlife, *Status Review of Fisher* (June 10, 2015), available at <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=101470>.



Eastern and Western Sierra Nevada populations, CC-N, CC-C, and EPR (Gustafson et al. 2018). The Sierra Nevada populations were the greatest genetic source populations and the CC-N population had only weak evidence of being a source population (Gustafson et al. 2018). The CC-S, SGSB, and SAM were identified as genetic sink populations with limited connectivity to source populations (Figure 4) (Gustafson et al. 2018). Maintaining and reestablishing genetic connectivity with source populations like the CC-C, EPR, and Western Sierra Nevada populations are important for the long-term viability of Southern California and Central Coast populations (Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Gray et al. 2016; Gustafson et al. 2017). This underscores the importance of the Tehachapi and Sierra Pelona Mountains as the key remaining linkage, though tenuous, for statewide genetic connectivity.



**Figure 4.** Functional connectedness of California mountain lion populations. Each color represents a genetically distinct population. In (a), the results of the discriminant analysis of principal components shows connectivity among California mountain lions. The x-axis represents latitude with north to the left and south to the right. The y-axis represents longitude, separating the Central Coast populations from Southern California populations. In (b), estimated migration rates between populations are shown. Source-sink dynamics are indicated by positive (source) or negative (sink) net migration rates. Source: Gustafson et al. (2018).

While genetics as currently understood could support several different ESU formulations, petitioners believe a single Southern California/Central Coast ESU is the most pragmatic from a management perspective, as recovery of the individual subpopulations ultimately depends upon maintaining and/or reestablishing connectivity between them. *See CCFA II*, 18 Cal.App.5th 1191, 1237 (“[T]he nature of the ESU designation is such that genetics alone are not determinative: One must look beyond genetics to questions of policy to determine which populations to include in an ESU.”) (quotations omitted). Designating Southern California and Central Coast mountain lions as an ESU would help ensure “geographically widespread and genetically diverse” populations of mountain lions in California.

While petitioners believe that listing of a single Southern California/Central Coast ESU as threatened is both a permissible and prudent course of action for the Commission, petitioners also request that as additional data become available over the course of CDFW conducting its status review that the agency also assess other possible ESU formulations for Southern California and Central Coast mountain lions. One such formulation would be to group all three Central Coast populations (CC-N, CC-C and CC-S) into one ESU, with the remaining three



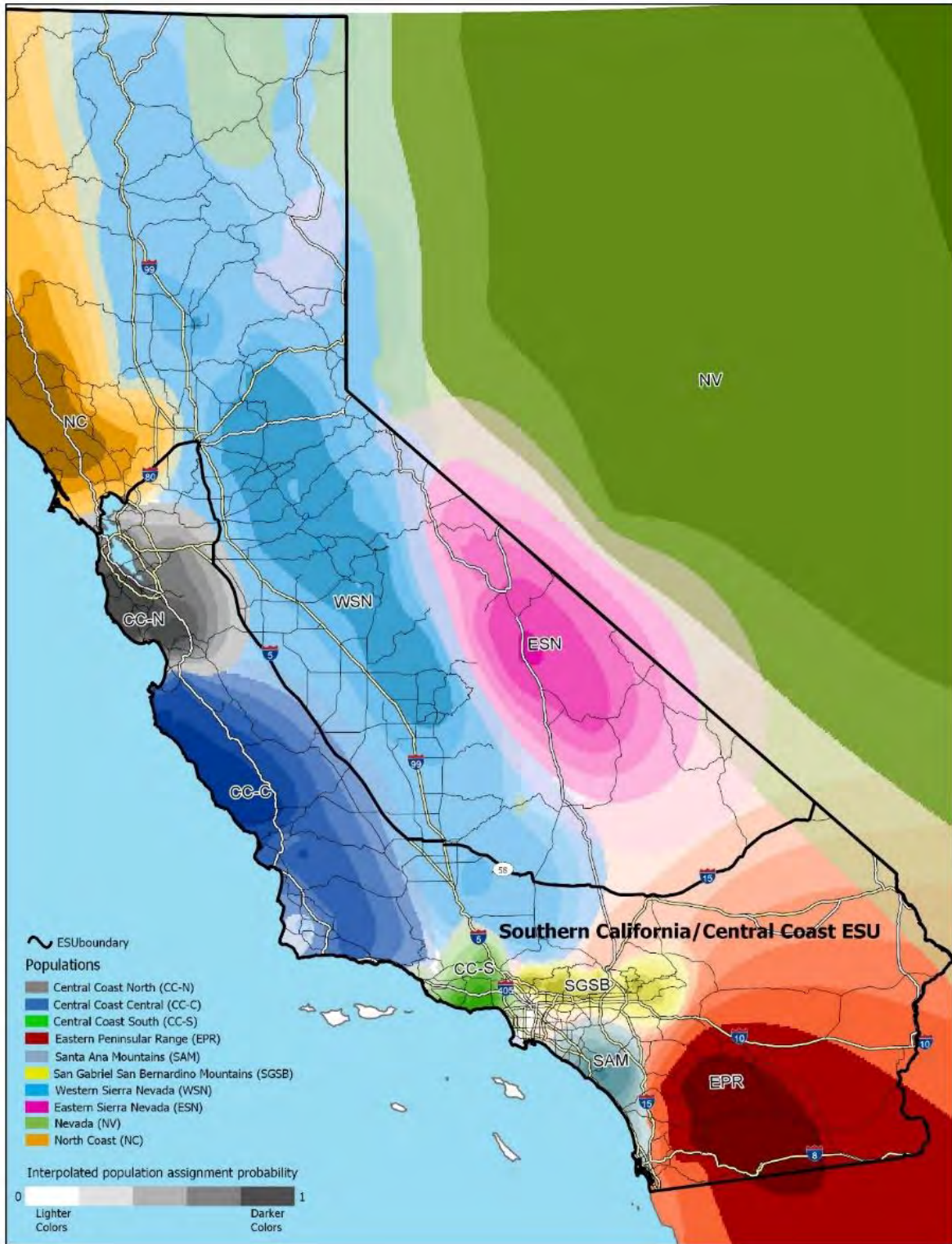
populations placed into a second ESU (SAM, EPR and SGSB). Alternatively, the Central Coast populations could be treated as one ESU, SAM and EPR as a second ESU, and SGSB separately listed as a third ESU. Petitioners believe the genetic data in Gustafson et al. (2018) could support each of these alternative formulations. Lastly, given each of the six populations at issue are themselves already genetically distinguishable and occupy significant portions of the range of mountain lions in California, each could be separately treated as an ESU. Under this formulation, the SAM and CC-S populations would clearly warrant endangered listing, the CC-C and EPR populations would warrant threatened listing, and the CC-N and SGSB populations would warrant at least threatened and likely endangered listing.

### *3.3 Proposed Boundary of the Southern California/Central Coast ESU*

We propose the Southern California/Central Coast ESU to include mountain lions that occur in areas east of the Pacific Ocean, south of the San Francisco Bay Area waters and I-80, west of I-5 to the intersection of I-5 and SR-58 at Bowerbank/Buttonwillow, south of SR-58 to I-15, south of the I-15 from the SR-58 intersection to the California-Nevada border, and, for the purposes of CESA, north of the California-Mexico border (Figure 5). These boundaries are recommended as they include virtually all mountain lions associated with the six populations comprising the ESU and are also unambiguous and readily discernable for purposes of management.<sup>6</sup>

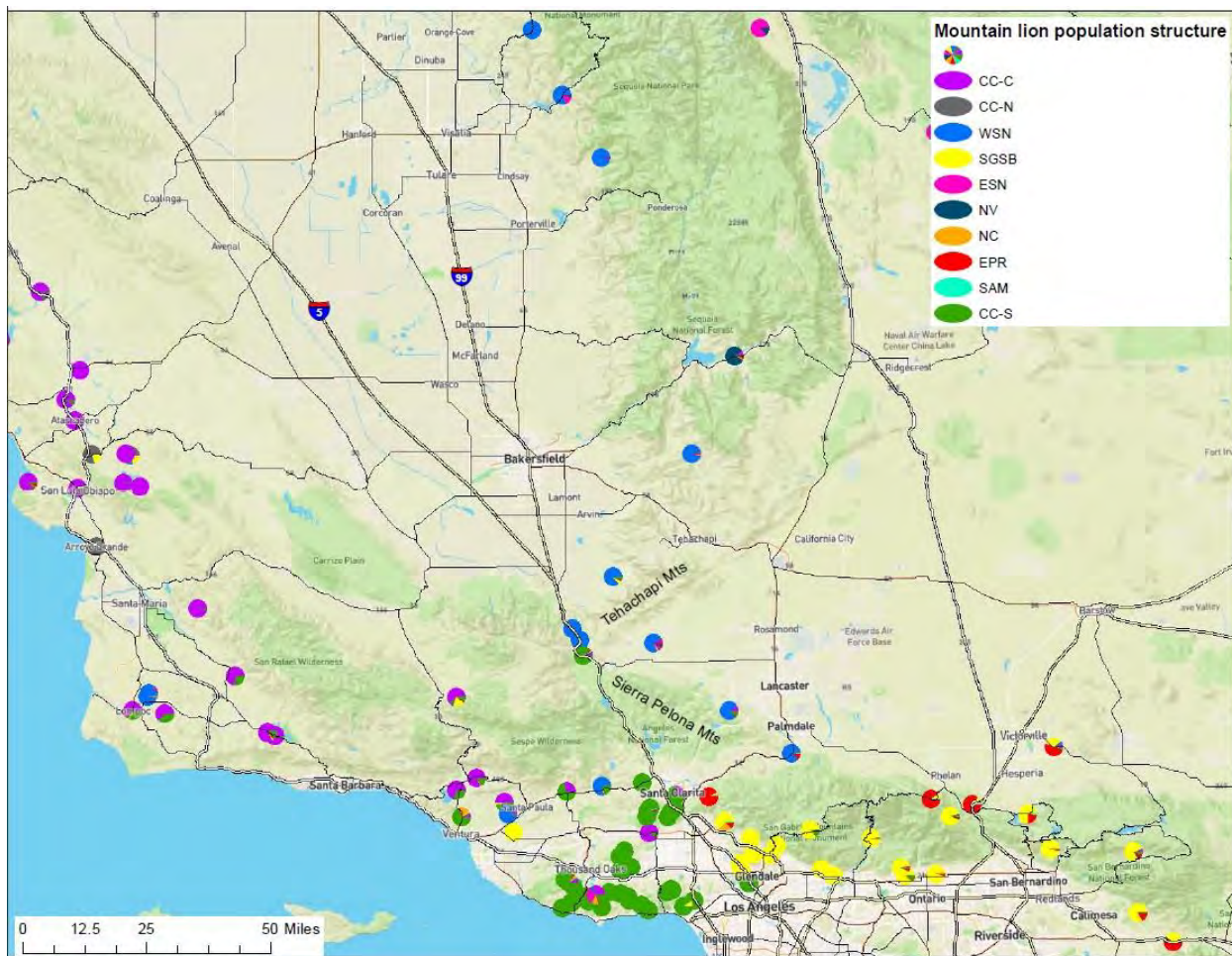
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<sup>6</sup> In the event the Commission determines that the proposed ESU should instead be treated as separate Southern California (SAM, EPR, SGSB) and Central Coast (CS-N, CS-C, CS-S) ESUs, we propose the boundary between them to be delimited by I-5 and I-710.



**Figure 5.** Map of the Southern California/Central Coast ESU boundary. Derived from Gustafson et al. (2018). Genetics data source: Kyle Gustafson, PhD, Department of Biology and Environmental Health, Missouri Southern State University, and Holly Ernest, DVM, PhD, Department of Veterinary Sciences, Program in Ecology, University of Wyoming, Laramie. Roads data source: ESRI.

We recommend including mountain lions in the Tehachapi and Sierra Pelona Mountains south of SR-58 in the Southern California/Central Coast ESU. While most mountain lions sampled from this region share some genetic affinities with Western Sierra Nevada (WSN) animals, individuals sampled in the Tehachapi Mountains and surrounding areas, including the Sierra Pelona Mountains in the Angeles National Forest and the Los Padres National Forest, had genetic structures made up of multiple genetic populations from the northern, central coastal, and southern populations (Figure 6). This area serves not just as a connecting link between mountain lion populations comprising the Southern California/Central Coast ESU, but also between this ESU and all other California mountain lions. The Tehachapi and Sierra Pelona Mountains are the last remaining linkages for statewide genetic connectivity and are critical for the overall genetic health of Southern California and Central Coast mountain lions. Consequently, mountain lions in these areas should be considered part of the listed entity.



**Figure 6.** Map of mountain lion genetic structure in and surrounding the Tehachapi and Sierra Pelona Mountains, the last remaining linkage between the coastal, southern, and northern populations. Data source: Kyle Gustafson, PhD, Department of Biology and Environmental Health, Missouri Southern State University, and Holly Ernest, DVM, PhD, Department of Veterinary Sciences, Program in Ecology, University of Wyoming, Laramie.

### 3.4 *Southern California and Central Coast Mountains Lions are Essential to the Region's Biodiversity*

Additional support for designation of a Southern California/Central Coast ESU is provided by the fact that mountain lions are a keystone species critical to maintaining biodiversity in coastal California's ecosystems. The loss of these mountain lions—which are the only remaining large predator in the region—would lead to a trophic cascade wherein deer populations would increase and overgraze vegetation due to the lack of predation and lack of risk of predation, causing other repercussions to other species and habitats (Ripple and Beschta 2006; Ripple and Beschta 2008; Ripple et al. 2014). In addition, their kills are an important source of food for multiple terrestrial and avian scavengers (Ruth and Elbroch 2014; Elbroch et al. 2017; Barry et al. 2019).

Ripple and Beschta (2006) highlighted the critical role of mountain lions in western ecosystems by comparing habitat quality and the levels of biodiversity in two separate areas of Zion National Park – Zion Canyon, which mountain lions generally avoid due to high human presence, and North Creek, which mountain lions inhabit due to less human presence. The sustained lack of mountain lions in Zion Canyon has led to an unnaturally high density of deer, which has had profound impacts on Zion Canyon ecosystems. Ripple and Beschta (2006) observed Zion Canyon had low numbers of hydrophytic plants, wildflowers, amphibians, lizards, and butterflies while North Creek had significantly higher numbers in each of these categories.

North Creek riparian areas had well vegetated and stable banks while Zion Canyon lacked bank vegetation and its banks were continuing to erode (Ripple and Beschta 2006). The study noted that such geomorphic transformation of stream channels where mountain lions were absent were caused by plant loss on stream banks, which led to high levels of erosion and sedimentation, less shading and higher water temperatures, a larger width:depth ratio in streams, loss of hydrologic connectivity with historical floodplains, and loss of a wide variety of species, including native plants, benthic invertebrates, butterflies, fish, amphibians, and reptiles (Ripple and Beschta 2006).

The study concluded that removing a large carnivore from an ecosystem “appears to have [] profound effects on lower trophic levels, as well as multiple indicators of ecosystem status and native species abundance.” (Ripple and Beschta 2006.) A similar study found that in Yosemite Valley—where mountain lions are largely absent due to high human presence—deer populations have expanded leading to a lack of oak recruitment and a decrease in biodiversity (Ripple and Beschta 2008). And their kills support disproportionately high levels of mammal, bird, and invertebrate diversity (Ruth and Elbroch 2014; Elbroch et al. 2017; Barry et al. 2019) and may even play a role in tree and other vegetation growth (Ruth and Elbroch 2014). In sum, extinction of Southern California and Central Coast mountain lions would result in degraded habitats and reduced abundance and diversity of other species, likely undermining the biological diversity, ecosystem function, and resilience of California's coastal regions.



### 3.5 *Californians Derive Aesthetic, Recreational, and Economic Value from Southern California and Central Coast Mountain Lions*

The people of California derive aesthetic, recreational, economic, spiritual, scientific, educational, and emotional value from Southern California and Central Coast mountain lions. For instance, the City of Los Angeles has designated October 22 as “P-22 day” to honor a young (and mate-less) male mountain lion that lives in Griffith Park and to acknowledge the importance of Southern California mountain lions to the region. Many people view mountain lions as a symbol of wildness and cherish landscapes that still are home to these predators. People from within and beyond the region choose to recreate, hike, bike, camp, fish, and hunt in California’s wildlands in part because they enjoy exploring and sharing landscapes with mountain lions. And these activities are a significant economic driver for the state: A report commissioned for California State Parks found that direct outdoor recreation expenditures for Los Angeles, Southern California, the Central Coast and the San Francisco Bay Area totaled nearly \$15 billion per year.<sup>7</sup> The Outdoor Industry Association concluded that outdoor recreation in California generates \$92 billion of consumer spending annually and directly employs 691,000 Californians—more jobs than the wine and television industry combined.<sup>8</sup>

Mountain lions also provide an economic and social benefit because, by controlling deer populations, they reduce collisions between deer and automobiles. There are 1.2 million deer-vehicle collisions in the United States per year, incurring an estimated \$1.66 billion in damages, 29,000 injuries, and 200 deaths (Gilbert et al. 2016). Impacts of deer-vehicle collisions are particularly severe in the eastern United States where white-tailed deer are overabundant. Gilbert et al. (2016) determined that if mountain lions recolonized the eastern United States, their presence would result in a 22 percent decline in deer-vehicle collisions over thirty years.

It is estimated that 7,000 to 23,000 wildlife vehicle collisions have occurred annually on California roads (Shilling et al. 2017; Shilling et al. 2018; State Farm Insurance Company 2016, 2018). These crashes result in human loss of life, injuries, emotional trauma, and property damages that can add up to \$300-600 million per year (Shilling et al. 2018). If Southern California and Central Coast mountain lions became extinct, there would likely be a significant increase in deer-vehicle collisions in the region, along with associated human fatalities, injuries, and property damage.

An overabundance of deer in the eastern United States is also linked to an increase in ticks, which has led to increased incidences of Lyme disease among humans (Telford 2017; Côté et al. 2004). Lyme disease is now the most common vector-borne illness in the United States, with over 30,000 cases per year, primarily in the eastern United States.<sup>9</sup> Increases in deer abundance and attendant increases in ticks and tick-borne disease among humans would be

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<sup>7</sup> BBC Research & Consulting, *California Outdoor Recreation Economic Study: Statewide Contribution and Benefits* (2010), available at <https://www.parks.ca.gov/pages/795/files/ca%20outdoor%20rec%20econ%20study-statewide%2011-10-11%20for%20posting.pdf>.

<sup>8</sup> Outdoor Industry Association, *California Recreation Report*, available at [https://outdoorindustry.org/wp-content/uploads/2017/07/OIA\\_RecEcoState\\_CA.pdf](https://outdoorindustry.org/wp-content/uploads/2017/07/OIA_RecEcoState_CA.pdf).

<sup>9</sup> Centers for Disease Control and Prevention, *Lyme Disease Data and Surveillance*, available at [https://www.cdc.gov/lyme/datasurveillance/index.html?CDC\\_AA\\_refVal=https%3A%2F%2Fwww.cdc.gov%2Flyme%2Fstats%2Findex.html](https://www.cdc.gov/lyme/datasurveillance/index.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Flyme%2Fstats%2Findex.html).



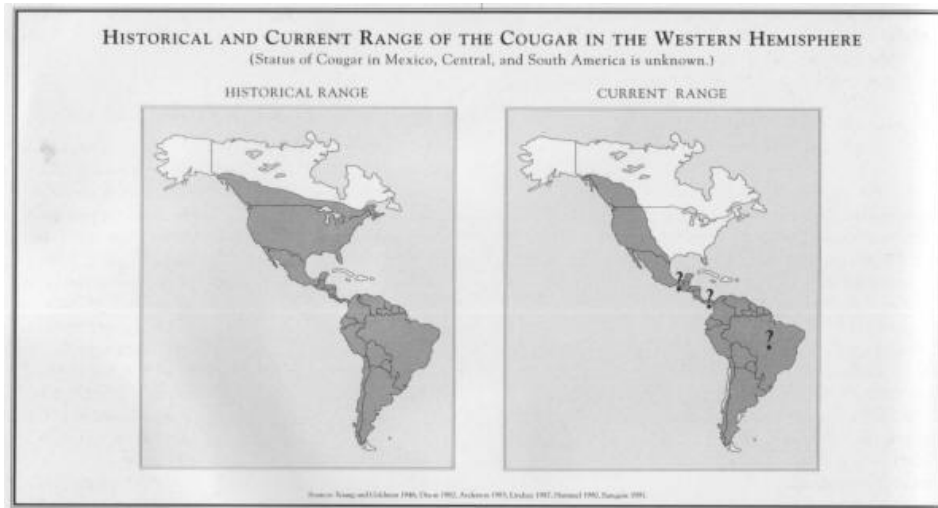
expected if Southern California and Central Coast mountain lions became extinct. Loss of Southern California and Central Coast mountain lions would have far-reaching effects not only on California's ecology, but also on public health and the region's economy.

Protection of Southern California and Central Coast mountain lions under CESA would confirm that this species is a vital member of our ecosystems which is worthy of protection. Conservation of these mountain lions would provide compelling evidence that large carnivores and abundant human populations can co-exist, even in densely populated landscapes (Benson et al. 2019).

#### 4 Historical and Current Distribution

Mountain lions once had the most expansive range of any New World terrestrial mammal (Seidensticker 1991). They roamed most of the Americas (excluding most of Alaska and the northern areas of Canada) from approximately 50° N to 50°S latitude and could be found from sea level to about 4,000m elevation (Young and Goldman 1946, Pierce and Bleich 2003) in habitats varying from dense forests, to dry deserts, savannahs, and swamp lands.

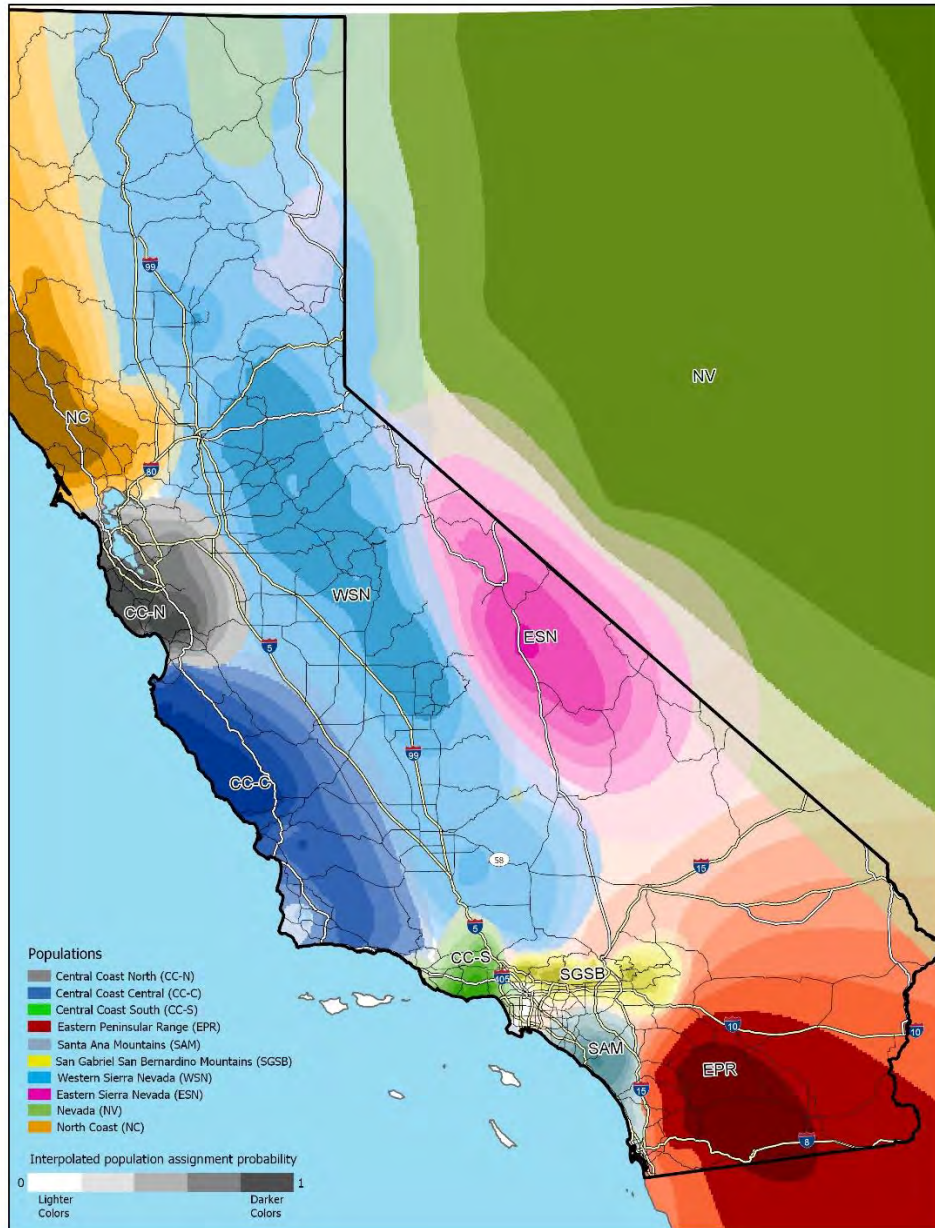
Due to habitat loss and hunting after the arrival of European colonists, the mountain lion's current range has been reduced to one third of its historical range in North America (Figure 7) (Culver et al. 2000; Pierce and Bleich 2003). In the United States, the species' range has been reduced to 15 western states and a small remnant population in Florida (endangered Florida panthers [*Puma concolor coryi*]), with isolated animals occasionally appearing in additional states. Continued hunting pressure and changes in land management practices have pushed most populations into mountainous, relatively unpopulated areas, though isolated populations are known to occur in more urban areas (Currier 1983; Gustafson et al. 2018).



**Figure 7.** Historical and current range of mountain lions. Source: Hansen 1992.

In California, habitat fragmentation from roads and development has led to highly fragmented, divergent populations (Ernest et al. 2003; Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Gustafson et al. 2018). As mentioned in *Section 2.2 Taxonomy and Population Genetics*, nine genetically distinct populations have been identified within California

(Gustafson et al. 2018), with Southern California and Central Coast populations being the most constrained populations, (and a tenth population centered in Nevada but extending slightly into California). Those located in highly urbanized areas of Southern California coastal mountain ranges, including the CC-S, SAM, and SGSB populations are especially restricted (Figure 8) (Vickers et al. 2015; Benson et al. 2016a; Gustafson et al. 2018; Benson et al. 2019).



**Figure 8.** Map of genetically distinct mountain lion populations and major roads in California. The CC-S (which includes the Santa Monica Mountains), SGSB, and SAM populations are exceptionally constrained. The map is based on data collected from 1992-2016 (the division and status of these populations could change over time and with further research. Derived from Gustafson et al. (2018). Genetics data source: Kyle Gustafson, PhD, Department of Biology and Environmental Health, Missouri Southern State University, and Holly Ernest, DVM, PhD, Department of Veterinary Sciences, Program in Ecology, University of Wyoming, Laramie. Roads data source: ESRI.

#### *4.1 Central Coast North (CC-N) Mountain Lion Population*

The CC-N mountain lion population occurs mostly within the counties of Alameda, Contra Costa, San Mateo, Santa Clara, and Santa Cruz (Figure 8). The area is almost divided into two portions: an eastern half and a western half. The Santa Cruz Mountains make up the core area of the CC-N, bound by the Pacific Coast to the west, development lining the San Francisco Bay to the north and north west, and Highway 101 to the south. The eastern portion of the CC-N consists of various open space and nature preserves in the Berkeley Hills and Diablo Range bound by development lining the San Francisco Bay and Highway 101 and associated developments to the west, San Pablo Bay and Suisun Bay and associated developments to the north, I-5 to the east, and State Route 130 (SR-130) to the south. Interestingly, the CC-N seems almost bisected by the San Francisco Bay and Highway 101 and associated developments.

#### *4.2 Central Coast Central (CC-C) Mountain Lion Population*

The CC-C mountain lion population occurs mostly within the counties of Monterey, San Benito, San Luis Obispo, and Santa Barbara. The area encompasses the central and southern portions of the Southern Coast Ranges, including the Santa Lucia Range, Sierra de Salinas, the Temblor Range, and the Sierra Madre Mountains. It is bound by the Pacific Ocean to the west, Highway 101 and SR-156 and associated development to the north, the I-5 and San Joaquin Valley to the east, and SR-126 and associated developments to the south (Figure 8).

#### *4.3 Central Coast South (CC-S) Mountain Lion Population*

The CC-S mountain lion population is limited to the Santa Monica Mountains, Simi Hills, and the Santa Susana Mountains in Ventura and Los Angeles Counties (Figure 8). The Santa Monica Mountains population has the isolated area with about 660 km<sup>2</sup> within the Santa Monica Mountains National Recreation Area (Riley et al. 2014). The Pacific Ocean lies to the south while the cities of Oxnard, Thousand Oaks, San Fernando Valley, Los Angeles, and Santa Monica and major freeways including Highway 101, Interstate 5 (I-5) and Interstate 405 surround the area and create major movement barriers.

The Simi Hills is a smaller area of open space located north of the Santa Monica Mountains; the areas are bisected by Highway 101. This open space is mostly surrounded by development, including Simi Valley to the northwest, Thousand Oaks to the west, Agoura Hills to the southwest, Calabasas to the southeast, and Woodland Hills, Canoga Park, and Chatsworth to the east.

The Santa Susana Mountains are located north of the Santa Monica Mountains and Simi Hills. The area is generally bordered by freeways and the edges of development and agriculture. SR-118 borders the south and southwest, SR-126 borders the north and northwest, and I-5 borders the east.

#### 4.4 *San Gabriel/San Bernardino Mountains (SGSB) Mountain Lion Population*

The SGSB mountain lion population occurs within the Transverse Ranges located northwest of the City of Los Angeles within Los Angeles, Kern, and San Bernardino Counties (Figure 8). The western and southern boundaries of the San Gabriel and San Bernardino Mountains are lined with urban developments and major freeways, including the San Fernando Valley, cities of San Bernardino, Rancho Cucamonga, and West Covina, and the I-5, I-210, and I-10 freeways. The northern and eastern boundaries of the area are abutted by agriculture, suburban development, high desert, and roads.

#### 4.5 *Santa Ana Mountains (SAM) Mountain Lion Population*

The SAM mountain lion population inhabits about 1,533km<sup>2</sup> of undeveloped areas of the SAM within Orange, Riverside, and San Diego Counties (Beier and Barrett 1993; Benson et al. 2019). The area is mostly bound by major freeways and development (Figure 8). SR-241 creates the western boundary, SR-91 borders the northwest boundary, I-5 creates the eastern boundary, and agriculture and development border the southern extent. The closest intact habitat known to be used by other mountain lions is to the east/southeast, in the Peninsular Ranges.

#### 4.6 *Eastern Peninsular Range (EPR) Mountain Lion Population*

The EPR mountain lion population occurs in mountain ranges east of the SAM and south of the San Bernardino Mountains. The EPR is a predominantly north to south range that runs through San Diego, Riverside, and Imperial Counties and the California-Mexico border. They include the San Jacinto, Laguna, and San Ysidro Mountains in California and continue south into the mountain ranges of Baja California, Mexico. The western boundary of the EPR population is lined with roads and urban development, including areas around the cities of Escondido, San Diego, and Chula Vista. Studies regarding the northern, southern, and eastern extent of the population are limited; however, movement patterns documented by Vickers et al. (2015) and Vickers et al. (2017) between 2001 and 2016 suggest that EPR mountain lions generally stay north of the U.S. – Mexico border, along the edges of the desert that borders the east side of the EPR, and south of I-10. Although the EPR population has been found to be largely disconnected from all other California populations, some mountain lion movement was documented traversing between the EPR and SGSB (Vickers et al. 2015), which would have occurred at the northern boundary of the EPR, and there is evidence of limited genetic exchange between the two populations (Gustafson et al. 2018). In addition, one young male mountain lion was documented to the south using the Parque-to-Park Linkage to cross the US-Mexico border several times (where the terrain is too rugged to install a border wall), but he was eventually killed in Mexico in a collision with a vehicle (Vickers et al. 2015; W. Vickers *unpublished data*). Little is known about the mountain lions south of the border, but the movement patterns of EPR mountain lions suggest that they may form a discrete population within the EPR north of the US-Mexico border (Vickers et al. 2015; Vickers et al. 2017).

## 5 Abundance and Population Trends

According to the International Union for Conservation of Nature (IUCN), mountain lion populations are decreasing throughout their remaining range (Nielsen et al. 2015). Mountain lion population densities are generally low, which may be driven by prey density, competition between males for access to females, and mutual avoidance (Pierce and Bleich 2003). In the United States, population densities for mountain lions have been found to range from 0.4 to 4.3 resident adults per 100km<sup>2</sup> and 0.4 to 7.1 total mountain lions per 100km<sup>2</sup>, though it varies by population and the presence of human-induced pressures (*e.g.*, hunting) (Pierce and Bleich 2003). In California, where hunting has been outlawed but other anthropogenic pressures such as roads and development are present, resident adult and total population densities have been found to be 1.1 and 3.6 per 100 km<sup>2</sup>, respectively (Pierce and Bleich 2003). Adult sex ratio has been reported to be about 2-3:1 in favor of females (Hornocker 1970; Seidensticker et al. 1973; Beier 1993; Santa Cruz Puma Project 2015). These low population densities and female-biased sex ratios further highlight the species' need for expansive, connected, heterogeneous habitats to support viable populations.

It has been estimated that 4,000 to 6,000 adult mountain lions roam California (Mansfield and Weaver 1989). However, CDFW acknowledges that this estimate from 1984 is outdated and relied on density estimates from regional studies to derive a statewide abundance. The agency has since declared that the number of mountain lions throughout the state is unknown, and they have embarked on an intensive statewide research project to better understand mountain lion numbers regionally and throughout the state.<sup>10</sup> Working with other agencies, academic institutions, and non-profits, CDFW plans to have statewide and region-specific mountain lion population estimates by 2022 (Vaughan 2018).

As mentioned in *Section 2.2 Taxonomy and Population Genetics*, one way in which the abundance of mountain lions can be estimated is with the ratio of effective to total adult population size ( $N_e/N$ ) of 0.25 to 0.5, as was used by USFWS to generate an abundance estimate for the endangered Florida panther (Ballou et al. 1989; USFWS 2008). Using this method with the estimated effective population sizes of the nine genetically distinct mountain lion populations centered in California from Gustafson et al. (2018) and Benson et al. (2019), the statewide total population would be 818 to 1,634 individuals (255 to 510 in the Central Coast and Southern California populations [Table 1], and 563 to 1,124 in the remaining Eastern Sierra Nevada, Western Sierra Nevada, and North Coast populations), which is much lower than the 4,000 to 6,000 estimate. This is also well below the recommended minimum viable population size of at least 5,000 adult individuals for the long-term persistence of a population (Frankham 1995; Reed et al. 2003; Traill et al. 2010). Petitioners recognize that the  $N_e/N$  methodology has limitations and is but one method of generating an overall abundance estimate. More studies are needed to determine regional and statewide mountain lion abundance, including CDFW's ongoing efforts which should produce a more scientifically robust statewide abundance estimate.

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<sup>10</sup> CDFW 2018 - Commonly Asked Questions About Mountain Lions. Accessed on 11 April 2019 at: <https://www.wildlife.ca.gov/Conservation/Mammals/Mountain-Lion/FAQ#359951241-how-many-mountain-lions-are-in-california>



Despite unknown statewide population estimates, researchers have been closely tracking several of the Central Coast and Southern California populations. Through their published studies and reports they provide some insights regarding abundance and population trends for these populations.

### 5.1 *Central Coast North (CC-N) Mountain Lion Population*

Studies on the CC-N mountain lion population are limited, and abundance and population trends are unknown. However, with an effective population size of 16.6 (Gustafson et al. 2018), and an  $N_e/N$  of 0.25 to 0.5 (Ballou et al. 1989; USFWS 2008), the estimated total adult population would be 33 to 66 individuals (see Table 1). As mentioned previously in *Section 2.2 Taxonomy and Population Genetics*, these numbers are grossly insufficient to prevent inbreeding depression in the short term or maintain evolutionary potential in the long term (Jamieson and Allendorf 2012; Frankham et al. 2014).

Gustafson et al. (2018) found that this population has low genetic diversity and a low effective population size, which suggests that it is at increased risk of inbreeding depression within five generations and eventual extinction. Ongoing studies in the Santa Cruz Mountains highlight high levels of human-caused mortalities. Depredation kills are the leading cause of death in collared mountain lions in the Santa Cruz Mountains (Wang et al. 2017), and CDFW reported 34 depredation kills between 2010 and 2016 in the CC-N counties of Alameda, Contra Costa, San Mateo, Santa Clara, and Santa Cruz (see Appendix A<sup>11</sup>). In addition, at least six mountain lions have been killed by vehicle strikes on Highway 17 in the Santa Cruz Mountains between 2008 and 2018 (Midpensinsula Regional Open Space 2017; Slade 2018) and news outlets reported at least three mountain lions killed by vehicle strikes on the I-280 in San Mateo County between 2014 and 2016 (Wilmers 2014, CBS SF 2015, Kamala 2016). The poor genetic health of the CC-N population is likely due to habitat fragmentation and isolation caused by roads and development combined with high levels of human-caused mortalities. CDFW has identified the Santa Cruz Mountains population as at risk due to current habitat and genetic concerns, at-risk internal habitat and connectivity, limited external connectivity, and lack of protected habitat (Dellinger 2019). Poor connectivity and continued development in the CC-N will likely lead to further isolation, increased human-caused mortalities, decreased genetic diversity, and increased risk of extinction in the foreseeable future.

### 5.2 *Central Coast Central (CC-C) Mountain Lion Population*

Studies on the CC-C mountain lion population are limited, and abundance and population trends are unknown. However, with an effective population size of 56.6 (Gustafson et al. 2018), and an  $N_e/N$  of 0.25 to 0.5 (Ballou et al. 1989; USFWS 2008), the estimated total adult population would be 113 to 226 individuals (see Table 1).

Although Gustafson et al. (2018) found that this population has intermediate levels of genetic diversity and the highest effective population size among the Central Coast and Southern

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<sup>11</sup> These data were downloaded from the CDFW website; however, they no longer appear to be available online. These numbers have been shown to be low by a factor of two in some areas, likely due to incomplete reporting, and therefore should be considered absolute minimums (W. Vickers, *pers comm*).

California mountain lion populations, with an effective population size of 56.6, it just barely exceeds the older standard of 50 to prevent inbreeding depression in the short-term (Frankham et al. 2014; Gustafson et al. 2018). In addition, it falls well below the recommended newer standard of 100 and is insufficient for the long-term viability of the population (Frankham et al. 2014). And the lack of sufficient protected lands and high rates of development in the area threaten the persistence of this population (Dellinger 2019). Thus, although the CC-C population appears to be the healthiest population in the Central Coast and Southern California, it is still at increased risk of inbreeding depression and extinction, and connectivity to smaller adjacent areas should be improved (Dellinger 2019).

### 5.3 Central Coast South (CC-S) Mountain Lion Population

The NPS has been studying the CC-S population since 2002, though most studies regarding population dynamics focus on the Santa Monica Mountains mountain lions (Riley et al. 2014; Benson et al. 2019). Since 2002, NPS has collected data from 55 mountain lions within the Santa Monica Mountains and 19 mountain lions from the Simi Hills and Santa Susana Mountains.<sup>12</sup> There are currently 20-25 live mountain lions being tracked in the Santa Monica Mountains, 7-12 of which are adults (born in 2014 or earlier, the status of 5 adults are unknown) and 13 of which are juveniles or subadults (born in 2015 or later).<sup>13</sup> Given that the Santa Monica Mountains area is relatively small, adult survival rate is high ( $\geq 75\%$ ), and juvenile/subadult survival is low due to intraspecific strife and the inability to disperse, the Santa Monica Mountains population is likely space-limited and these numbers may represent the Santa Monica Mountains' carrying capacity (Riley et al. 2014; Benson et al. 2019). As mentioned previously in *Section 2.2 Taxonomy and Population Genetics*, the extremely low effective population size and total adult population size are grossly insufficient to prevent inbreeding depression in the short term or maintain evolutionary potential in the long term (Jamieson and Allendorf 2012; Frankham et al. 2014). And CDFW has identified the CC-S population as at risk due to current habitat and genetic concerns, at-risk internal habitat and connectivity, limited external connectivity, and lack of protected habitat (Dellinger 2019).

The long-term survival of the Santa Monica Mountains population is severely threatened due to extreme habitat fragmentation and isolation caused by surrounding roads and development that impede movement in or out of the area (Riley et al. 2014). Limited space and lack of connectivity with suitable mountain lion habitat inhibit dispersal for subadults and likely drive unusually high levels of intraspecific strife, which is the most common cause of mortalities in the

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<sup>12</sup> The NPS provides puma profiles (last updated August-November 2018) of the marked animals (*i.e.*, tagged or radio-collared) they have been studying in the CC-S, which includes those studied in Riley et al. (2014). Some data presented in this section take these data into account. Accessed on 3 April 2019 at: <https://www.nps.gov/samo/learn/nature/puma-profiles.htm>.

<sup>13</sup> The adult population in the Santa Monica Mountains is generally consistent with the estimated 0.25 to 0.5  $N_e/N$ ; the Santa Monica Mountains was estimated to have an effective population size of four (Benson et al. 2019), which would suggest a total adult population size of 8 to 16. Interestingly, Gustafson et al. (2018) estimated an effective population size of 2.7 for the greater CC-S population, which would indicate a total adult population of 5 to 10 individuals throughout the Santa Monica Mountains, Simi Hills, and Santa Susana Mountains (see Table 1). There are currently 10 to 17 adult mountain lions being tracked throughout the CC-S area, which would put their  $N_e/N$  ratio at 0.16 to 0.27, which is still within the range of other species'  $N_e/N$  ratios (Frankham et al. 1995; Ballou et al. 1989; Mace and Lande 1991; Spong et al. 2000; Laundré and Clark 2003).

area (Riley et al. 2014). Although intraspecific strife is known to occur among mountain lions, there have been multiple cases of aggressive adult males killing their siblings, female offspring, and previous mates documented in the Santa Monica Mountains population, and researchers noted that “clearly this is rarely a sound evolutionary strategy as the survivorship of offspring or siblings is traded against the probability of future reproduction” (Riley et al. 2014). For 23 radio-collared individuals within the Santa Monica Mountains for which the cause of death is known, nine deaths were the result of intraspecific strife. Eight of the nine deaths (89%) were of animals less than four years old. In addition, three uncollared mountain lions in the Santa Monica Mountains less than four years old were found dead by intraspecific strife, which brings the total to 12 deaths by intraspecific strife documented in the Santa Monica Mountains between 2002 and 2018.

Although all subadult males and half of subadult females typically disperse from their natal areas (Logan and Sweaner 2010), only one subadult successfully dispersed from the Santa Monica Mountains between 2002 to 2012 – P-22, the famous male mountain lion who successfully crossed Highway 101 and I-405 freeways and established his home range in Griffith Park (Riley et al. 2014). Unfortunately, P-22 is extremely isolated with the smallest home range ever reported for an adult male (26km<sup>2</sup>), and he has not had any opportunities to mate (Riley et al. 2014). In addition, vehicle strikes account for 17% (4/23) of known radio-collared mountain lion deaths in the Santa Monica Mountains. According to the NPS, most males in the Santa Monica Mountains do not live past the age of two. Thus, many healthy, young animals are not able to disperse from the Santa Monica Mountains, establish their own home ranges, and successfully reproduce.

Conversely, lack of connectivity also inhibits migrants coming from outside the Santa Monica Mountains and contributing to the population’s gene pool. Only two outside mountain lions have been known to immigrate into the Santa Monica Mountains since 2002: P12 (from Simi Hills, alive as of August 2018, age 12) and P45 (from north of Highway 101, status unknown, age would be 6-7 if alive). While there has been no sign of P-45 since February, 2019 and no offspring from him have been detected, P-12 has been fairly prolific in the Santa Monica Mountains, fathering at least eight litters. Although P-12’s appearance initially improved genetic diversity in the Santa Monica Mountains population, consistent immigration in small populations is needed so that the genetic diversity gains of immigrant mountain lions are not lost (Riley et al. 2014; Benson et al. 2016a; Benson et al. 2019). Subsequent inbreeding by P-12 with his daughters and granddaughters and inbreeding already occurring with other breeding adults in the Santa Monica Mountains have led to dangerously low genetic diversity (Riley et al. 2014; Benson et al. 2016a; Gustafson et al. 2018; Benson et al. 2019). With continued isolation, inbreeding, and loss of genetic diversity, there is increasing risk of inbreeding depression and extinction. With inbreeding depression, the probability of extinction within 50 years is predicted to be 99.7 %, with a median time to extinction of 15.1 years (Benson et al. 2016a; Benson et al. 2019).

#### 5.4 Santa Ana Mountains (SAM) Population

Restricted habitat availability and high mortality rates in the SAM likely limits population size, and Benson et al. (2019) estimated that the SAM population is likely comprised of 16 adults and 13 juveniles (kittens and subadults). These numbers are slightly lower than the 31 to 62 adult mountain lions estimated from the SAM population's effective population size of 15.6 (Gustafson et al. 2018) (see Table 1). According to (Benson et al. 2019), high levels of human-caused adult mortalities may limit growth potential in the SAM, and it is uncertain if the population could be larger without as many anthropogenic pressures. In fact, although hunting is illegal in California, mountain lions in Southern California have a lower annual survival than many hunted populations (Vickers 2014). Interestingly, other studies calculated a much lower effective population size of 5.1 (Ernest et al. 2014) and four (Benson et al. 2019), which would align with the suggested carrying capacity. Regardless of which effective population size is used, they are all well below the frequently-used threshold of 50 and insufficient to prevent inbreeding depression in the short-term.

Although population trends are unclear, two long-term studies on radio-collared mountain lions in the SAM provide some insight (Beier 1993; Vickers et al. 2015). In a study that consisted of 32 radio-collared animals in the SAM from 1988 to 1993, researchers found a 75% adult survival rate (Beier and Barrett 1993), which is similar to adult survival rates in other populations, like the CC-S population (Riley et al. 2014). However, in a second, more recent study conducted in the area consisting of 31 marked mountain lions from 2001 to 2013, researchers found a 56.5% survival rate across all sexes and age groups (Vickers et al. 2015). The marked decrease in adult survival rate between the two studies coincides with an increase in the proportion of mortalities caused by vehicle strikes, with the 1988-1993 and the 2001-2013 studies resulting in 32% (10/31) and 46% (6/13) of deaths caused by vehicle strikes, respectively (Beier 1993; Vickers et al. 2015). It also parallels an upward trend of mountain lion mortalities caused by vehicle strikes throughout Southern California over time (Vickers et al. 2015). Other causes of death in the SAM population included depredation kills, illegal killing, disease, intraspecific strife, and human-caused wildfires (Beier and Barrett 1993; Vickers et al. 2015). Depredation kills were found to be 3.4 times more likely with males compared to females (Vickers et al. 2015).

The SAM mountain lion population's high adult mortality rates combined with isolation, small size, low genetic diversity, low effective population size, and limited immigration of new individuals cause demographic instability and put the population at high risk of extinction (Beier 1993; Beier and Barrett 1993; Ernest et al. 2014; Vickers et al. 2015; Gustafson et al. 2017; Gustafson et al. 2018; Benson et al. 2019). As mentioned previously in *Section 2.2 Taxonomy and Population Genetics*, the extremely low effective population size and total adult population size are insufficient to prevent inbreeding depression in the short term or maintain evolutionary potential in the long term (Jamieson and Allendorf 2012; Frankham et al. 2014). Roads and development prevent dispersal and sustained immigration in the SAM, and lack of consistent gene flow has led to high levels of inter-relatedness and inbreeding (Ernest et al. 2014; Gustafson et al. 2017; Gustafson et al. 2018; Benson et al. 2019). Further genetic erosion is likely without improved connectivity to facilitate immigration (Benson et al. 2019). CDFW has identified the SAM population as at risk due to current habitat and genetic concerns, at-risk internal habitat and

connectivity, limited external connectivity, and lack of protected habitat (Dellinger 2019). If inbreeding depression occurs within this population, population growth will likely decline and the probability of extinction within 50 years is predicted to be 100%, with a median time to extinction of 11.7 years (Benson et al. 2019).

In 13 years, only one radio-collared individual crossed I-15, the major barrier between the SAM and the EPR, and that animal was killed 25 days after his crossing for depredating domestic sheep (Vickers et al. 2015). And although Gustafson et al. (2017) documented three males immigrating into the SAM from the EPR and four males emigrating from the SAM to the EPR over a 15-year period, only one of the males (M86, an immigrant to the SAM) is known to have successfully bred. While M86 improved the SAM population's genetic diversity (Gustafson et al. 2017), high levels of mortalities due to vehicle strikes and depredation/illegal killings likely reduce the number of immigrants that can successfully establish as breeding adults (Vickers et al. 2015). With high levels of adult mortalities due to vehicle strikes, depredation kills affecting 3.4 times more males than females, and a small population with a female-biased adult sex ratio, there is potential for occasional male extinction in the SAM, which could severely limit the short- and long-term viability of the population (Beier and Barrett 1993; Benson et al. 2019).

### 5.5 *San Gabriel/San Bernardino Mountains (SGSB) Population*

Studies on the SGSB mountain lion population are limited, and the abundance and population trends are unknown. However, with an effective population size of 5 (Gustafson et al. 2018), and an  $N_e/N$  of 0.25 to 0.5 (Ballou et al. 1989; USFWS 2008), the estimated total adult population would be 10 to 20 individuals (see Table 1). As mentioned previously in *Section 2.2 Taxonomy and Population Genetics*, these numbers are grossly insufficient to prevent inbreeding depression in the short term or maintain evolutionary potential in the long term (Jamieson and Allendorf 2012; Frankham et al. 2014). And CDFW has identified the SGSB population as at risk due to current habitat and genetic concerns, at-risk internal habitat and connectivity, limited external connectivity, and lack of protected habitat (Dellinger 2019).

Although a population viability study has not been conducted for the SGSB population, given its low genetic diversity, low effective population size, and patterns of isolation due to roads and development creating movement barriers (Gustafson et al. 2018), the SGSB mountain lion population likely has high risk of inbreeding depression and extinction. The loss of this population could undermine genetic connectivity for mountain lions statewide because the SGSB population, along with the Tehachapi and Sierra Pelona Mountains, represents a critical linkage between mountain lion populations in the northern and southern mountain ranges of California (Gustafson et al. 2018). Restoration and enhancement of connectivity in the SGSB and surrounding mountain ranges are key for the continued survival of the SGSB population as well as all of the Central Coast and Southern California mountain lion populations.

### 5.6 *Eastern Peninsular Range (EPR) Population*

Studies on the EPR mountain lion population are limited and the abundance and population trends are unknown. However, with an effective population size of 31.6 (Benson et al. 2019), and an  $N_e/N$  of 0.25 to 0.5 (Ballou et al. 1989; USFWS 2008), the estimated total adult



population would be 63 to 126 individuals (see Table 1). As mentioned previously in *Section 2.2 Taxonomy and Population Genetics*, these numbers are insufficient to prevent inbreeding depression in the short term or maintain evolutionary potential in the long term (Jamieson and Allendorf 2012; Frankham et al. 2014).

Vickers et al. (2015) followed 43 marked mountain lions in the EPR from 2001 to 2013, and their study provides some insight regarding survival rate and causes of mortality. Annual survival rate was found to be 55.4% in the EPR, which is similar to the SAM population (Vickers et al. 2015). The primary causes of death of marked mountain lions were depredation kills (26% [6/23]) and vehicle strikes (17% [4/23]). When assessing mountain lion death data from CDFW from 1981 to 2013, depredation and vehicle strikes accounted for about 70% of mountain lion deaths in the EPR: 40% (62/154) by depredation kills and 30% (46/154) by vehicle strikes (Vickers et al. 2015).

Although the EPR population was found to have the highest genetic diversity and effective population size among the Southern California mountain lion populations (Gustafson et al. 2018), movement and genetic studies have shown that the EPR population is largely disconnected from all other California populations (Ernest et al. 2014; Vickers et al. 2015; Vickers et al. 2017; Gustafson et al. 2018). And CDFW has identified the EPR population as at risk due to current habitat and genetic concerns, at-risk internal habitat and connectivity, limited external connectivity, and lack of protected habitat (Dellinger 2019). Thus, high human-caused mortality rates combined with continued development in San Diego, Riverside, and Imperial Counties could lead to further isolation, decreased genetic diversity, increased inbreeding depression, and increased risk of extinction.

## 6 Factors Affecting Ability to Survive and Reproduce



Female mountain lion, P-23, crossing a road in the Santa Monica Mountains. She was struck by a vehicle and found dead near Malibu Canyon Road in January 2018. Photo: NPS

Most, if not all, factors affecting the ability of the Southern California and Central Coast mountain lion populations to survive and reproduce are caused by humans. Lack of wildlife connectivity is the primary driver of their potential demise. Habitat loss and fragmentation due to roads and development have led to extreme levels of isolation and high mortality rates, which are driving these populations towards extinction. Continued development in current suitable

mountain lion habitat further threatens these populations. With low genetic diversity and high risk of inbreeding depression due to genetic isolation, vehicle strikes on roads, increased conflicts with humans that lead to depredation kills, high levels of intraspecific strife likely due to limited space and lack of connectivity, rodenticide and other environmental toxicant poisoning, and impacts of more frequent wildfires and climate change, Southern California and Central Coast mountain lions will likely not persist unless there is a concerted effort to restore and enhance functional connectivity between populations and large blocks of heterogeneous habitats.

The populations in Southern California are especially vulnerable to extinction, which is reflected in a 2005 review conducted by the US Forest Service regarding Land Management Plans in the National Forests of Southern California that states the “greatest concern for the long-term health of mountain lion populations on the national forests of southern California is loss of landscape connectivity between mountain ranges and large blocks of open space on private land.”<sup>14</sup> The review emphasizes that continued development along with new and wider roads degrade habitat linkages and create movement barriers, and “[w]ithout the national forests and linkages between the mountain ranges and other large habitat preserves, there is not much long term potential for mountain lions in southern California.”

Ultimately, the persistence of mountain lions in the Central Coast and Southern California requires maintenance and restoration of connectivity between subpopulations and adequate habitat. The extreme isolation, dangerously low genetic diversity, high levels of inbreeding, and high rates of human-caused mortalities (e.g., vehicle strikes, depredation kills, intra-specific strife due to limited space, rodenticide poisoning, etc.) underscore the urgent need for proactive measures to enhance connectivity (Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Gustafson et al. 2017; Benson et al. 2019).



Male mountain lion M110 in San Diego County was euthanized by a CDFW warden because he was severely injured and for stated public safety concerns (he was found in a neighborhood close to homes). This occurred days after he was illegally shot by a livestock owner (open wound on right flank). Necropsy results indicated he had two broken legs consistent with a vehicle strike and four different compounds of anticoagulant rodenticides in his blood. Had he not been euthanized, he likely would have died from starvation due to his injuries. Source: Vickers (2014).

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<sup>14</sup> Forest Service, U.S. Department of Agriculture, *Final Environmental Impact Statement, Land Management Plans, Angeles National Forest Cleveland National Forest Los Padres National Forest San Bernardino National Forest* (Sept. 2005), available at [https://www.fs.usda.gov/Internet/FSE\\_DOCUMENTS/stelprdb5166889.pdf](https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5166889.pdf).

Measures to conserve core habitat areas and functional wildlife corridors, like the recently adopted Habitat Connectivity and Wildlife Movement Ordinances in Ventura County,<sup>15</sup> are vital to the preservation of Central Coast and Southern California mountain lion populations, but just protecting land is not enough to ensure their survival. Conserving natural habitats on both sides of freeways and constructing effective crossing infrastructure (*e.g.*, culverts, underpasses, vegetated overpasses, and exclusionary fencing) at existing roads and barriers would facilitate movement and gene flow while reducing mortalities due to vehicle strikes (Riley et al. 2014; Vickers et al. 2015; Benson et al. 2019). Promoting wider implementation of predator-proof enclosures for domestic animals would further reduce human-caused mortalities by limiting opportunities for potential conflict and reducing the use of depredation permits (Vickers et al. 2015). In addition, changes in depredation permit policy could further reduce mortalities. For example, CDFW adopted a new depredation permit policy based on a 2017 bulletin for mountain lions in the CC-S and SAM areas, which requires affirmative non-lethal alternatives and improved husbandry before kill permits are issued when mountain lion depredations occur in those areas (CDFW 2017; see *Section 8.1.1 CDFW Departmental Bulletins*). Expanding these policies in conjunction with enforceable implementation and reporting requirements across the state, or at least into the SGSB, EPR, CC-N, and CC-C, population areas, would reduce mortalities from this source. Prohibiting the use of second-generation anticoagulants, rodenticides, and other environmental toxicants in California (*i.e.*, with AB 1788, sponsored by Assembly Member Richard Bloom in 2019) would even further reduce human-caused mortalities of mountain lions, as toxicants bioaccumulate up the food chain and can kill mountain lions or weaken their immune systems and make them more susceptible to disease or more vulnerable to conspecifics (Riley et al. 2003; Riley et al. 2007; Serieys et al. 2015). A combination of habitat conservation, implementation of effective road/barrier crossing infrastructure, and outreach and education to property owners and owners of domestic animals combined with depredation permit policy change could save these populations from extinction (Vickers et al. 2015).

### 6.1 Low Genetic Diversity and Inbreeding Depression

As detailed in *Section 2.2 Taxonomy and Population Genetics* and *Section 5.0 Abundance and Population Trends*, inbreeding is a serious threat to the persistence of the Central Coast and Southern California mountain lion populations. Inbreeding depression, loss of genetic diversity, and accumulation of deleterious mutations can lead to elevated extinction risk due to reduced reproductive fitness and evolutionary potential (*i.e.*, the ability to adapt to change) (Spielman et al. 2004; Frankham 2005; Traill et al. 2010). Decades of isolation due to roads and development fragmenting habitat and limiting connectivity has led to low genetic diversity and effective population sizes, high levels of inter-relatedness, and dangerous levels of inbreeding, especially in the CC-S, SAM, SGSB, and CC-N populations (Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Gustafson et al. 2017; Gustafson et al. 2018; Benson et al. 2019). Although demographic and environmental stochasticity (*e.g.*, a disease outbreak, wildfire, drought or flooding) can increase risk of extinction, especially in small populations, inbreeding has also been shown to be an indicator of extinction risk and may impact how populations are able to respond to stochastic events (Frankham and Ralls 1998). In addition, endangered species

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<sup>15</sup> More information regarding the Habitat Connectivity and Wildlife Movement Ordinances available at: <https://vcrma.org/habitat-connectivity-and-wildlife-movement-corridors>

tend to have lower genetic diversity than non-endangered species, which suggests that inbreeding and low genetic variation may have an important role in a species' risk of extinction (Frankham and Ralls 1998). Thus, genetic factors should be considered when assessing the status of these populations.

The CC-S, SAM, SGSB, and CC-N populations have been found to have low genetic diversity, with the SAM population's genetic variation nearly as low as the endangered Florida panther's (*Puma concolor coryi*) (Ernest et al. 2014; Riley et al. 2014; Gustafson et al. 2017). And, as mentioned previously in *Section 2.2 Taxonomy and Population Genetics*, the CC-S, SGSB, SAM, CC-N, and EPR populations have effective population sizes well below the older and less conservative threshold of 50, while the CC-C population's effective population size is just barely above that threshold at  $N_e = 56.6$  (Ernest et al. 2014; Riley et al. 2014; Benson et al. 2016a; Gustafson et al. 2018; Benson et al. 2019). These numbers suggest that inbreeding depression could occur within the short-term (over the duration of five generations) and these populations are at increased risk of extinction.

Without improved connectivity, the SAM and Santa Monica Mountains (within the CC-S) populations are predicted to experience continued genetic erosion and losses in heterozygosity of 28-49% and 40-57%, respectively, within 50 years (Benson et al. 2016a; Benson et al. 2019). This could lead to inbreeding depression, which could cause reduced fitness in a variety of ways. In Florida panthers, inbreeding depression led to reproductive issues (e.g., poor sperm quality, low testosterone levels, poor fecundity and recruitment, failure of testes to descend), increased susceptibility to parasites and disease, and physical issues (e.g., atrial septal defect, a deadly congenital heart defect; kinked tails) (Roelke et al. 1993; Johnson et al. 2010). Suffering from shrinking, fragmented habitats, high mortality rates from hunting, and inbreeding depression, the Florida panther population declined to less than 30 individuals, and genetic restoration via the translocation of eight female mountain lions from Texas (*Puma concolor stanleyana*) was needed to prevent their extinction (Johnson et al. 2010).

The SAM and CC-S populations are severely constrained in fragmented habitats with similar numbers as the Florida panther population prior to genetic rescue (Beier and Barrett 1993; Johnson et al. 2010; Riley et al. 2014; Vickers et al. 2015). Although the fragmented populations appear to be stable, high levels of inbreeding have been documented in the Santa Monica Mountains (Riley et al. 2014) and evidence of inbreeding depression (i.e., low genetic diversity and kinked tails) has been observed in the SAM (Ernest et al. 2014). If these populations remain isolated, they will inevitably have the same fate as the Florida panthers. Researchers predict that with inbreeding depression, the SAM and Santa Monica Mountains populations have a 100% and 99.7% chance of becoming extinct within 50 years, with median time to extinction of 11.7 and 15.1 years, respectively (Benson et al. 2019).

The SGSB population was also found to have low genetic diversity and effective population size (Gustafson et al. 2018), which suggests that the population experienced a prior genetic bottleneck and inbreeding is likely. Although genetic studies on this population are limited, it is clear that continued development in and around the SGSB will further isolate the population and lead to more inbreeding and even lower genetic diversity, which will drive the population faster towards extinction. It is important to note that despite only limited gene flow

between the SGSB population and the Western Sierra Nevada, CC-C, and the EPR (Gustafson et al. 2018), this population represents a critical linkage between mountain lion populations in the northern and southern mountain ranges of California. Restoration and enhancement of connectivity is key for the continued survival of the SGSB population as well as all of the other the Central Coast and Southern California mountain lion populations.

Gustafson et al. (2018) found that the EPR population also exhibits a prior genetic bottleneck. The EPR population was found to be largely disconnected from all the other California populations, with limited gene flow and low connectivity with the SAM and SGSB populations (Gustafson et al. 2018). Movement patterns and genetics indicate potential isolation from other populations (Vickers et al. 2015; Gustafson et al. 2017; Gustafson et al. 2018), and continued development in these areas will likely lead to further isolation, genetic drift, and risk of extinction similar to what is being observed in the CC-S, SAM, and SGSB populations.

Although genetic studies are limited for the CC-N population, it was found to have low genetic diversity and low effective population size (Gustafson et al. 2018), which forewarns of inbreeding depression and increased risk of extinction. CDFW has identified the Santa Cruz Mountains mountain lion population, which occurs within the CC-N area, as vulnerable to decline and extinction due to fragmentation from roads and development as well as lack of protected habitat (Dellinger 2019).

Studies suggest that one immigrant every 1-2 years would reduce extinction risk in the SAM and Santa Monica Mountains populations (Beier and Barrett 1993; Gustafson et al. 2017; Benson et al. 2019). This may apply to the other populations with low genetic diversity and effective population size (Gustafson et al. 2018). Increasing connectivity throughout the Central Coast and Southern California would address issues of inbreeding by facilitating movement between populations, increasing effective population size, and reducing high mortality rates driven by vehicle strikes and depredation. Thus, proactive measures to effectively restore and enhance connectivity are needed to minimize risk of inbreeding depression and extinction in Central Coast and Southern California populations.

## 6.2 *Vehicle Strikes*

In California, an estimated 100 mountain lions are killed every year by vehicle strikes (Pollard 2016). In the Central Coast and Southern California, vehicle strikes represent a significant threat to the persistence of mountain lion populations, though Southern California has more documentation regarding this issue. The number of mortalities caused by vehicle strikes has been increasing in Southern California since the 1980s, and vehicle strikes account for a high proportion of deaths in mountain lions in the SAM, CC-S, and EPR (Beier and Barrett 1993; Riley et al. 2014; Vickers et al. 2015; Vickers et al. 2017). From 1981 to 2013 vehicle strikes accounted for 53% (50/94) of mountain lion deaths in the SAM and 30% of mountain lion deaths in the EPR (46/154) (Vickers et al. 2015). Riley reported that 14% (2/14) of collared mountain lion deaths from 2002 to 2012 were due to vehicle strikes, and the NPS reported that 18 mortalities from vehicle strikes occurred between July 2002 and January 2018 in the CC-S (Figure 9). Although the CC-N population is less studied, there is evidence that vehicle strikes are a significant cause of mortalities in this population; at least six mountain lions have been



killed by vehicle strikes on Highway 17 in the Santa Cruz Mountains between 2008 and 2018 (Midpeninsula Regional Open Space 2017; Slade 2018) and news outlets reported at least three vehicle strikes killing mountain lions on the I-280 in San Mateo County between 2014 and 2016 (Wilmers 2014; CBS San Francisco 2015; Kamala 2016). Similarly, in 2018 at least two mountain lions were reported to have been killed by vehicle strikes in San Luis Obispo County in the CC-C (Tanner 2018). Clearly, vehicle strikes are an important cause of mortality for the Central Coast and Southern California mountain lion populations.



**Figure 9.** Locations of 18 mountain lion vehicle strikes in the Santa Monica Mountains and surrounding areas from July 2002 to January 2018. Source: NPS

High adult mortality rates can have severe consequences, particularly for small populations with female-biased adult sex ratios and low effective population sizes (Beier and Barrett 1993; Benson et al. 2019). Vehicle strikes have been found to affect males and females equally, regardless of age, which can result in relatively high adult male mortalities (Vickers et al. 2015). Low male adult survival increases the risk of extinction, as it could result in occasional extinctions of breeding males and therefore reduced reproductivity (Benson et al. 2019), which has been previously observed in the SAM (Beier and Barrett 1993). In the Santa Monica Mountains, where adult survival is high, vehicle strikes (along with intraspecific strife) make it more difficult for subadults to successfully disperse, which limits breeding opportunities for mountain lions born in the Santa Monica Mountains (Riley et al. 2014; Benson et al. 2019). Freeways and vehicle strikes also limit the ability for immigrants to enter the Santa Monica Mountains and contribute to the population’s gene pool (Riley et al. 2014; Benson et al. 2019). These patterns highlight the dire outlook for Central Coast and Southern California mountain lion populations due to lack of connectivity between populations and suitable habitat. The continued construction of roads and development and inaction to enhance connectivity threatens the survival of these struggling populations.

### 6.3 Depredation and Illegal Kills



Mountain lions killed on depredation permits (and one killed by vehicle strike) in San Diego County in 2015. Source: Vickers et al. (2017).

In 1990 California voters passed The California Wildlife Protection Act (Proposition 117), making the mountain lion a “specially protected species” and outlawing mountain lion sport-hunting in California. However, the law requires CDFW to issue depredation permits that allow people to “take” mountain lions when a mountain lion kills or injures domestic animals such as livestock or pets or damages property. The legal definition of “take” is to “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill” (Cal Fish & Game Code, §86), and the vast majority of permits to take in the three decades since the passage of Proposition 117 have authorized killing one or more mountain lions. The number of depredation permits issued and the number of reported kills has varied over time, and on average over 40% of permits result in reported kills. Since 1990 there has been an average of 97 reported depredation kills every year; however, these estimates are likely low due to underreporting and incomplete records (W. Vickers, *pers comm*). Depredation kills (along with vehicle strikes) account for the majority of mountain lion mortalities in the SAM and EPR (Vickers et al. 2015; Vickers et al. 2017). Although less is known about depredation kill impacts in the CC-N and CC-C, there is evidence that suggests depredation kills could be a significant source of mortality in these populations. In the Santa Cruz Mountains in the CC-N, depredation kills are the leading cause of death in collared mountain lions (Wang et al. 2017), and CDFW reported 34 depredation kills between 2010 and 2016 in the CC-N counties of Alameda, Contra Costa, San Mateo, Santa Clara, and Santa Cruz (see Appendix A<sup>16</sup>). Although population dynamics are even less studied in the CC-C, between 2010 and 2016 there were 46 reported depredation kills in the counties of Monterey, San Benito, San Luis Obispo, and Santa Barbara (See Appendix A<sup>1d</sup>).

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<sup>16</sup> These data were downloaded from the CDFW website; however, they no longer appear to be available online. These numbers have been shown to be low by a factor of two in some areas, likely due to incomplete reporting, and therefore should be considered absolute minimums (W. Vickers, *pers comm*).



An illegally killed mountain lion in San Mateo County. Photo: Tiffany Yap

Depredation kills result in more deaths in male mountain lions compared to female mountain lions. Statewide, of mountain lions killed for depredation in 2017, 68% were males (CDFW 2018), and from 1981 to 2013, there were 3.4 times more male than female mountain lions killed for depredating in the SAM and EPR (Vickers et al. 2015). The majority of lions reported killed for depredating were of subadult (1-2 years old) and adult mountain lions (>2 years old) (CDFW 2018), many of which were likely dispersers that may have not yet established home ranges. Dispersing lions often come up against roads and development as they search to establish home ranges (Beier 1995, Vickers 2015, Riley 2014). This suggests that even if individuals are able to navigate across roads and freeways without being struck by vehicles, they often come into conflict with humans, which threatens their survival. This was reflected in the EPR, when the only GPS collared immigrant to have crossed I-15 from 2001 to 2013 arrived from the SAM only to be killed on a depredation permit 25 days after his arrival for depredating a sheep (Vickers et al. 2015). Not only do lions killed for depredating diminish the total abundance of these populations, but because males are predominantly killed, the number of animals that are the primary gene dispersers are also greatly reduced, which further inhibits adequate genetic connectivity (Vickers et al. 2017).

Reported depredation kills do not include mountain lions that are illegally poached or killed, many of which likely go undocumented (Beier and Barrett 1993; Vickers et al. 2015). Illegal kills have been observed in the CC-S, SAM, and EPR (Beier and Barrett 1993; Riley et al. 2014; Vickers et al. 2015) as well as in the CC-N (Yap 2018 *pers observation*), and although 80 mountain lions were reported as being killed under depredation permits in 2017, 89 deaths were being investigated (CDFW 2018).

As mentioned in *Section 6.2 Vehicle Strikes*, high levels of mortalities among male breeders or potential male breeders (*i.e.*, dispersers) can have severe impacts on small, isolated mountain lion populations with female-biased adult sex ratios and low effective population sizes (Beier and Barrett 1993; Benson et al. 2019). Low survival of breeding males increases extinction risk, as occasional breeding male extinctions can occur and therefore reduce reproductivity throughout the population (Beier and Barrett 1993; Benson et al. 2019). And low survival of subadults and adults may limit both dispersers and immigrants from successfully



breeding and increasing genetic diversity (Vickers et al. 2015; Benson et al. 2019). Thus, depredation and illegal kills in conjunction with lack of connectivity between populations and suitable habitat in the Central Coast and Southern California severely limit the potential for these populations to survive and reproduce. Continued development and lack of connectivity will likely push mountain lions into more conflicts with humans, which could increase depredation and retributory kills and further drive these populations towards extinction.

#### 6.4 *Intraspecific Strife*



Intraspecific strife: a female mountain lion, P-7, was killed by her father, P-1. Photo: NPS

As detailed in *Section 5 Abundance and Population Trends*, intraspecific strife is the leading cause of mortality in the Santa Monica Mountains (Riley et al. 2014). Although intraspecific strife is a common source of mortality in mountain lion populations, (Beier and Barrett 1993; Logan and Sweaner 2001; Allen 2014), unusually high levels of intraspecific strife have been observed in this population (Riley et al. 2014). About 41% (9/22) of deaths in radio-collared mountain lions being tracked from 2002 to 2018 were from intraspecific strife,<sup>17</sup> with multiple cases of aggressive adult males killing their siblings, offspring (male and female), and previous mates (Riley et al. 2014). While males are likely to have larger home ranges to protect food resources and access to females, killing offspring or potential mates has no apparent evolutionary benefit, as it reduces chances of future reproduction (Riley et al. 2014). In addition, infanticide has been documented in the Santa Monica Mountains (Riley et al. 2014), perhaps to trigger the female to come into estrous. These high levels of intraspecific strife are likely due to limited space in the Santa Monica Mountains caused by dispersal barriers (Riley et al. 2014; Benson et al. 2019). As roads and development further encroach on Central Coast and Southern California mountain lion populations, intraspecific strife could become more common; this was

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<sup>17</sup> The NPS provides puma profiles (last updated August-November 2018) of the marked animals (*i.e.*, tagged or radio-collared) they have been studying in the CC-S, which includes those studied in Riley et al. (2014). Some data presented in this section take these data into account. Accessed on 3 April 2019 at: <https://www.nps.gov/samo/learn/nature/puma-profiles.htm>.

documented in the SAM on two occasions (one GPS-collared, one previously GPS-collared) since the publication of Vickers et al. (2015) (W. Vickers *unpublished data*). Enhanced connectivity between populations and suitable habitat would facilitate dispersal, which would reduce and/or prevent high levels of intraspecific strife (Riley et al. 2014; Benson et al. 2019) and improve the survival and reproduction rates, especially for the most struggling populations.

### 6.5 Abandonment



Santa Monica Mountains mountain lion kittens P-57 and P-58 were abandoned by their mother, P-42, a first-time mother who left with male P-27 and never returned. Photo: NPS

Abandonment of kittens is fairly common in the Santa Monica Mountains and accounts for about 23% (5/22) of the known causes of death for marked/collared animals.<sup>18</sup> Although this likely occurs in other mountain lion populations, the causes of abandonment are unclear. There are various reasons why females might abandon their cubs. The cubs could be sick, the female may not be able to take care of them, or perhaps the female was initially protecting them from a mature male. Unfortunately, there is a lack of data regarding why and how often cubs get abandoned. Yet this is one of the main causes of death for mountain lions in the Santa Monica Mountains, which likely affects this already-small population.

Mountain lion cubs can also become orphaned if the mother is killed before they have dispersed. If they are too young to fend for themselves, they likely starve to death or are preyed upon by other predators. If the young are more mobile, they may come up against areas where they are more likely to encounter humans as they search for food. This was seen in November 2017, when a mother mountain lion was killed by a vehicle strike in the SAM and two of her cubs were found roaming near human establishments – one in a backyard and the other along a road (Veklerov 2018). Both were too young to survive on their own and were placed in the Oakland Zoo.

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<sup>18</sup> Id.



## 6.6 Poisoning from Rodenticides and Other Environmental Toxicants



The famous mountain lion of Griffith Park, P-22, suffering from notoedric mange, a parasitic skin disease that has been linked with the ingestion of rodenticide poisoning (left) and mountain lion P-34 found dead on a trail due to rodenticide poisoning (right). Photos: NPS

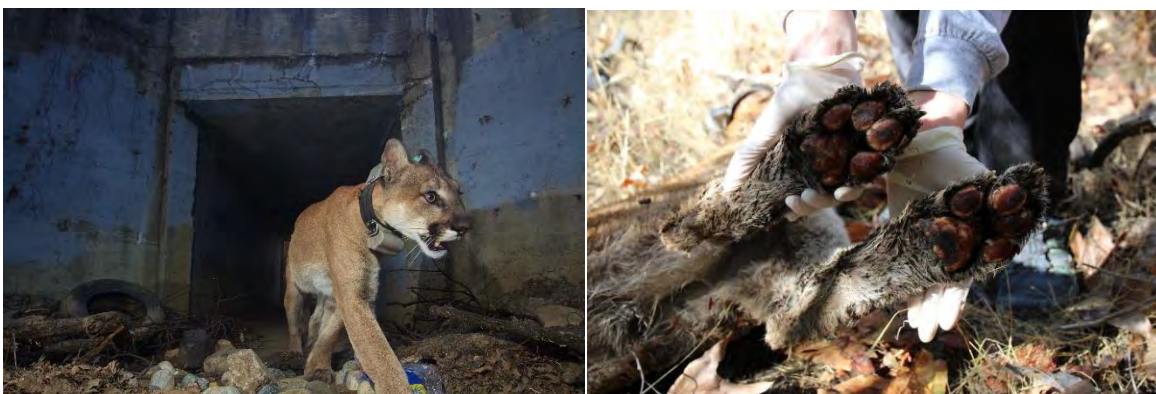
Although mountain lions are not the primary target of environmental toxicants, such as rodenticides and other pesticides and herbicides, secondary poisoning has been documented in many non-target animals, especially predators (e.g., coyotes (Riley et al. 2003), bobcats (Riley et al. 2007; Serieys et al. 2015), San Joaquin kit fox (McMillin et al. 2008), California fishers (Gabriel et al. 2012), raptors (Lima and Salmon 2010), and many more). Data regarding pesticide poisoning in mountain lions are limited; however, there is evidence that these big cats are likely vulnerable to similar negative impacts that other predators experience, including direct death, weakened immune systems, and vulnerability to predators or conspecifics (Riley et al. 2003; Riley et al. 2007; Serieys et al. 2015; Rudd et al. 2019).

While poisoning can sometimes lead to direct death, rodenticide exposure has also been associated with notoedric mange, a parasitic skin disease that has led to high levels of mortalities, population declines, and even local extirpations in Southern California bobcats (Riley et al. 2007; Serieys et al. 2015). Although the link between rodenticide poisoning and mange is not as clear in mountain lions, since 2002 five mountain lions in the CC-S have been found suffering from mange, and researchers suspect that rodenticide poisoning may have played a role (Reyes-Velarde 2019a). In addition, of four dead mountain lions in the Santa Monica Mountains that were found to have rodenticides in their systems, two died from poisoning and two died from intraspecific strife, and it is possible that indirect effects of poisoning may have prevented the mountain lions from escaping conflict or fighting back (Riley et al. 2007). And rodenticide poisoning is suspected to be the cause of death in mountain lion P-47, who was recently found dead in Santa Monica Mountains (Reyes-Velarde 2019b), and CC-N mountain lion 36m, who was found dead in the Santa Cruz Mountains in 2015 (Wilmers 2015).

The Department of Pesticide Regulation (DPR) analyzed data provided by CDFW and found that 92% (59/64) of tested mountain lions from throughout the state had detectable levels of anticoagulant rodenticides, which indicates alarmingly high exposure rates (DPR 2018). This has been found to be true in the CC-S as well, where researchers have found that 94% (17/18) of mountain lions tested had traces of rodenticides in their systems (Reyes-Velarde 2019a).

Rodenticides have been implicated in mountain lion mortalities in the CC-S, and in the SAM anticoagulant rodenticide residues were detected in the livers of 100% of deceased animals tested, with up to five different compounds being detected in some animals (Riley et al. 2007; Riley et al. 2014; W. Vickers, *pers comm*). And a study conducted by CDFW and the Integral Ecology Research Center (IERC) has found that mountain lions are being exposed to dangerously high levels of illegal pesticides, such as carbofuran, being used on illegal marijuana grow sites, which can also bioaccumulate and cause health issues (Rudd et al. 2019). Furthermore, it is possible that herbicide exposure from deer could be detrimental to mountain lions as well. Although poisoning from environmental toxicants may not constitute a large proportion of direct deaths (that we are aware of), it is possible that high exposure levels influence other causes of mortalities. Any additional mortalities in the small, isolated Central Coast and Southern California populations suffering from other anthropogenic pressures could impact the short- and long-term survival of these mountain lions.

### 6.7 Wildfires



After the Woolsey Fire, the body of mountain lion P-64, known to use culverts to cross the Hwy-101 and SR-118 freeways a total of 41 times, was found dead with severely burned paws. Photos: NPS

Although fire is a natural disturbance in California ecosystems, sprawl development with low/intermediate densities extending into habitats that are prone to fire have led to more frequent wildfires that burn larger areas (Syphard et al. 2007; Syphard et al. 2009). Most wildfires in California are caused by human ignitions, like power lines, arson, improperly disposed cigarette butts, debris burning, fireworks, campfires, or sparks from cars or equipment (Keeley and Fotheringham 2003; Syphard et al. 2007; Syphard et al. 2012; Bistinas et al. 2013; Balch et al. 2017; Radeloff et al. 2018; Syphard et al. 2019). In fact, human-caused fires account for 95-97% of all fires in California's Mediterranean habitats (Syphard et al. 2007, Balch et al. 2017). In addition, climate change is leading to hotter, drier conditions that make fires more likely to burn. At least 29 fires throughout California in the last two years were caused by electric power and distribution lines, and transmission lines are suspected to be the cause of last year's Camp Fire and Woolsey Fire (Atkinson 2018; Chandler 2019).

Increased frequency of wildfires poses a threat to the survival of Central Coast and Southern California mountain lions. Although mountain lions are highly mobile and generally able to move away from wildfires, in severe weather conditions wind-driven fires can spread quickly – they can cover 10,000 hectares in one to two days, as embers are blown ahead of the

fires and towards adjacent fuels (*e.g.*, flammable vegetation, structures) (Syphard et al. 2011). If their movement is constrained by roads and development and they are unable to access escape routes, then their chances of surviving wildfires are greatly reduced. Vickers et al. (2015) documented one death of a collared mountain lion in the SAM and one in the EPR due to human-caused wildfires, and the deaths of two collared mountain lions in the CC-S in 2018 have been attributed to the Woolsey Fire.<sup>19</sup> Environmentally stochastic events (*e.g.*, wildfires, flooding) could destabilize small mountain lion populations and make them vulnerable to extinction (Benson et al. 2016a; Benson et al. 2019). In addition, increased frequency of fire ignitions can cause shifts in natural fire regimes, which can lead to large-scale landscape changes, such as vegetation-type conversion or habitat fragmentation, which can impact wide-ranging species like the mountain lion (Jennings 2018).

Increasing landscape connectivity (*e.g.*, by designing corridors, removing barriers, and preserving habitats that are close to each other) is important for resilience to environmentally stochastic events and climate change adaptation (Heller and Zavaleta 2009). Enhanced connectivity that incorporates corridor redundancy (*i.e.* the availability of alternative pathways for movement) would allow for improved functional connectivity and resilience. Compared to a single pathway, multiple connections between habitat patches increase the probability of movement across landscapes by a wider variety of species, and they provide more habitat for low-mobility species while still allowing for their dispersal (Mcrae et al., 2012; Olson & Burnett, 2008; Pinto & Keitt, 2008). In addition, corridor redundancy provides resilience to uncertainty, impacts of climate change, and extreme events, including wildfires, by providing alternate escape routes or refugia for animals seeking safety (Cushman et al., 2013; Mcrae et al., 2008; Mcrae et al., 2012; Olson & Burnett, 2008; Pinto & Keitt, 2008).

## 6.8 Climate Change

A strong, international scientific consensus has established that human-caused climate change is causing widespread harms to human society and natural systems, and climate change threats are becoming increasingly dangerous. In a 2018 *Special Report on Global Warming of 1.5°C* from the Intergovernmental Panel on Climate Change (IPCC), the leading international scientific body for the assessment of climate change describes the devastating harms that would occur at 2°C warming, highlighting the necessity of limiting warming to 1.5°C to avoid catastrophic impacts to people and life on Earth (IPCC 2018). In addition to warming, many other aspects of global climate are changing. Thousands of studies conducted by researchers around the world have documented changes in surface, atmospheric, and oceanic temperatures; melting glaciers; diminishing snow cover; shrinking sea ice; rising sea levels; ocean acidification; and increasing atmospheric water vapor (USGCRP, 2017).

Climate change is increasing stress on species and ecosystems, causing changes in distribution, phenology, physiology, vital rates, genetics, ecosystem structure and processes, and increasing species extinction risk (Warren et al., 2011). A 2016 analysis found that climate-related local extinctions are already widespread and have occurred in hundreds of species, including almost half of the 976 species surveyed (Wiens 2016). A separate study estimated that nearly half of terrestrial non-flying threatened mammals and nearly one-quarter of threatened

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<sup>19</sup> Id.

birds may have already been negatively impacted by climate change in at least part of their distribution (Pacifi et al. 2017). A 2016 meta-analysis reported that climate change is already impacting 82% of key ecological processes that form the foundation of healthy ecosystems and on which humans depend for basic needs (Scheffers et al. 2016). Genes are changing, species' physiology and physical features such as body size are changing, species are moving to try to keep pace with suitable climate space, species are shifting their timing of breeding and migration, and entire ecosystems are under stress (Cahill et al., 2012; Chen et al., 2011; Maclean & Wilson, 2011; Parmesan, 2006; Parmesan & Yohe, 2003; Root et al., 2003; Warren et al., 2011).

Improving landscape connectivity is a key factor for climate change resilience and adaptation (Heller and Zavaleta 2009). Without functional connectivity that provides multiple pathways for mountain lion movement, isolated Central Coast and Southern California mountain lion populations and the prey they depend on may not be able to shift their ranges as available resources shift. Enhanced connectivity that provides redundant corridors for safe passage between suitable habitats would improve chances of survival and reproduction in the face of climate change by increasing the probability of movement across landscapes by a wider variety of species and providing alternate escape routes or refugia for animals seeking safety (Mcrae et al. 2008; Pinto and Keitt 2008; Mcrae et al. 2012; Cushman et al. 2013; Olson and Burnett 2013).

## **7 Degree and Immediacy of Threat**

As demonstrated in the previous sections, Central Coast and Southern California mountain lions are at risk of extirpation under current conditions. Roads and development have fractured connectivity, which has led to the separation of at least six isolated, genetically distinct populations in the CC-N, CC-C, CC-S, SAM, SGSB, and EPR (Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Benson et al. 2019). Due to extreme isolation and high levels of human-caused mortalities, the SAM and CC-S mountain lions have low genetic diversity, low effective population sizes, and high levels of inbreeding (Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Benson et al. 2019). Benson et al. (2019) predicted high losses of heterozygosity in the SAM and Santa Monica Mountains populations, which suggests that inbreeding depression is imminent. If inbreeding depression occurs, the SAM and Santa Monica Mountains/CC-S populations will likely go extinct within 50 years, with median times to extinction of 11.7 years and 15.1 years, respectively (Benson et al. 2019). With similarly low genetic diversity and effective population size, the SGSB and CC-N populations likely have a similar fate. And although the CC-C and EPR populations appear to be slightly healthier with more genetic diversity and a higher effective population size, these populations have effective population sizes that are still well below the most recent recommended threshold to prevent inbreeding depression in the short-term (Frankham et al. 2014; Gustafson et al. 2018); continued development in these areas could propel these populations towards extinction more quickly. Clearly, Central Coast and Southern California mountain lion populations are succumbing to anthropogenic pressures, and without immediate action to restore and enhance connectivity between the populations and suitable habitat, they will be lost, potentially within our lifetimes.

Immediate action is critical for the long-term persistence of Central Coast and Southern California mountain lions and the health of Central Coast and Southern California ecosystems. Connectivity between the populations and suitable habitat must be restored and enhanced to facilitate movement and gene flow while reducing human-caused mortalities. Anthropogenic pressures, especially vehicle strikes and depredation kills, should be minimized to help the recovery of these populations. Although translocation of outbred animals has been shown to be effective to increase genetic diversity (Johnson et al. 2010), this would only be a short-term, unsustainable solution given the current level of isolation of these populations (Ernest et al. 2014; Riley et al. 2014; Vickers et al. 2015; Benson et al. 2016a; Benson et al. 2019). Strategically-placed road/barrier crossing infrastructure that allows for dispersal and gene flow and reduces mortalities would be a more comprehensive, long-term solution to save these populations in perpetuity. And the preservation of intact linkages, especially the Tehachapi and Sierra Pelona Mountains, is essential to maintain statewide genetic connectivity. Immediate regulatory action under the CESA is needed to enhance connectivity among Central Coast and Southern California mountain lion populations and suitable habitat to ensure the conservation of these iconic big cats.

## **8 Inadequacy of Existing Regulatory Mechanisms**

### *8.1 State Regulatory Mechanisms*

#### Proposition 117

The California Wildlife Protection Act of 1990 (Proposition 117) declared that the mountain lion is a “specially protected mammal under the laws of this state.” (Cal. Fish & Game Code § 4800(a).) Proposition 117 acknowledged that mountain lion habitat in the Santa Monica Mountains, Santa Ana Mountains, Santa Susana Mountains, and Simi Hills is disappearing rapidly and that “[s]mall and often isolated wildlife populations are forced to depend upon these shrinking habitat areas within the heavily urbanizing areas of this state.” (Cal. Fish & Game Code § 2780(d).) Proposition 117 further found that “[c]orridors of natural habitat must be preserved to maintain the genetic integrity of California’s wildlife.” (*Id.*)

In order to preserve mountain lion populations in California, Proposition 117 mandated that mountain lions are not to be considered a “game mammal,” such that hunting is generally prohibited. (Cal. Fish & Game Code § 3950.1(a).) Subject to certain exceptions, Proposition 117 makes it unlawful to take, injure, possess, transport, import, or sell a mountain lion. (Cal. Fish & Game Code § 4800(b).) Nonetheless, a mountain lion may still be removed or killed if it is “perceived to be an imminent threat to public health or safety” or is perceived by CDFW to be “an imminent threat to the survival of any threatened, endangered, candidate, or fully protected sheep species.” (Cal. Fish & Game Code § 4801.) Mountain lions that have not been designated an “imminent threat to public health or safety” may still be removed via nonlethal means. (Cal. Fish & Game Code § 4801.5(a).)

A person whose livestock or other property has been damaged or destroyed by a mountain lion may request a permit to “take” the mountain lion. (Cal. Fish & Game Code § 4802.) CDFW is required to immediately take action to confirm that there has been a



depredation. (Cal. Fish & Game Code § 4803.) If CDFW is satisfied that there has been a depredation, CDFW “shall promptly issue a permit to take the depredating mountain lion.” (*Id.*) There is no limit to the number of depredation permits a property owner can request from CDFW. In addition, mountain lions that are encountered while pursuing or inflicting injury on livestock or domestic animals may be taken immediately without the need for a permit. (Cal. Fish & Game Code § 4807.)

While Proposition 117 prohibits all hunting of mountain lions as well as the purposeful killing of mountain lions in most circumstances, it does not contain provisions to ensure that connectivity between core habitats for the Southern California or Central Coast mountain lions will be protected. As discussed above in *Section 6.0 Factors Affecting the Ability to Survive and Reproduce*, the primary threat to Southern California and Central Coast mountain lions is not hunting—it is habitat fragmentation and the lack of crossing infrastructure, which has led to major declines in genetic diversity, high levels of inbreeding, and high levels of human-caused mortalities via vehicle strikes, depredation kills, and intraspecific strife due to limited space and the inability for young mountain lions to disperse.

### 8.1.1 CDFW Departmental Bulletins

CDFW has issued “Departmental Bulletins” relating to mountain lions. The most recent bulletin was issued in December 2017 and applied specifically to the Santa Monica Mountains and SAM mountain lion populations (the “2017 Bulletin”) (CDFW 2017).<sup>20</sup> The 2017 Bulletin acknowledged (1) the lack of genetic diversity in the Santa Monica Mountains and SAM mountain lion populations and (2) that human population growth and anthropogenic barriers are restricting connectivity with other mountain lion populations. In order to reduce unnecessary killings of mountain lions in the Santa Monica Mountains and SAM populations, the 2017 Bulletin provides that any person reporting a depredation (a “reporting party”) may be issued a first permit to employ non-lethal measures to deter mountain lions from further depredation, and a second permit to “haze” a depredating mountain lion. In the first instance, the reporting party would institute economically feasible measures designed to reduce the potential for attracting mountain lions such as removing the carcasses of depredated animals, installing or repairing and consistently using enclosures to exclude mountain lions, or employing guardian animals in the immediate vicinity of livestock or other domestic animals. The 2017 Bulletin provides that CDFW would not be required to issue a lethal depredation permit until (1) a third depredation event has occurred, and (2) CDFW has confirmed that the reporting party has already implemented all reasonable preventative measures.

In January of 2018, CDFW adopted the 2017 Bulletin’s new depredation permit policy. Although this provides some additional protections and will likely reduce lethal take of mountain lions in the Santa Monica Mountains and the SAM, researchers have documented instances wherein domestic animal owners killed mountain lions in these areas without complying with CDFW instructions under the new policy (W. Vickers, *pers comm*). The 2017 Bulletin does not apply to other vulnerable populations, like the SGSB, EPR, CC-N, and CC-C mountain lions. In

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<sup>20</sup> California Department of Fish and Wildlife, *Human/Wildlife Interactions in California: Mountain Lion Depredation, Public Safety, and Animal Welfare – Amendment to Department Bulletin 2013-02* (Dec. 15, 2017), available at <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=153021>.

addition, the new policy is not designed to ensure protection of habitat or connectivity necessary for the continued survival of the Santa Monica Mountains and SAM mountain lion populations and is insufficient to ameliorate the anthropogenic mortalities related to potential extirpation.

### 8.1.2 California Environmental Quality Act

The California Environmental Quality Act (“CEQA”) is California’s landmark environmental law and establishes a state policy to prevent the “elimination of fish or wildlife species due to man’s activities, ensure that fish and wildlife populations do not drop below self-perpetuating levels, and preserve for future generations representations of all plant and animal communities....” (Cal. Pub. Res. Code § 21001(c)). Towards this end, state and local agencies are required to analyze and disclose the impacts of any discretionary decision or activity. CEQA contains a substantive mandate that agencies should not approve projects as proposed if there are feasible alternatives or mitigation measures which would substantially lessen the significant environmental effects of such projects. (Cal. Pub. Res. Code § 21002.)

CEQA requires a “mandatory finding of significance” if a project may “substantially reduce the number or restrict the range of an endangered, rare or threatened species.” (Cal. Code Regs., tit. 14, § 15065(a)(1).) CDFW has interpreted this provision to apply to species of special concern, which are species that are “experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (not reversed) that, if continued or resumed, could qualify it for State threatened or endangered status.”<sup>21</sup> CDFW further provides that species of special concern “should be considered during the environmental review process.” (*Id.*; Cal. Code Regs., tit. 14, § 15380.) Thus, a potentially substantial impact on a species of special concern, threatened species, or endangered species could be construed as “per se” significant under CEQA. (*Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 449.) And under CEQA, when an effect is “significant,” the lead agency approving the project must make a finding that changes or alterations have been incorporated into the project to avoid or mitigate its significant impacts, or that such changes are within the responsibility of another agency, or that mitigation is infeasible. (Cal. Pub. Res. Code § 21081(a).) These provisions therefore provide some protections to species that are listed as species of special concern, threatened, or endangered.

However, Southern California and Central Coast mountain lions are not listed as a species of special concern or as threatened or endangered, such that a project that has the potential to significantly impact one of these populations would not necessarily qualify as a “significant effect” under a lead agency’s interpretation of CEQA. In such case, CEQA’s substantive mandate to adopt all feasible alternatives or mitigation measures might not be triggered.

CEQA also requires a “mandatory finding of significance” if a project may “substantially reduce the habitat of a fish or wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community.” (Cal. Code Regs., tit. 14, § 15065.) Moreover, CEQA’s “Environmental Checklist” in Appendix G of the CEQA

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<sup>21</sup> California Department of Fish and Wildlife, *Species of Special Concern*, available at <https://www.wildlife.ca.gov/Conservation/SSC>.

Guidelines characterizes a project's effects as "significant" if the project would "interfere substantially with the movement of any native [] wildlife species or with established native resident or migratory wildlife corridors...."

While these provisions might theoretically offer some protection for Southern California or Central Coast mountain lions, in practice they have not provided sufficient protection. Under CEQA, lead agencies have discretion to develop their own thresholds of significance. (*East Sacramento Partnerships for a Livable City v. City of Sacramento* (2016) 5 Cal.App.5th 281, 300; Cal. Code Regs., tit. 14, § 15064(d)). This allows local agencies—who are often under pressure from developers to approve projects—to make significance determinations that are inconsistent with independent scientific analysis, including CDFW's analysis. For instance, in December 2017, the City of Temecula approved a 200-acre mixed use project called the Altair Specific Plan that would allow development in the last remaining viable linkage for the SAM mountain lion population between the Santa Ana Mountains and Peninsular Ranges. The City determined that impacts to mountain lions were not significant despite strong disagreement by CDFW, USFWS, and independent mountain lion experts.<sup>22</sup> CDFW warned the City of Temecula that the SAM population has "extremely low genetic diversity which is attributed to low gene flow between the small Santa Ana Mountains population and the larger population in the Peninsular Ranges" and that development is contributing to this genetic decay. (*Id.*) CDFW concluded that "increased human activity associated with the proposed Civic Site at this sensitive location would [] be detrimental to facilitating the movement of mountain lions across Interstate Highway 15 (I-15) to the Peninsular Range." (*Id.*)

Even when a lead agency acknowledges that an effect is "significant," CEQA allows a lead agency to adopt a "statement of overriding considerations" and approve a project if the agency finds that other factors outweigh the environmental costs of the project or that further mitigation is infeasible. (Cal. Code Regs., tit. 14, § 15093(b); Cal. Pub. Res. Code § 21081.) This means that even if a project may have a significant effect on a "wildlife population" like the CC-S, SAM, SGSB, or EPR mountain lions, an agency could interpret CEQA as still allowing approval of the project. CEQA in practice is therefore inadequate to protect the Southern California and Central Coast mountain lions.

Finally, as noted above, the lack of adequate wildlife connectivity and wildlife crossings is the primary factor driving Southern California and Central Coast mountain lions closer to extinction. Yet, agencies have not interpreted CEQA (or the National Environmental Policy Act, discussed further below) as including a clear legal mechanism for mitigation for impacts on wildlife connectivity. For example, in the Final Environmental Impact Report/Final Environmental Impact Statement for the Northwest 138 Corridor Improvement Project (the "Northwest 138 EIR"), Caltrans and the Los Angeles County Metropolitan Transportation Authority wrote: "The proposed project has the potential to directly or indirectly impact wildlife movement throughout the project limits. However, with the inclusion of the proposed avoidance and minimization measures, impact levels are expected to be relatively low. Exact acres of impacts to wildlife corridors are unable to be quantified, and currently there is no real

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<sup>22</sup> City of Temecula, *Altair Specific Plan Final Environmental Impact Report* (Oct. 2017), available at <https://temeculaca.gov/DocumentCenter/View/4513/Altair-Specific-Plan-Final-Environmental-Impact-Report-FEIR>.

mechanism for compensatory mitigation for these types of impacts.”<sup>23</sup> The Northwest 138 EIR also contained no analysis of the highway’s impacts on mountain lions, given that they are not presently listed as threatened or endangered.

Indeed, CDFW has urged lead agencies to consider wildlife connectivity in CEQA planning documents, without success. For instance, the Los Angeles County General Plan Draft EIR concluded that the buildout of the General Plan “will impact regional wildlife linkages” and have a “significant adverse effect on wildlife movement.”<sup>24</sup> The Draft EIR concluded that policies proposed in the General Plan “do not provide for mitigation for loss of wildlife movement opportunities. If development impacts regional wildlife linkages and impedes wildlife movement, connectivity will be lost on a regional scale in these vital landscape corridors and linkages. Thus impacts to wildlife movement remain significant at the General Plan level.” (*Id.*) In commenting on the Draft EIR, CDFW specifically objected to this conclusion:

The Department does not concur with the conclusion in the DPEIR that unavoidable loss of wildlife movement opportunities or nursery sites within or outside of an SEA does not warrant mitigation. Without mitigation, the Project and subsequent projects would result in direct and cumulative loss of biological diversity. Mitigation opportunities for wildlife corridors and nursery sites are best established during large scale planning efforts such as this General Plan. Wildlife corridor areas can be delineated and set aside in the General Plan for current and future conservation efforts. An assessment could be placed on development within the Project area to secure the acquisition of these critical linkages and sites, therefore reducing impacts to wildlife corridors and nursery sites and ensuring biological diversity.<sup>25</sup>

In responding to this comment, Los Angeles County refused to implement CDFW’s recommendations, claiming “it cannot be assumed that wildlife corridor areas for future conservation that can be set aside because those properties may not become publicly owned.” (*Id.*) Los Angeles County’s responses to CDFW’s recommendations underscore that lead agencies have not interpreted CEQA to include a clear legal mechanism for mitigation for impacts on wildlife connectivity, even though such connectivity is critical to the survival of Southern California and Central Coast mountain lions.

### 8.1.3 Significant Natural Areas Program

The Significant Natural Areas Program (“SNAP”) requires CDFW to develop and maintain a spatial data system that identifies those areas in the state that are most essential for maintaining habitat connectivity, including wildlife corridors and habitat linkages. (Cal. Fish & Game Code § 1932(b).) SNAP also requires CDFW to consult with other government agencies and stakeholders to identify natural areas deemed to be most significant. (Cal. Fish & Game

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<sup>23</sup> State of California Department of Transportation, *Northwest State Route 138 Corridor Improvement Project Final Environmental Impact Report / Environmental Impact State and Section 4(f) Evaluation* (June 2017), available at <https://www.metro.net/projects/nw138/nw138-FEIR-FEIS/>.

<sup>24</sup> County of Los Angeles, *Los Angeles County General Plan Update Draft Environmental Impact Report* (June 2014), available at [http://planning.lacounty.gov/assets/upl/project/gp\\_2035\\_deir.pdf](http://planning.lacounty.gov/assets/upl/project/gp_2035_deir.pdf).

<sup>25</sup> County of Los Angeles, *Los Angeles County General Plan Update Final Environmental Impact Report* (March 2015), available at [http://planning.lacounty.gov/assets/upl/project/gp\\_2035\\_lac-gpu-final-eir-final.pdf](http://planning.lacounty.gov/assets/upl/project/gp_2035_lac-gpu-final-eir-final.pdf).

Code § 1932(f.) SNAP further requires CDFW to seek maintenance and perpetuation of the state’s most significant natural areas for present and future generations in the most feasible manner. (Cal. Fish & Game Code § 1932(g).)

However, SNAP does not require or authorize any particular land use action or decision. (Cal. Fish & Game Code § 1932.5.) Likewise, SNAP does not change or prevent the change of use of any area identified pursuant to the program. (Cal. Fish & Game Code § 1933.) It therefore does not *require* any particular natural areas to be conserved. Because of this, it is insufficient to protection wildlife connectivity essential to the survival of Southern California and Central Coast mountain lions.

#### 8.1.4 Natural Community Conservation Planning Act

The Natural Community Conservation Planning Act is a voluntary conservation planning mechanism for proposed development projects within a planning area to avoid or minimize impacts to wildlife. (Cal. Fish & Game Code § 2801(f).) The NCCP Act is designed to promote coordination among agencies and landowners to conserve unfragmented habitat areas and multihabitat management. (Cal. Fish & Game Code § 2801(d).)<sup>26</sup>

There are no Natural Community Conservation Plans (“NCCPs”) that cover the Santa Monica Mountains or San Gabriel Mountains. There are a few NCCPs that cover portions of the Santa Ana Mountains and Eastern Peninsular Ranges, some of which also act as “habitat conservation plans” or “HCPs” pursuant to the Federal Endangered Species Act (16 U.S.C. § 1539). These include the County of Orange (Central Coastal) NCCP/HCP, the Orange County Transportation Authority NCCP/HCP, Western Riverside County Multiple Species HCP, San Diego Multiple Habitat Conservation Program, San Diego Multiple Species Conservation Program, and the San Diego North County Multiple Species Conservation Plan. There also is an NCCP that covers the Coachella Valley and portions of the San Bernardino Mountains called the Coachella Valley NCCP/HCP.

Of these NCCPs, only four “cover” portions of the Southern California mountain lion populations: (1) Western Riverside County Multiple Species HCP; (2) San Diego Multiple Habitat Conservation Program; (3) San Diego County Multiple Species Conservation Program; and (4) San Diego North County Multiple Species Conservation Plan.<sup>27</sup> Below is a discussion of each as they relate to mountain lions:

- (1) The Western Riverside County Multiple Species HCP acknowledges that the SAM mountain lion population is at high risk of extirpation due to demographical instability unless there is a “movement connection between the Santa Ana Mountains

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<sup>26</sup> The NCCP Act also is described on CDFW’s website at <https://www.wildlife.ca.gov/conservation/planning/NCCP>.

<sup>27</sup> California Department of Fish and Wildlife, *Conservation Plans By Species*, available at <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=108719&inline>. Both San Diego Gas & Electric and San Diego County Water Authority are permittees of HCPs/NCCPs covering mountain lions, but these only apply to activities undertaken by these entities.



and the Palomar Mountains.”<sup>28</sup> However, mountain lions are considered to be “adequately conserved.”<sup>29</sup> As such, the Western Riverside County Multiple Species HCP offers little protection for the SAM mountain lion population. While this HCP does identify linkages designed to ensure connectivity for mountain lions, the Western Riverside County Regional Conservation Authority has failed to enforce the HCP to protect such linkages when permittees such as the City of Temecula approve development that would severely constrict or impair such linkages.

- (2) The San Diego Multiple Habitat Conservation Program is an NCCP and HCP that purportedly covers mountain lions, but the program readily concedes that mountain lions (as well as deer) “were not a major consideration in linkage design.”<sup>30</sup> In addition, the EIR/EIS states that “[d]ue to the limited availability of habitat in the study area, implementation of the MHCP is not expected to substantially increase or decrease the population viability of the mountain lion.”<sup>31</sup> The EIR/EIS likewise concludes there are no major populations or critical locations for the mountain lion within the plan area, and concludes it is “adequately conserved” under the plan. (*Id.*)
- (3) The San Diego Multiple Species Conservation Program is an NCCP and HCP that covers 900 square miles in the southwestern portion of the San Diego. The Program lists mountain lions as “conserved” and states that mountain lions “will be covered by the MSCP because 81% of the core areas (105,000± acres) that support its habitat will be conserved.”<sup>32</sup> While the Program generally notes that linkage areas were designed to accommodate “large animal movement,” the Program does not identify any linkages designed for mountain lions or any specific measures designed to protect them. Likewise, while the Program states that “[s]pecific design criteria for linkages and road crossings/undercrossings are included in subarea plans,” not all subarea plans are complete.

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<sup>28</sup> Western Riverside County Regional Conservation Authority, *Western Riverside County MSHCP Species Accounts*, available at [http://wrcrca.conserveriverside.com/wrcrca/Permit\\_Docs/MSHCP\\_Docs/volume2/vol2-secb\\_Mammals.pdf](http://wrcrca.conserveriverside.com/wrcrca/Permit_Docs/MSHCP_Docs/volume2/vol2-secb_Mammals.pdf).

<sup>29</sup> Western Riverside County Regional Conservation Authority, *Western Riverside County Multiple Species Habitat Conservation Plan*, available at [http://wrcrca.conserveriverside.com/wrcrca/Permit\\_Docs/MSHCP\\_Docs/volume1/Vol1-sec2.pdf](http://wrcrca.conserveriverside.com/wrcrca/Permit_Docs/MSHCP_Docs/volume1/Vol1-sec2.pdf).

<sup>30</sup> San Diego Association of Governments, *San Diego Multiple Habitat Conservation Program Biological Monitoring and Management Plan (Volume III)* (Mar. 2003), available at [https://www.sandag.org/programs/environment/habitat\\_preservation/mhcp\\_vol3.pdf](https://www.sandag.org/programs/environment/habitat_preservation/mhcp_vol3.pdf).

<sup>31</sup> San Diego Association of Governments, *Final Environmental Impact Statement/Environmental Impact Report for Threatened and Endangered Species Due to Urban Growth within the Multiple Habitat Conservation Program Planning Area* (Mar. 2003), available at [https://www.sandag.org/programs/environment/habitat\\_preservation/mhcp\\_eir\\_voll.pdf](https://www.sandag.org/programs/environment/habitat_preservation/mhcp_eir_voll.pdf).

<sup>32</sup> County of San Diego, *Final Multiple Species Conservation Program* (Aug. 1998), available at <https://www.sandiegocounty.gov/content/dam/sdc/pds/mscp/docs/SCMSCP/FinalMSCPPProgramPlan.pdf>.

- (4) The San Diego North County Multiple Species Conservation Plan is one of the “subarea” plans anticipated by San Diego Multiple Species Conservation Program. However, it has not been completed and is still “in development.”<sup>33</sup>
- (5) The Orange County Transportation Authority NCCP/HCP (“OCTA Plan”) lists the mountain lion as a covered species for purposes of the federal HCP, but not for purposes of the NCCP permit. The OCTA Plan acknowledges that despite protection from hunting, annual survival for radio-collared lions is “surprisingly low” at 55.8 percent and that vehicle collisions and depredation permits are primary sources of mortality. The OCTA Plan states that targeted investment in habitat protection is “especially urgent to maintain viability of the Santa Ana Mountains populations.”<sup>34</sup> The OCTA Plan does contain four “Species Goals” for mountain lions, including (1) acquiring 1,013 acres of suitable habitat; (2) fencing realignment near the Highway 241 toll road; (3) funding of the North Coal Canyon Restoration Project; and (4) a “wildlife crossing policy” requiring pre-construction surveys to ensure existing crossings “maintain or improve functionality” if modified by new freeway projects. However, despite allowing the expansion of two highways in lion habitat (Projects G and J), the OCTA Plan does not require the construction of any specific wildlife crossings. The OCTA Plan nonetheless claims that impacts on the mountain lion will be offset through these “Species Goals.”

There are no NCCPs that cover the Central Coast. In addition, there are no NCCPs that cover portions of the Santa Cruz Mountains except the Santa Clara Valley Habitat Plan. However, this Plan does not cover mountain lions.

## 8.2 Federal Regulatory Mechanisms

### 8.2.1 National Environmental Policy Act

The National Environmental Policy Act (“NEPA”) is the nation’s charter for protection of the environment. (40 C.F.R. § 1500.1(a).) NEPA is designed to ensure that environmental information is available to the public *before* decisions are made or actions taken and to help public officials make decisions based on an understanding of the environmental consequences. (40 C.F.R. § 1500.1(b)-(c).) Federal agencies must prepare an environmental impact statement (“EIS”) if it is known that an action will significantly affect the environment, or an environmental assessment (“EA”) if the extent of effects are unknown. (42 U.S.C§ 4332; 40 C.F.R. §§ 1502.3 & 1508.9.) NEPA further requires federal agencies to analyze reasonable alternatives to the proposed project. (40 C.F.R. § 1502.14(a)-(c).) NEPA requires the federal agency to consider the degree of adverse effect on a species or its critical habitat designated pursuant to the Federal Endangered Species Act. (*Conservation Cong. v. United States Forest Serv.* (E.D.Cal. 2017) 235 F.Supp.3d 1189, 1207.)

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<sup>33</sup> County of San Diego, *Multiple Species Conservation Program*, available at <https://www.sandiegocounty.gov/pds/mscp/>.

<sup>34</sup> Orange County Transportation Authority, *Natural Community Conservation Plan/Habitat Conservation Plan* (Nov. 2016), available at <https://www.octa.net/pdf/NCCP%20HCP%20FINAL.pdf>.

However, agencies have not interpreted NEPA as requiring analysis of impacts to populations that are not currently listed as threatened or endangered, such as the Southern California or Central Coast mountain lions. For instance, Caltrans prepared an Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment for the State Route 118 Widening Project (the “State Route 118 EA”) in October 2017 pursuant to NEPA and CEQA. The State Route 118 EA contains no analysis of whether adding more traffic lanes to State Route 118 will impact mountain lions or degrade wildlife connectivity even though multiple mountain lions have died recently attempting to cross State Route 118.<sup>35</sup>

NEPA also is insufficient to protect Southern California and Central Coast mountain lions because courts have interpreted NEPA as primarily a “procedural” statute. While NEPA does require federal agencies to consider detailed information regarding a project’s environmental effects, “NEPA itself does not mandate particular results.” (*Winter v. NRDC, Inc.* (2008) 555 U.S. 7, 23.)

### 8.3 Regional and Local Plans and Policies

#### 8.3.1 Santa Monica Mountains National Recreation Area General Management Plan

The Santa Monica Mountains National Recreation Area General Management Plan (“GMP”) was prepared pursuant to NEPA and provides a framework for the management of the Santa Monica Mountains National Recreation Area (“SMMNRA”), which is administered by the National Park Service, California State Parks, and the Santa Monica Mountains Conservancy. The GMP recognizes that the Santa Monica Mountains mountain lion population’s ability to survive in the face of large-scale habitat fragmentation and destruction is uncertain.<sup>36</sup> (GMP at 154.) The GMP states that “it is likely that their persistence [] would depend upon their capability of dispersing to and from other habitat areas beyond the Santa Monica Mountains.” (GMP at 154; see also GMP at 157.) The GMP identifies the “greatest threat” to natural resource preservation in the SMMNRA as “loss of habitat connectivity from increased development and urban encroachment.” (*Id.* at 157.) The GMP concedes that “the situation is especially serious for mountain lions” and lists mountain lions as a “park species of concern.” (*Id.* at 157 & 161.) The GMP agrees that improvements to facilitate wildlife movement across freeways or through developments may be necessary, but does not propose or require any specific actions to improve wildlife movement across freeways or through development.

The preferred alternative in the GMP provides for enhancing connectivity of undisturbed habitats in the SMMNRA by creating large expanses of open space. (*Id.* at 292.) In addition, the Las Virgenes Canyon and Liberty Canyon areas are included within the SMMNRA boundary to help provide wildlife connectivity for mountain lions and other large species. (*Id.* at 293.) Even though the GMP recognizes the threats facing the Santa Monica Mountains mountain lion

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<sup>35</sup> National Parks Traveler, *Another Mountain Lion Killed Near Santa Monica Mountains National Recreation Area* (Jan. 27, 2017), available at <https://www.nationalparkstraveler.org/2017/01/another-mountain-lion-killed-near-santa-monica-mountains-national-recreation-area>.

<sup>36</sup> National Park Service, U.S. Department of Interior, *Santa Monica Mountains National Recreation Area General Management Plan Environmental Impact Statement* (July 2002), available at <https://www.nps.gov/samo/learn/management/loader.cfm?csModule=security/getfile&PageID=383979>.

population and takes steps to protect this population, the GMP does not apply to lands outside of the SMMNRA and thus is insufficient to address the regional connectivity issues facing the population. Nor does the GMP apply to roads and highways under Caltrans' jurisdiction.

### 8.3.2 Ventura County Wildlife Connectivity Ordinance

The Ventura County Board of Supervisors adopted an ordinance on March 12, 2019 (the "Connectivity Ordinance") to help facilitate wildlife connectivity and minimize habitat fragmentation for mountain lions, mule deer, California gnatcatchers, bobcats, least bell's vireos, California red-legged frogs, and other species. The Connectivity Ordinance establishes overlay zones called "habitat connectivity and wildlife corridors" ("HCWCs") and "critical wildlife passage areas" ("CWPAAs") in which development standards and permitting requirements apply. Development standards include 200-foot setbacks from surface water features such as streams and wetlands, limits on certain wildlife impermeable fencing, encouraging compact siting of development, and prohibiting non-commercial planting of invasive plants. Two of the linkages targeted in the Connectivity Ordinance are the Santa Monica Mountains – Sierra Madre Mountains connection and the Sierra Madre Mountains – Castaic Connection, which connect wildlife habitat in the Santa Monica Mountains, Santa Susana Mountains, Simi Hills, and Los Padres National Forest.

While the Connectivity Ordinance should help allow wildlife to move more easily through private lands between core habitat areas, it would do little to ensure connectivity across major roads and highways because Ventura County does not have jurisdiction over these areas. The ordinance would, however, establish 200-foot setbacks from the exit and entry points of 25 existing road crossings in order to facilitate wildlife movement through the crossings. Caltrans and its road maintenance and improvement activities are not regulated by the Connectivity Ordinance. The Connectivity Ordinance is therefore a step in the right direction but insufficient on its own to address the threats facing the CC-S mountain lion population.

### 8.3.3 Los Angeles County Significant Ecological Areas Program

Los Angeles County is currently in the process of updating the Significant Ecological Areas ("SEAs") Ordinance. The draft ordinance is intended to protect biodiversity in SEAs from incompatible development and ensure that projects reduce habitat fragmentation and edge effects by providing technical review of impacts and requiring mitigation.<sup>37</sup> Like the Ventura County ordinance, the SEAs designations can lead to compact development and allow wildlife to more easily move across private lands between core habitat areas. However, the SEA ordinance is not specifically designed to protect mountain lions and would not regulate Caltrans and its road maintenance and expansion activities.

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<sup>37</sup> Los Angeles County Department of Regional Planning, *Significant Ecological Areas Ordinance Update, Public Hearing Draft* (Feb. 14, 2019), available at <http://planning.lacounty.gov/site/sea/wp-content/uploads/2019/02/EX-C-SEA-Ordinance-Public-hearing-Draft-2-14-2019.pdf>

#### 8.4 *Future Development Will Further Threaten the Survival of Southern California Mountain Lions*

Continued development in Southern California is expected to further impair connectivity between core habitat areas, leading to further decreases in genetic diversity for Southern California mountain lions. In the environmental review for Southern California national forest land management plans, the U.S. Forest Service found that impaired connectivity poses a serious threat to Southern California mountain lions: the “greatest concern for the long-term health of mountain lion populations on the national forests of southern California is loss of landscape connectivity between mountain ranges and large blocks of open space on private land.”<sup>38</sup> The review warned that private land development in Southern California is “steadily reducing the habitat linkages that wildlife species need to connect large blocks of national forest land with other public and private natural spaces and habitat reserves.” The review observed that the “widening of the existing highway system and new highways” are a threat to mountain lions because they create barriers to movement. The review concluded that “[w]ithout the national forests and linkages between the mountain ranges and other large habitat preserves, *there is not much long term potential for mountain lions in southern California.*” The review noted that maintenance and restoration of corridors between large wildlands is essential to conserving mountain lions in Southern California

As anticipated by the U.S. Forest Service’s environmental review, private land development is currently being approved on linkage areas without sufficient mitigation for Southern California mountain lions or wildlife connectivity. For instance, the 1,000-acre Northlake Specific Plan (“Northlake”) was approved by the Los Angeles County Board of Supervisors on April 2, 2019. The Santa Monica Mountains Conservancy (“SMMC”) formally objected to the Board’s approval of Northlake, noting that the development would degrade a known wildlife linkage between the Angeles National Forest and Los Padres National Forest.<sup>39</sup> CDFW raised similar concerns about the development because it would impair a linkage that is “highly suitable for regional wildlife movement and connectivity” for mountain lions and other species.<sup>40</sup> The Board of Supervisors approved Northlake notwithstanding the objections and concerns of SMMC and CDFW.

Likewise, the Los Angeles County Board of Supervisors approved the 12,000-acre Centennial Specific Plan (“Centennial”) on April 30, 2019, despite SMMC warning the Board that Centennial “would sever the most optimal five-mile-wide habitat linkage across Highway 138 between I-5 and State Route 14.”<sup>41</sup>

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<sup>38</sup> Forest Service, U.S. Department of Agriculture, *Final Environmental Impact Statement, Land Management Plans, Angeles National Forest Cleveland National Forest Los Padres National Forest San Bernardino National Forest* (Sept. 2005), available at [https://www.fs.usda.gov/Internet/FSE\\_DOCUMENTS/stelprdb5166889.pdf](https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5166889.pdf).

<sup>39</sup> Santa Monica Mountains Conservancy, *Draft Supplemental Environmental Impact Report Comments on Northlake Specific Plan Project*, May 22, 2017.

<sup>40</sup> California Department of Fish and Wildlife, *Draft Supplemental Environmental Impact Report Comments on Northlake Specific Plan*, June 12, 2017.

<sup>41</sup> Santa Monica Mountains Conservancy, *Centennial Project Draft Environmental Impact Report Comments County Project No. 02-232*, July 17, 2017.



In the SAM, key linkage and habitat areas remain unprotected and subject to potential or actual development. The Altair Specific Plan discussed in *Section 8 Inadequacy of Existing Regulatory Mechanisms* exemplifies this trend. Other lands in the Santa Ana-Palomar Mountain linkage have been subject to development proposals such as the Temecula Creek Inn (Vickers 2015). The Orange County Board of Supervisors also approved a 6,000-acre development in the Santa Ana Mountains in the “center of puma habitat” (Vickers 2015).<sup>42</sup>

Development in wildlands and linkages will intensify as Southern California’s population increases. The Southern California Association of Governments (“SCAG”) Program EIR estimates that between 2016 and 2040 the Southern California region will grow by 3.8 million residents and 1.5 million households.<sup>43</sup> The SCAG Program EIR concludes that transportation projects within the SCAG region such as “mixed flow lane projects” and “grade separation projects” may result in significant impacts on wildlife movement, including direct habitat removal and fragmentation that would disrupt corridor functionality. The SCAG Program EIR also acknowledges that “an increase in wildlife-roadway interactions as a result of the development of new transportation projects may increase wildlife injury and fatalities.”

The SCAG Program EIR recognizes that “[b]arriers to wildlife movement exist throughout the SCAG region, including large areas of urban development and multilane freeways that cut off regional movement corridors for large migratory species such as mountain lions (*Puma concolor*).” SCAG Program EIR further notes that “wildlife crossings serve to alleviate these barriers and facilitate wildlife movement through the region” and references the planned Liberty Canyon Crossing. However, the Program EIR does not identify any other planned crossings or identify funding for the Liberty Canyon Crossing.

The SCAG Program EIR also confirms that only portions of the lands in the Santa Monica Mountains, SAM, SGSB, and EPR are designated as “open space and recreation” or “undevelopable and protected.” Indeed, much of these lands are designated for single family residential or mixed residential. At this time, there are also “vast areas” in Southern California that are undeveloped but are not designated as open space or are otherwise protected, according to SCAG. In addition, agricultural lands are rapidly being converted to urban development throughout Southern California with an estimated 230,000 acres converted between 1996 and 2004 and up to 700,000 acres may be converted by 2030. In short, SCAG recognizes that wildlife connectivity will become even more impaired in the Southern California region due to anticipated growth, but SCAG does not offer any solutions to address the effects of this impaired connectivity on Southern California mountain lions.

Other studies confirm that much of the remaining mountain lion habitat in Southern California is on unprotected lands and at risk of development. According to Burdett et al. (2010), almost half of suitable mountain lion habitat in Southern California (since 1970) is on private lands, of which 35% will be developed by 2030, and other currently contiguous habitat will

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<sup>42</sup> See also Chris Boucly, “New community coming to South County,” *The Orange County Register* (Mar. 24, 2012), available at <https://www.ocregister.com/2012/03/24/new-community-coming-to-south-county/>

<sup>43</sup> Southern California Association of Governments, *Draft Program Environmental Impact Report* (Dec. 2015), available at [http://scagrtpscs.net/Documents/2016/peir/draft/2016dPEIR\\_Complete.pdf](http://scagrtpscs.net/Documents/2016/peir/draft/2016dPEIR_Complete.pdf).

become fragmented. Hunter et al. (2003) similarly found that 30% of high suitability mountain lion habitat and 76% of medium suitability mountain lion habitat in Southern California is not protected from development. In addition, Zeller et al. (2017) found that only 35% of resource-use patches and 47% of corridors identified in their study area, which encompassed much of the SAM and EPR, were fully protected. Given the extreme isolation, low genetic diversity, and high adult mortality rates from vehicle strikes and depredation kills, increased efforts to protect the species and their habitat are warranted.

Within Riverside County, which covers a significant portion of the Santa Ana Mountains, population growth is expected to be especially high; the Riverside County General Plan predicts that the County's population and housing stock will increase to 3.6 million people and 1.3 million dwelling units by 2035, which constitutes a 65 percent increase.<sup>44</sup> Within San Bernardino County, which encompasses portions of the San Bernardino and San Gabriel Mountains, more than 630,000 people will be added to the County along with 230,000 homes.<sup>45</sup> As urban development overtakes mountain lion habitat and linkage areas throughout the region, conflict with mountain lions, and consequent killing of lions under depredation permits will likely increase. Similarly, use of anticoagulant rodenticides and other environmental toxicants in these areas will likely increase, leading to increased illness and fatalities to "non-target organisms" such as Southern California mountain lions.

Caltrans and local transportation agencies are expected to continue building and expanding roads and highways in Southern California to accommodate actual and anticipated vehicles and development. Caltrans' 2018 State Transportation Improvement Program ("STIP") lists many large-scale road and highway projects planned for Southern California.<sup>46</sup> These include converting SR-71 to a four- and six-lane freeway as well as adding more lanes to the I-15 Freeway adjacent to the SAM,<sup>47</sup> which already acts as a nearly impenetrable barrier to the SAM and EPR mountain lion populations. As noted in *Section 8 Inadequacy of Existing Regulatory Mechanisms*, Caltrans has certified an EIR/EIS to convert the existing two-lane SR-138 into a four or six-lane highway, which will create major barrier between the Tehachapi Mountains and Angeles National Forest. Caltrans also intends to widen SR-118, which will further impair connectivity between the Santa Monica Mountains and Santa Susana Mountains to the detriment of the Santa Monica Mountains mountain lions. There are numerous other road and highway projects planned for Southern California in the next few years.<sup>48</sup> These projects will be funded in part by SB 1, which will raise approximately \$52 billion over 10 years.

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<sup>44</sup> County of Riverside, *Riverside County General Plan Environmental Impact Report No. 521* (March 2014), available at [https://planning.rctlma.org/Portals/14/genplan/general\\_plan\\_2014/EnvironmentalImpactReport/03-0\\_ProjectDescription\\_2014-04-07.pdf](https://planning.rctlma.org/Portals/14/genplan/general_plan_2014/EnvironmentalImpactReport/03-0_ProjectDescription_2014-04-07.pdf).

<sup>45</sup> San Bernardino County, *Countywide Plan Growth Forecast*, available at [http://countywideplan.com/wp-content/uploads/2018/08/CWP\\_OH\\_GrowthForecast\\_FINAL\\_20180809.pdf](http://countywideplan.com/wp-content/uploads/2018/08/CWP_OH_GrowthForecast_FINAL_20180809.pdf).

<sup>46</sup> California Department of Transportation, *2018 Report on STIP Balances County and Interregional Shares* (Aug. 1, 2018), available at [http://www.catc.ca.gov/programs/stip/2018-stip/2018\\_ORANGE\\_BOOK.pdf](http://www.catc.ca.gov/programs/stip/2018-stip/2018_ORANGE_BOOK.pdf).

<sup>47</sup> Riverside County Transportation Commission, *I-15 Express Lanes Project Southern Extension*, <https://www.rctc.org/i15-express-southern-extension/>

<sup>48</sup> Kurt Snibbe, "Here are the major highway improvement projects happening in Southern California through 2023," *Orange County Register* (Jan. 23, 2018), <https://www.ocregister.com/2018/01/23/here-are-maps-and-a-list-of-the-major-highway-improvement-projects-in-southern-california/>; Jeong Park, "2019 will be a busy year for big road construction projects in Orange County," *Orange County Register* (Dec. 31, 2018),

Along with this expansion in roads and highways will come an increase in automobile use: SCAG predicts that the number of vehicle miles travelled (“VMT”) in the region is expected to increase 13.3 percent by 2040 (from 448 million VMT per day to 504 million VMT per day). This significant increase in automobile use will further impair connectivity and lead to more collisions between automobiles and lions.

### 8.5 *Future Development Will Further Threaten the Survival of Central Coast Mountain Lions*

Future development and highway expansion in the San Francisco Bay Area and Central Coast is anticipated to further fragment habitat for Central Coast mountain lion populations and will increase threats to their survival.

The Association of Bay Area Governments’ Plan Bay Area projects that the population of the San Francisco Bay Area is expected to increase from 7.2 million to 9.3 million by 2040—a 30 percent increase.<sup>49</sup> This includes a 26 percent increase in San Mateo County and a 36 percent increase in Santa Clara County, both of which encompass significant portions of the Santa Cruz Mountains. The Plan Bay Area also envisions a 25 percent increase in housing units in San Mateo County, and a 31 percent increase in Santa Clara County.

The Greenbelt Alliance’s “At Risk” Report (“Greenbelt Report”) estimates that 22,700 acres in San Mateo County are at medium or high risk for development, significant portions of which are in the Santa Cruz Mountains.<sup>50</sup> The Greenbelt Report shows that only 113,000 acres of the Santa Cruz Mountains are permanently protected and warns that San Mateo County has planned to develop housing in remote areas on the eastern slope of the Santa Cruz Mountains. The Greenbelt Report estimates that Santa Clara County has 54,100 acres at high or medium risk of development, significant portions of which are in the Santa Cruz Mountains and eastern foothills. The Greenbelt Report further shows that while large swaths of the eastern Santa Cruz Mountains are currently at “low risk” for development, only fragmented portions enjoy permanent protection.

Similarly, the EIR for the Plan Bay Area 2040 notes that land use growth footprints overlap with approximately 1,040 acres of “Essential Connectivity Areas” or “ECAs.”<sup>51</sup> The EIR claims these growth footprints are in already urbanized corridors that are degraded so that their function as linkages is limited. The EIR acknowledges that development projects may directly encroach on wildlife corridors, but does not provide any plan to address the effects of

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<https://www.ocregister.com/2018/12/31/2019-will-be-a-busy-year-for-big-road-construction-projects-in-orange-county/>.

<sup>49</sup> Metropolitan Transportation Commission and Association of Bay Area Governments, *Bay Area Plan: A Strategy for A Sustainable Region* (July 18, 2013), available at [http://files.mtc.ca.gov/pdf/Plan\\_Bay\\_Area\\_FINAL/Plan\\_Bay\\_Area.pdf](http://files.mtc.ca.gov/pdf/Plan_Bay_Area_FINAL/Plan_Bay_Area.pdf).

<sup>50</sup> Greenbelt Alliance, *At Risk 2017* (May 2017), available at <https://www.greenbelt.org/at-risk-2017/>.

<sup>51</sup> Metropolitan Transportation Commission and Association of Bay Area Governments, *Draft Environmental Impact Report for Plan Bay Area 2040* (April 2017), available at [http://2040.planbayarea.org/cdn/farfuture/JHbwWZgw24OSpVBL0b8cJ5\\_2KH0dckVexpYp5McOkI/1499352691/sites/default/files/2017-07/PBA%202040%20DEIR\\_0\\_1.pdf](http://2040.planbayarea.org/cdn/farfuture/JHbwWZgw24OSpVBL0b8cJ5_2KH0dckVexpYp5McOkI/1499352691/sites/default/files/2017-07/PBA%202040%20DEIR_0_1.pdf).

such encroachment. In addition, Caltrans has a number of highway improvement projects planned in Santa Clara and San Mateo counties.<sup>52</sup>

There also is development pressure on the Pajaro Hills linkage, which is important to the Central Coast North mountain lion population and connects the Santa Cruz Mountains and Gabilan Range.<sup>53</sup> The Land Trust of Santa Cruz County notes that while a few large ranches cover most of the Pajaro Hills, many of the properties are parcelized, creating the potential for development which would fragment the landscape. Only 8 percent of the Pajaro Hills is permanently protected.

Growth is expected to increase in the Monterey Bay Area, leading to further fragmentation of natural habitats by urban or exurban development. The Association of Monterey Bay Area Governments predicts that the population in the Monterey Bay Area will rise from 755,403 in 2015 to 883,300 in 2040.<sup>54</sup> The Land Trust of Santa Cruz County notes that while high rates of conversion of forests, rangeland and farmland has largely been prevented in Santa Cruz County, exurban development, roads and mining are fragmenting wildlife habitat. Vineyard conversion adjacent to Zayante, Beer Creek, and Summit roads is causing habitat fragmentation in one of the largest intact habitat patches connecting Santa Cruz and Santa Clara counties. The Land Trust of Santa Cruz County estimates that only 44 percent of the large patches of intact habitat are protected. The Conservation Lands Network likewise confirms that much of the Santa Cruz Mountains do not currently qualify as protected areas.<sup>55</sup>

In San Luis Obispo County, the population is expected to increase by 41,650 between 2015 and 2045.<sup>56</sup> The sparsely populated North Coast region of San Luis Obispo County is currently characterized by ranchlands, rural development, and open space. However, the San Luis Obispo Council of Governments (“SLOCOG”) predicts more population growth in this region as compared to other regions. SLOCOG also predicts significant increases in traffic volumes on Highway 101 throughout San Luis Obispo County. The US 101 Corridor Mobility Master Plan also contains various proposals to expand the Interstate 101 freeway in San Luis Obispo County, including adding more lanes to the freeway.<sup>57</sup> There are also proposals to widen portions of State Route 46, the western portions of which bisect mountain lion habitat. The Caltrans State Route 46 Corridor System Management Plan concedes that widening segments 2 and 3 of State Route 46 “could present additional barriers to animal movements by further

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<sup>52</sup> Caltrans District 4, *Projects By County*, available at [http://www.dot.ca.gov/d4/projects\\_list.htm](http://www.dot.ca.gov/d4/projects_list.htm).

<sup>53</sup> Land Trust of Santa Cruz County, *A Conservation Blueprint* (May 2011), available at [https://landtrustsantacruz.org/blueprint/conservation-blueprint\\_low-res\\_110522.pdf](https://landtrustsantacruz.org/blueprint/conservation-blueprint_low-res_110522.pdf).

<sup>54</sup> Association of Monterey Bay Area Governments, *2040 Metropolitan Transportation Plan/Sustainable Communities Strategy* (June 2018), available at [http://ambag.org/programs/met\\_transp\\_plann/documents/Final\\_2040\\_MTP\\_SCS/AMBAG\\_MTP-SCS\\_Final\\_EntireDocument.pdf](http://ambag.org/programs/met_transp_plann/documents/Final_2040_MTP_SCS/AMBAG_MTP-SCS_Final_EntireDocument.pdf).

<sup>55</sup> Conservation Lands Network, *1.0 Progress Report* (2014), available at <https://www.bayarealands.org/wp-content/uploads/2017/07/CLN-1.0-Progress-Report.pdf>.

<sup>56</sup> San Luis Obispo Council of Governments, *2019 Regional Transportation Plan Public Review Draft* (Feb. 2019), available at <https://www.dropbox.com/s/6pysudp1g36n4a5/Public%20Rev%20draft.pdf?dl=0>.

<sup>57</sup> San Luis Obispo County of Governments, *US 101 Corridor Mobility Master Plan* (Sept. 2014), available at [http://www.dot.ca.gov/hq/tpp/offices/ocp/5\\_SLOCOG%20101\\_executive\\_summary\\_draft\\_9%2019%2014.pdf](http://www.dot.ca.gov/hq/tpp/offices/ocp/5_SLOCOG%20101_executive_summary_draft_9%2019%2014.pdf).

dividing large, contiguous wildlife habitat areas.”<sup>58</sup> There are numerous other road and highway expansion projects planned for Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara counties.<sup>59</sup> The expansion of existing roads and highways along with increased numbers of automobiles will further impair connectivity in the Central Coast region.

## **9 CESA Listing for Southern California and Central Coast Mountain Lions Would Supplement Proposition 117’s Protections.**

### *9.1 CESA Listing is Consistent with Proposition 117.*

CESA protections for Southern California and Central Coast mountain lions are consistent with and supplemental to those established by Proposition 117. Both CESA and Proposition 117 include “take prohibitions”—CESA makes it unlawful for any person or agency to import, export, take, possess, or purchase a listed species. (Cal. Fish & Game Code § 2080.) By the same token, Proposition 117 makes it unlawful to take, injure, possess, transport, import, or sell a mountain lion. (Cal. Fish & Game Code § 4800(b).)

Both CESA and Proposition 117’s take prohibitions are subject to certain exceptions. Under CESA, CDFW may authorize that a person, agency, or institution take a listed species “for scientific, educational, or management purposes.” (Cal. Fish & Game Code § 2081(a).) CESA defines scientific resources management activities to include “research, census, law enforcement, habitat acquisition, restoration and maintenance, propagation, live trapping, and, transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, [] regulated taking.” (*San Bernardino Valley Audubon Society v. City of Moreno Valley* (1996) 44 Cal.App.4th 593, 604, quoting Cal. Fish & Game Code § 2061.) The regulations implementing CESA also allow for the take of a listed species for management or law enforcement purposes: “Department wildlife management activities. The possession or take of endangered, threatened, or candidate species by employees and agents of the Department for scientific, educational and management purposes, and for law enforcement purposes, is not prohibited.” (Cal. Code Regs., tit. 14, § 783.1(c).) As discussed above in *Section 8 Inadequacy of Existing Regulatory Mechanisms*, Proposition 117 also contains exceptions which allow for the take of mountain lions in certain circumstances. These exceptions are sufficiently similar that in most cases take of mountain lions properly authorized by Proposition 117 could be consistent with CESA’s exceptions for wildlife management activities or law enforcement purposes. (Cal. Code Regs., tit. 14, § 783.1(c).)

### *9.2 CESA Listing Would Further the Goals of Proposition 117.*

CESA listing would further Proposition 117’s goals of protecting and restoring wildlife habitat as human populations increase. (Cal. Fish & Game Code § 2780(a).) CESA listing would also help preserve “corridors of natural habitat [] to maintain the genetic integrity” of mountain lions in the Santa Monica Mountains, Santa Ana Mountains, Santa Susana Mountains, Simi Hills, and Coast Range. (Cal. Fish & Game Code § 2780(a).)

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<sup>58</sup> Caltrans, *State Route 46 Corridor System Management Plan* (June 2009), available at [http://www.dot.ca.gov/hq/tpp/corridor-mobility/CSMPs/d5\\_CSMPs/SR%2046/SR-46%20CSMPo100.pdf](http://www.dot.ca.gov/hq/tpp/corridor-mobility/CSMPs/d5_CSMPs/SR%2046/SR-46%20CSMPo100.pdf).

<sup>59</sup> Caltrans District 5, *Projects By County*, available at <http://www.dot.ca.gov/d5/>.



Likewise, CESA requires that “reasonable and prudent alternatives” that will not jeopardize the existence of a listed species be developed in coordination with the project proponent and state lead agency consistent with conserving the listed species and maintaining the project purpose to the greatest extent feasible. (Cal. Fish & Game Code § 2053(b).) In the event that such alternatives are infeasible, individual projects may still be approved if appropriate mitigation measures are implemented. (Cal. Fish & Game Code § 2054.) CESA envisions these mandates will be incorporated into the CEQA process. (Cal. Fish & Game Code §§ 2064-2065; Cal. Code Regs., tit. 14, §§ 783.3 & 783.5.)

Consistent with Proposition 117, CESA further provides that it is the policy of the state to conserve and protect listed species and their habitat, including through acquiring lands for habitat. (Cal. Fish & Game Code § 2052.) Towards this end, CESA directs state agencies to utilize their authority to conserve listed species. (Cal. Fish & Game Code § 2055.) If the Southern California and Central Coast mountain lions were listed under CESA, this mandate would apply to, for example, Caltrans, which currently lacks a clear mandate to conserve these lions or habitat connectivity necessary for their continued survival.

CESA authorizes CDFW to develop and implement “nonregulatory recovery plans” for listed species with priority given to species that are or may be “significantly affected by anticipated land use changes, climate change, or changes in aquatic conditions.” (Cal. Fish & Game Code §§ 2079.1(a) & (b).) Given the strong evidence that land use changes will significantly affect (and have already significantly affected) Southern California and Central Coast mountain lions, CDFW could develop and implement a recovery plan for these lions pursuant to this provision.

In sum, CESA listing would build upon the protections in Proposition 117 by establishing an affirmative duty to ensure the survival and recovery of the Southern California and Central Coast mountain lions by, *inter alia*, (1) prohibiting the approval of projects that could jeopardize their continued existence or result in destruction of essential habitat (Cal. Fish & Game Code § 2053(a)); (2) requiring state agencies such as Caltrans to utilize their authority to conserve listed species (Cal. Fish & Game Code § 2055); and (3) requiring appropriate mitigation measures be implemented for projects that could destroy mountain lion habitat or impair connectivity (Cal. Fish & Game Code § 2054).

To the extent there is any tension between the provisions in Proposition 117 and CESA, Proposition 117 is to be “liberally construed to further its purposes.” (Prop. 117 § 9.) Because Proposition 117 and CESA both have similar purposes, Proposition 117 should be construed to be consistent with CESA.

## **10 Recommended Management and Recovery Actions**

Recommendations for the management and recovery of Southern California and Central Coast mountain lion populations are as follows:

1. Design and build crossing infrastructure in strategic locations to improve wildlife connectivity and permeability at existing roads and highways. Crossing infrastructure should include but is not limited to overcrossings, underpasses, culverts, and exclusionary fencing that guides animals to safer crossing areas. The following crossing locations have been identified by mountain lion experts and should be prioritized for the implementation of crossing infrastructure: 1) I-15 Freeway at Temecula Creek Bridge to enhance the Palomar Linkage and connect the Santa Ana and Eastern Peninsular Mountain Ranges (Gustafson et al. 2017; Zeller et al. 2017; Ernest et al. 2014; Riley et al. 2018); 2) I-15 Freeway at “Site 5” as described in Riley et al. (2018); 3) Hwy-101 at West Liberty Canyon. (Riley et al. 2018.)
2. Improve or add large culverts to existing freeways in areas suitable for mountain lion crossing. (Vickers 2015).
3. Dedicate sufficient Wildlife Conservation Board, Habitat Conservation Fund and other state funding sources towards acquiring key mountain lion habitat and for establishment of highway crossing infrastructure.
4. Ensure that suitable habitat exists (through preservation or restoration/enhancement) on both sides of crossing structures and culverts (South Coast Wildlands 2008). Restrict human activity near crossing structures and relocate foot trails away from these structures (South Coast Wildlands 2008).
5. Fully protect mountain lion habitat, including resource-use patches and corridors (Zeller et al. 2017; Vickers et al. 2015). Prohibit large-scale development in primary travel corridors and habitat linkages, such as in and around the last remaining linkage for statewide genetic connectivity in the Tehachapi and Sierra Pelona Mountains (Gustafson et al. 2018) and in corridor areas between the SAM and EPR (Gustafson et al. 2017).
6. Require analysis of region-wide wildlife connectivity in all new development proposals (Gustafson et al. 2018).
7. Reduce depredation conflicts that precipitate mountain lion deaths (Vickers et al. 2015). Develop and implement outreach and education activities to promote use of predator-proof enclosures for domestic animals. (Vickers et al. 2015.) Expand CDFW’s new three-step depredation permit policy in the CC-S and SAM areas to include all mountain lions across the state, or at a minimum, within the SGSB, EPR, CC-N, and CC-C population areas. Enhance the policy with enforceable implementation of non-lethal protective measures and reporting requirements.
8. Prohibit the use of second-generation anticoagulant rodenticides (“SGARs”), such as brodifacoum, bromadiolone, difenacoum, and difethialone in Southern California and Central Coast mountain lions’ core habitat areas and linkages. Limit the use of other pesticides and herbicides that may have negative effects on mountain lion populations in Southern California and the Central Coast.

9. Identify “priority areas” for establishing wildlife passage features for the Southern California and Central Coast mountain lions using the best available science, including data collected by various agencies, academic institutions, and organizations, including but not limited to the National Park Service, the Karen C. Drayer Wildlife Health Center at UC Davis, the Road Ecology Center at UC Davis, and the Santa Cruz Puma Project at UC Santa Cruz.
  
10. Require Caltrans to analyze how projects in the State Highway Operation Protection Program and State Transportation Improvement Program can be designed to facilitate wildlife connectivity through wildlife passage features such as culverts, undercrossings, overcrossings, bridges, directional fencing, scuppers, barrier breaks, roadside animal detection systems, etc. Require Caltrans to collect and analyze roadkill data to identify hotspots where mountain lions are killed. Require Caltrans to implement wildlife passage features to the greatest extent feasible and as expeditiously as possible.

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